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Screening Tests of Terminal Block Performance in a Simulated LOCA Environment

Charles M. Craft

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Sandia National Laboratories
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for the
U. S. Department of Energy

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Abstract

Twenty-four terminal blocks were tested in simulated Design Basis Event (DBE), Loss of Coolant Accident (LOCA) environments. The terminal blocks were powered at voltages of 4 Vdc, 45 Vdc, and 125 Vdc. Resulting currents associated with these voltage levels were 1.8 mA, 20 mA, and 1 A, respectively. Terminal-to-terminal and terminal-to-ground leakage currents were monitored on a discrete time basis throughout the test. Based on these measurements, insulation resistances were calculated. During exposure to the LOCA steam environment insulation resistance was observed to decrease from initial values of 10^8 to 10^{10} ohms to 10^2 to 10^5 ohms. These decreases in IR are interpreted as being caused by conduction in surface moisture films rather than bulk conduction through the insulation material. Insulation resistance for all applied voltage levels appear to be approximately the same. Sporadic breakdowns lasting from fractions of a second to several minutes were observed. Further, rapid increases in applied voltage caused large decreases in insulation resistance. The measured IR was also dependent upon temperature. Subsequent to the test, terminal block insulation resistance returned to acceptable levels (10^6 to 10^8 ohms), though not to pre-test levels. The comparison of spray and no-spray results shows that no discernable difference in IRs existed between the periods with and without chemical spray.

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Executive Summary

Twenty-four terminal blocks (TBs) (five models from four manufacturers) were tested in simulated Design Basis Event (DBE) Loss-of-Coolant Accident (LOCA) environmental conditions. The environmental exposure profiles closely followed the recommended qualification profiles for temperature of IEEE 323-1974 Appendix A [1]. The primary objective of this test was to determine the failure and degradation modes of TBs when exposed to simulated LOCA conditions. The terminal blocks tested were those commonly used in nuclear power plants. They were tested in a configuration representative of plant installations and powered at voltages typical of RTD, pressure transmitter, and control circuits. Secondary objectives were to (1) investigate and compare performance differences in different TB designs, and (2) characterize insulation resistance in terms of leakage currents as functions of environment temperature, pressure, circuit voltage, and the presence of chemical spray.

This report documents the Terminal Block Screening Test (TBST) procedure and the data obtained. A cursory analysis of the data is presented with a hypothesis about the degradation mechanism. A more detailed analysis which includes potential effects on nuclear plant systems is contained in Reference 2.

The terminal block tests were conducted in two phases. Each phase used new terminal blocks in the "as-received" condition. No thermal or seismic aging was conducted and no radiation was applied either as an aging environment or during the LOCA simulation. Phase I consisted of an 11-day exposure to a steam only environment. Phase II consisted of approximately one day of exposure to a simultaneous steam and chemical spray environment followed by a 5-day exposure to a steam only environment. Temperature profiles for both test phases closely followed the PWR temperature profile of IEEE 323-1974, Appendix A [1]. Saturated steam conditions were maintained throughout both test phases. In the Phase I test, the terminal blocks were connected in an alternating pole serpentine, similar to the wiring scheme commonly implemented in industry qualification tests. In the Phase II testing, the terminal blocks were connected in a more realistic configuration: one pole was powered and the two adjacent poles and ground plate to which the block was attached were monitored for leakage currents. The voltages applied were typical of in-plant applications: 4 Vdc typical of RTD circuits (Phase I only), 45 Vdc typical of instrumentation circuits, and 125 Vdc typical of control circuits. The terminal-to-terminal leakage currents were monitored during both Phase I and Phase II tests, and the terminal-to-ground leakage currents were monitored in the Phase II tests. One TB in the Phase II test was connected to a pressure transmitter in a circuit configuration representative of a plant transmitter circuit. This transmitter circuit was included to validate the results obtained from the other circuits and to confirm the analysis of the effects of terminal block degradation on low power instrumentation and control circuits. Another terminal block in the Phase II test was specially cleaned to test the effectiveness of cleaning in reducing leakage currents in a steam environment. Microprocessor based

dataloggers were employed to collect test data on a discrete time basis. Based on this data, values of insulation resistances for each leakage path on each terminal block were calculated. Four channels of leakage current data (not necessarily the same ones) were monitored continuously by strip chart recorders throughout the test.

During the tests surface insulation resistance (IR) dropped from initial values of 10^8 to 10^{10} ohms to 10^2 to 10^5 ohms. At 45 Vdc, leakage currents were on the order of 0.1 to 10 mA. At 4 Vdc, insulation resistance varied between 5×10^3 and 7×10^4 ohms and at 125 Vdc the values of IR were comparable to the 45 Vdc values. During the periods of cooldown to 95°C and the post-test ambient temperature period, the insulation resistance values increased to the 10^6 to 10^8 ohms but not to the pre-test values of 10^8 to 10^{10} ohms. This behavior illustrates three points: first, the similarity between cooldown and post-test IR values indicates that the same conduction mechanism is probably occurring during these periods; second, IR recovery to higher values after exposure indicates that a transient phenomenon is responsible for the low IR values during the steam exposure; and third, that some permanent degradation of the terminal block insulation occurs. A conductive moisture film is the most probable explanation for the transient phenomenon. During cooldown periods, the residual heat of the terminal block will keep its temperature higher than the surrounding atmospheric temperature. Since the surface film will be close to the temperature of the terminal block, its vapor pressure will exceed the surrounding atmosphere's pressure, causing the film to vaporize. In the post-test case, the same phenomenon occurs until the terminal blocks cool to ambient temperature. Then the normal relative humidity regime takes over. The permanent degradation of the terminal block IR may have been caused by carbonization of the terminal block surface or other organic materials in the vicinity, or by residues of semiconducting mediums such as cadmium sulfide. Post-test chemical analysis of three Phase II terminal blocks showed the presence of both cadmium sulfide deposits and carbonaceous residues in a graphite-like structure.

There was a noticeable dependence of IR on temperature. The IRs at temperatures less than 110°C tended to be 1/2 to 1-1/2 orders of magnitude greater than IRs at temperatures greater than 110°C. All of the terminal blocks tested exhibited similar temperature related performance trends, though there were block-related differences in absolute performance.

Since saturated steam conditions were maintained throughout the test, the temperature dependence could also have been interpreted as a pressure dependence. Pressure per se, though, is not the governing factor in film conduction, but it is important in determining the conditions necessary for film formation. If a system is superheated, and at equilibrium, films will not form and the performance of the terminal block will be relatively good. Similarly, if the terminal block temperature is above the dew point in an air environment the same condition will exist. Alternately, if the terminal block temperature is below the dew point in an air environment, or if films have formed due to a cool terminal block being surrounded with steam and the system remains at saturation, films will form and remain on the surface of the terminal block.

Consistent with our hypothesis that film conduction is the dominant conduction mechanism, we believe that terminal block design and construction impacts performance. Some phenolic terminal blocks having sectional construction showed about one to two orders of magnitude lower IR than phenolic terminal blocks of one-piece molded construction. Also, the sectional terminal blocks had lower IR values to ground than their terminal-to-terminal IR values. In contrast, one-piece terminal blocks had terminal-to-ground and terminal-to-terminal IRs which were generally comparable.

Sporadic breakdowns to very low values of insulation resistance (a few to several hundred ohms) lasting from less than a second to several minutes were observed. The occurrence of these breakdowns was more prevalent in some block designs than others, but they occurred in all designs. Also, power cycling affected IR. Immediately after repowering or rapidly increasing applied voltage, IR dropped to very low values and then slowly (minutes to hours) recovered to higher nominal values. The changes were 1/2 to 2 orders of magnitude in range.

In the voltage range tested (i.e., 4 to 125 Vdc) the dependence of IR on applied voltage appears to be minimal. The Phase I terminal blocks exhibited a slight voltage dependence of IR with applied voltage, but this behavior was not observed in the Phase II tests.

During the chemical spray periods of the Phase II tests, no effect of the chemical spray was observed. This finding was somewhat surprising since we expected the chemical spray to enter the conduit, penetrate down through the conduit-cable interstitial space, and drip onto the terminal blocks. We hypothesized that the introduction of Na^+ and OH^- ions to the surface film would enhance the conductivity of the film. The lack of any observed change in leakage currents initially indicated to us that the NEMA-4 enclosures with unsealed conduit entrances provided adequate protection against the intrusion of chemical spray. To check this result, at the conclusion of the Phase II environmental exposure we conducted a submergence experiment to observe the performance of blocks positively known to be spray contaminated. In this test three blocks were submerged in a chemical spray and steam condensate solution and three blocks were left unsubmerged. IRs in a steam environment after the submergence were compared. They indicated that there was only slight difference between submerged and unsubmerged blocks, with the unsubmerged blocks being slightly better. This data coupled with the observation that the Phase I test results are compatible with the Phase II results shows that even if spray had penetrated the enclosures little difference in leakage currents may have been observed. Apparently the additional conducting ions from the spray may not significantly alter the conductivity of the film. It also precludes a definite conclusion about the effectiveness of the NEMA-4 enclosure in preventing chemical spray from penetrating to the terminal blocks. However, we believe the NEMA-4 enclosures as they were installed in our tests are reasonably effective in preventing such penetration.

When circuits were connected in a serpentine fashion, terminal-to-terminal insulation resistance varied predominantly between 1/3 and 1/10 of the insulation resistances observed for the once-through type of connections. This result supports the conclusion that distributed conduction occurs in the film and is consistent with what would be expected based on a parallel conducting paths argument.

The terminal block connected in the transmitter circuit performed substantially the same as the other terminal blocks, thus confirming the validity of the test circuit designs. The effects of the low level leakage currents on the circuit were as expected. These effects are discussed in Reference 2.

The specially cleaned terminal block did not perform significantly different from the uncleaned "as-received" terminal blocks and hence the effectiveness of cleaning as a method of reducing leakage currents in a steam environment is questionable.

This report focuses on the effects of LOCA environment on TB performance, however when evaluating terminal block performance, it is necessary to consider the requirements of specific terminal block applications. Example analyses of the effects of terminal block performance on specific nuclear power plant circuits are contained in Reference 2.

1.0 OBJECTIVES

The primary objective of the Terminal Block Screening Test (TBST) was to determine the failure and degradation modes of terminal blocks (TBs) when exposed to simulated Loss-of-Coolant Accident (LOCA) conditions. The terminal blocks tested were those commonly used in nuclear power plants. They were tested in a configuration typical of plant installations and powered at voltages typical of RTD, pressure transmitter, and control circuits. Secondary objectives were to (1) investigate and compare performance differences in different TB designs and (2) characterize insulation resistance in terms of leakage currents as functions of environment temperature, pressure, circuit voltage, and chemical spray.

This report documents the TBST procedure and the data obtained. A cursory analysis of the data is presented with a hypothesis about the degradation mechanism. A more detailed analysis which includes potential effects on nuclear plant systems is contained in Reference 2.

2.0 TEST PHILOSOPHY AND APPROACH

The basic hypothesis for our tests was that failure mechanisms, if any, would be related to leakage currents caused by increased surface conductivity resulting from water films forming on the terminal block surface. Our reviews of industry qualification tests reports [3-10] showed that little TB degradation occurred during thermal or radiation aging, and that terminal blocks apparently functioned properly subsequent to accelerated aging sequences. Such behavior should be expected from a passive component such as terminal blocks, since the materials used to make them (wood flour or glass-filled phenolic or ceramic insulators, and metallic conductors) are generally unaffected by radiation levels less than 10^8 to 10^{10} rad(C) [11] and temperatures less than 180°C [12]. The same industry qualification reports [3-10] also state that circuit fuses fail at various times during the LOCA simulation, indicating that problems with leakage currents do exist <u>during</u> the tests. Therefore, the focus of our tests was to determine the failure and degradation modes of TBs in a LOCA steam environment; no thermal aging of samples was conducted. Likewise, radiation aging was also not conducted, nor was radiation included in the accident steam exposures. Thus the terminal blocks tested were in a new, "as-received" condition, and represented the best initial condition that might possibly exist for field installed terminal blocks prior to a LOCA accident. The terminal blocks were mounted in NEMA-4 electrical enclosures. The test installation as far as practical typified actual nuclear plant installation practices.

Our investigation was conducted in two phases. The Phase I test employed a test circuit design commonly used by industry in their TB qualification tests. This configuration provided a baseline for comparison of our results to industry data. The Phase II test employed a circuit design that more closely represented the physical arrangement of circuits in actual plant installations. The circuit design used in Phase II allowed measurement of leakage currents between individual TB poles and cumulatively between all of the poles and ground. In order to maintain commonality between Phase I and Phase II test, 9 of the 12 TBs tested in Phase II were models tested in Phase I.

For cost considerations, both phases of the TBST were conducted adjunct to other scheduled NRC tests. As a result, the environmental profiles were defined by other experimenters. However, the test profiles for both phases were in basic agreement with the IEEE 323-1974, Appendix A [1] recommended temperature profile and were within a few degrees Centigrade of each other. Saturated steam was used throughout both test phases.

3.0 EXPERIMENTAL

3.1 Environmental Profiles

Figures 1 and 2 show the environmental profiles achieved for Phase I and Phase II tests, respectively. The salient features of these profiles are:

(1) Saturated steam conditions prevailed throughout both tests.

(2) Chemical spray was introduced only in the Phase II tests. The spray rate was 0.15 (gal/min)/ft^2 and the composition of the spray was 0.28 molar boric acid (H_3BO_3), 0.064 molar sodium thiosulfate ($Na_2S_2O_3$), and sufficient sodium hydroxide (NaOH), to bring the spray to a pH of between 10 and 11 at 77°C. The spray rate and spray chemical composition were in accordance with IEEE 323-1974 [1] specifications.

(3) An unanticipated cooldown of 1 hour, 50 min. duration occurred 11 hours, 6 minutes into the Phase II test due to the failure of a thermocouple feedthrough in a test chamber penetration. Appendix 2 discusses this anomaly.

After the Phase II tests were concluded, the chamber was allowed to remain at room temperature and open to the atmosphere for six days. At that time, steam and chemical spray were reintroduced and a submergence experiment conducted. The profile for this special test is given in Figure 3. The purpose of this special test was to compare the leakage currents on terminal blocks positively known to have chemical spray solution on their surface to terminal blocks that had been subjected only to chemical spray external to the electrical enclosure. This special test was conducted to investigate the rather surprising results observed during the early portion of the Phase II test when chemical spray did not affect TB leakage current as expected. Section 4.5.2 discusses the results of this special test. To achieve submergence, the condensate drain lines were closed and the test chamber was allowed to fill with chemical spray/steam condensate solution until the bottom two TBs in each enclosure were covered. The remaining terminal blocks in the enclosures were not covered with solution. After approximately 14 minutes of submergence the spray-condensate solution was expelled from the chamber via the drain valve with pressurized nitrogen. The steam was then reintroduced into the chamber for about 3 hours at which time the test was concluded and a natural cooldown occurred. The leakage currents were monitored until the cooldown was complete.

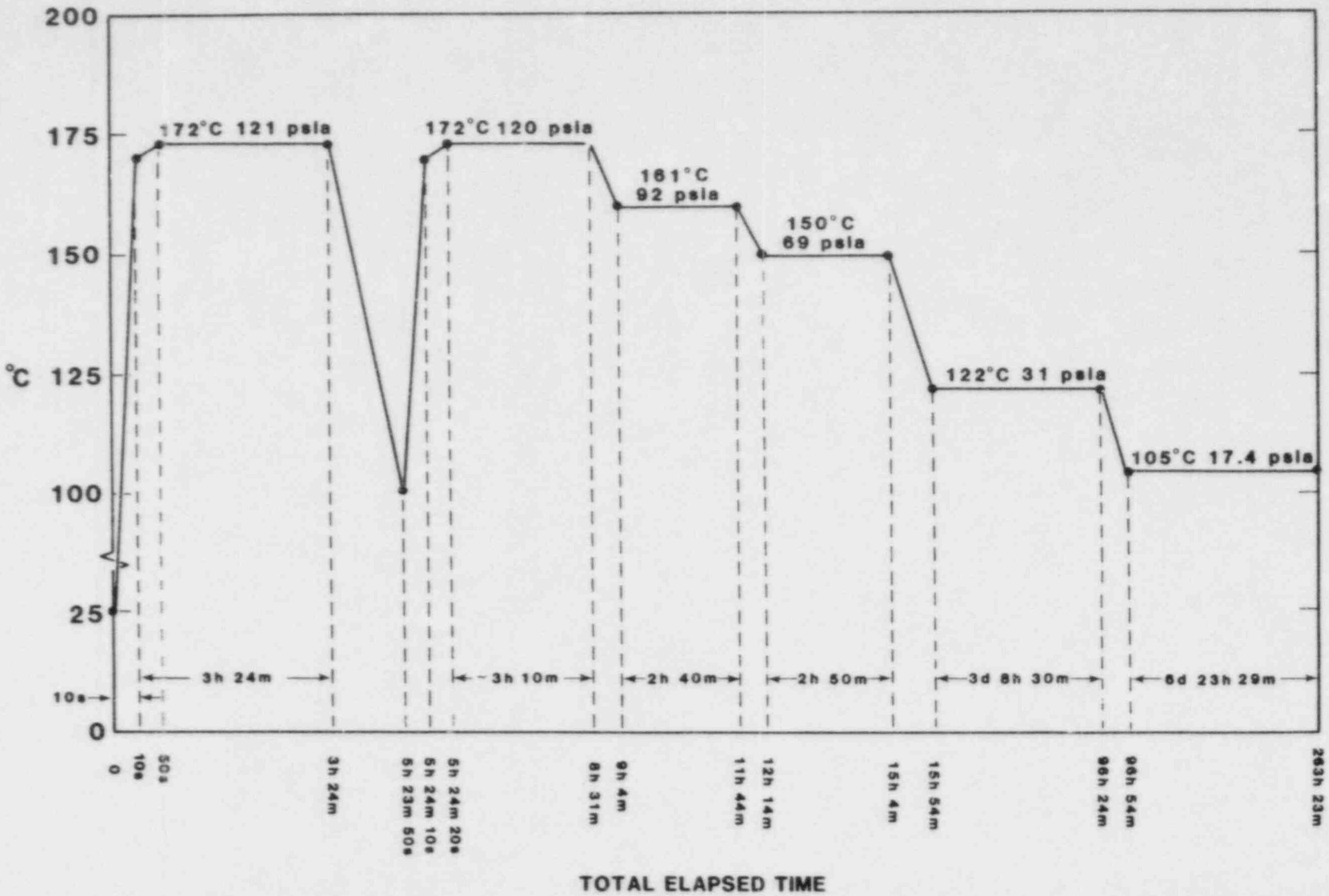

Figure 1

Phase I Environmental Temperature Profile

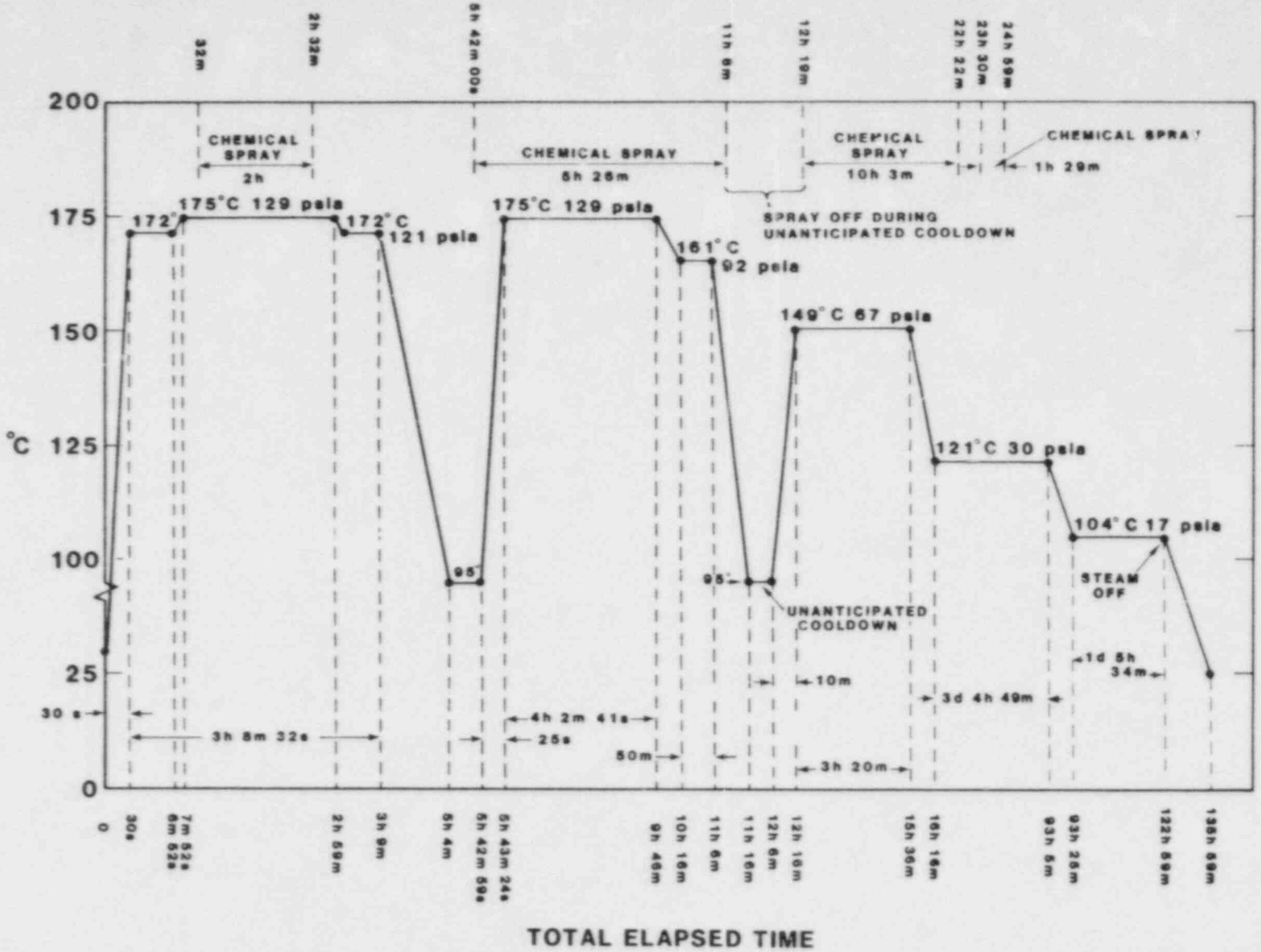

Figure 2

Phase II Environmental Temperature Profile

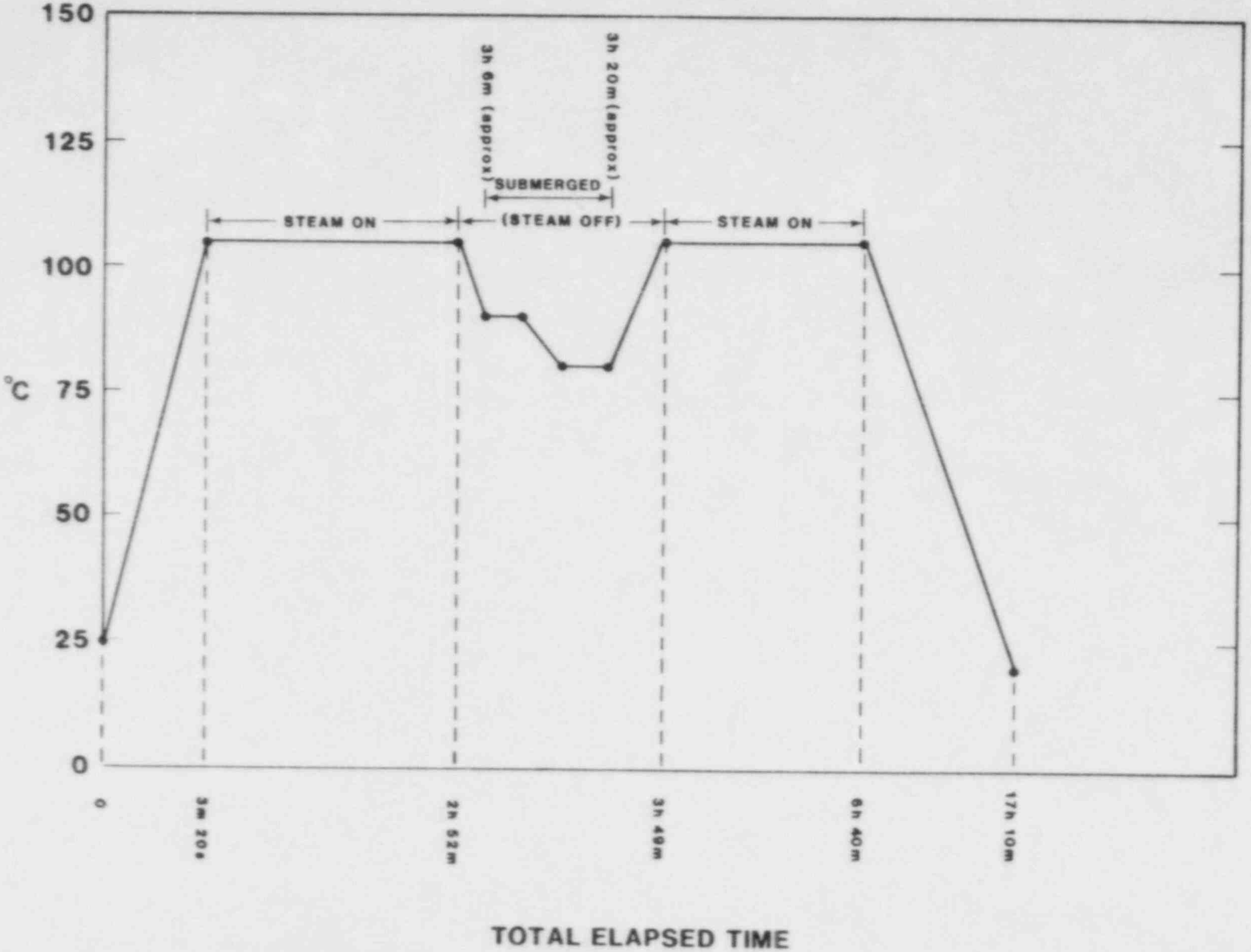

Figure 3

Temperature Profile for Special Submergence Test

3.2 Phase I Physical Configuration

Twelve terminal blocks (3 each of 4 different designs) were tested in the Phase I test. Figure 4 shows a schematic representation of how these blocks were arranged in the NEMA-4 enclosures and indicates their test identification number. Six of the blocks were sectional designs from two different manufacturers, and six of the blocks were different model, one-piece designs from the same manufacturer. All blocks were six-pole terminal blocks, and all but one model are in use at nuclear power plants.[2] Manufacturer IV, TB model E, which was tested only in Phase II, is not currently installed in U.S. reactors. Table 1 tabulates the correlation between manufacturer, model, test identification number and applied voltage/current (Vdc/A) for both the Phase I and Phase II terminal blocks.

The blocks were installed in two 41 cm x 30 cm x 10 cm (16" x 12" x 4") Hoffman A16H12ALP NEMA-4 enclosures, six blocks to each enclosure. The six blocks in each enclosure were mounted on a single unfinished steel mounting plate that was approximately one inch smaller in each dimension than the interior dimensions of the NEMA-4 enclosure. The paint on the mounting studs of the enclosures was removed to insure good electrical contact between the mounting plate and the enclosures. All terminal blocks were installed in a new, "as-received" condition, with no special

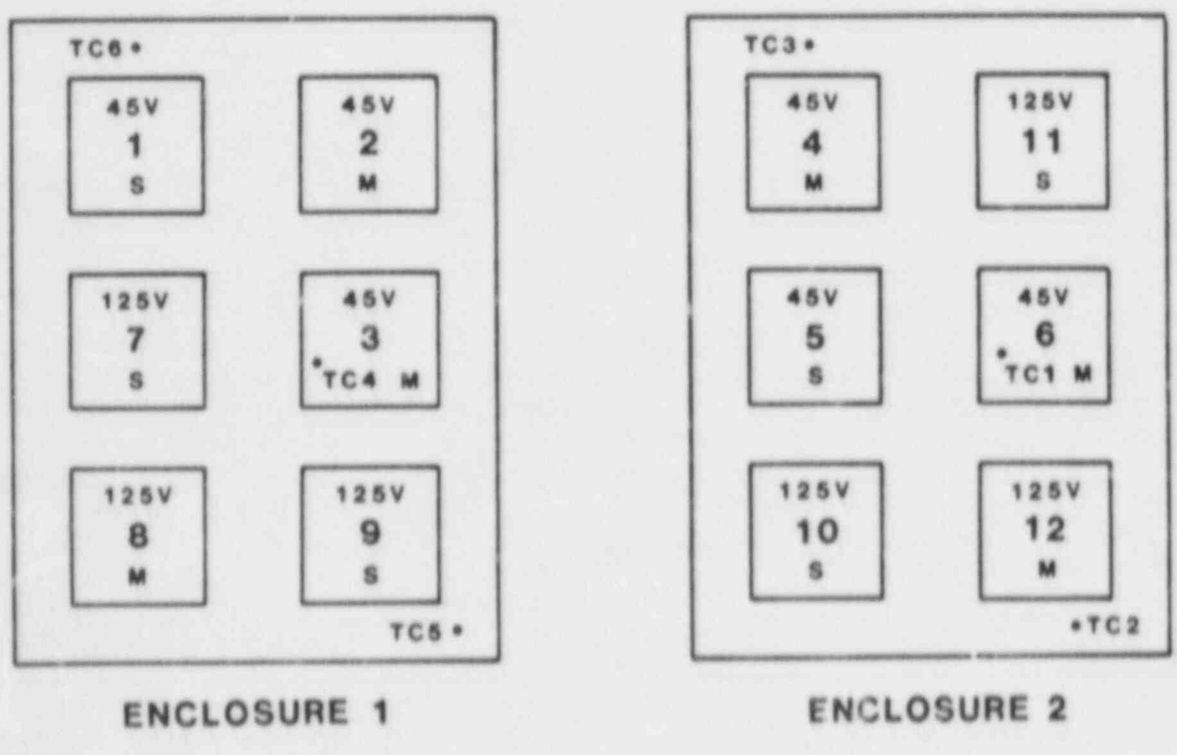

Figure 4

Phase I Terminal Block Arrangement and Identification

Table 1

Correlation of Manufacturer and Model With Terminal Block Identification Number and Applied Voltage/Current Levels for Phase I and Phase II

		------Phase I------		------Phase II-----	
Manufacturer	Model	TB Test ID No.	Voltage/ Current	TB Test ID No.	Voltage/ Current
I	A	1	45/0.02	2	125/1.0
	One-Piece	7	125/1.0	3	125/1.0
		8	125/1.0	4	125/1.0
				9	45/0.02
				10	45/0.02
				11	45/0.02
I	B	4	45/0.02		
	One-Piece	5	45/0.02		
		10	125/1.0		
II	C	2	45/0.02	5	125/1.0
	Sectional	3	45/0.02	6	125/1.0
		9	125/1.0	12	45/0.02
III	D	6	45/0.02		
	Sectional	11	125/1.0		
		12	125/1.0		
IV	E			1	125/1.0
	Sectional			7	45/0.02
				8	45/0.02

cleaning or care taken to prevent fingerprints or other normal contaminants from being deposited on the terminal block surfaces. This procedure was done to simulate normal installation procedures that might occur in nuclear power plants. The cables were brought into the side of the enclosures through 1.9 cm (3/4") diameter Anaconda nuclear grade, liquid tight metal hose, Type NWC. RACO 90° elbow conduit terminators were used to penetrate the enclosure walls.

The conduit was routed up the exterior of the enclosures and terminated in the test chamber head approximately 30 cm below the steam inlet port. The cables exited the conduit and were directly exposed to the steam environment for these 30 cm before they exited the test chamber through compression feedthroughs. There were no splices or junctions in the cable internal to the test chamber. The reason for terminating the conduit in the chamber head was to simulate actual installation practices, where a cable exits the cable tray system, normally at an elevation higher than the electrical enclosure, enters a conduit, and runs in the conduit to the electrical enclosure. Neither end of the conduit was sealed. Nuclear qualified cables were used to make all inside chamber connections. These cables were Anaconda Durasheath EP, 600 V, 1-conductor 12 AWG cable and Anaconda Flame-Guard-EP, 1 kv, 3-conductor, 12 AWG cable. Standard crimp-type ring lugs were used to connect the cables to the terminal blocks. Figure 4 includes the annotations "S" or "M" to indicate which terminal blocks were wired with single or multiconductor cable.

A 7.036 mm diameter (38.8 mm^2 area) condensate drain hole was drilled in the center of each enclosure bottom. This hole was also used as the entrance for three 1.63 mm diameter (cumulative cross-sectional area of 6.23 mm^2) Type K, sheathed, ungrounded junction, thermocouples. This arrangement gave an effective cross-sectional area of the drain hole of 32.7 mm^2, which corresponds to a 0.254-inch diameter hole, or approximately the quarter-inch diameter drain hole that most utilities report are present in their terminal block enclosures. No flow retarder was installed in the drain holes.

Two of the three thermocouples in each box indicated interior temperature of the enclosures, i.e., the temperature of the environment immediately surrounding the terminal blocks. The remaining thermocouple in each enclosure measured the temperature of terminal block material. One thermocouple was wedged between the phenolic end piece on the phenolic insulation of terminal block 3 and one was mounted on a spare pole of terminal block 6. Figure 4 includes annotations that indicate the approximate location of the thermocouples inside the enclosures.

The NEMA-4 enclosures were placed in the test chamber back to back with approximately 3.8 cm separating them. Figure 5 illustrates the placement of the enclosure in the test chamber. Six Type K thermocouples of the same type used inside the NEMA-4 enclosures were placed around the exterior of the enclosures to measure chamber temperature. Figure 6 indicates their approximate location. The time constant for these thermocouples is approximately 3.5 seconds. The thermocouple outputs were monitored automatically by an Accurex Autodata 10 datalogger.

A 0.635 cm (1/4") diameter stainless steel tube connected one enclosure interior with the exterior of the test chamber. A similar tube connected the chamber interior with the external environment. These two ports allowed measurement of the differential pressure between the enclosure and the chamber during the steam ramps.

Table 2 summarizes the equipment used in the Phase I test. Calibration of the power supplies was not required since their outputs were monitored by calibrated instrumentation.

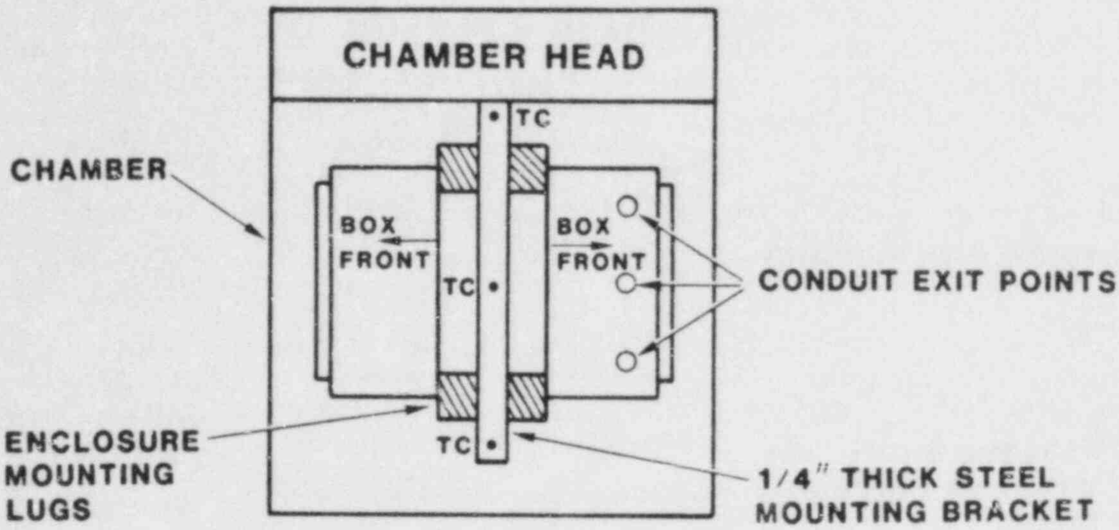

Figure 5

Physical Arrangement of Electrical Enclosures in Chamber

Table 2

Equipment Used in Phase I Test

Nomenclature	S/N and (Property No.)	Calibration Period
Accurex Autodata 10 Datalogger	3/210-1 (12793)	4/82 - 10/82
Magtrol Model 4612 Power Analyzer	N/A	N/A
DCR-600 Power Supply	N/A	N/A
DCR-300 Power Supply	N/A	N/A
HP Model 895 Power Supply	N/A	N/A
Fluke Digital Multimeter	3318 (213043)	4/82 - 10/82

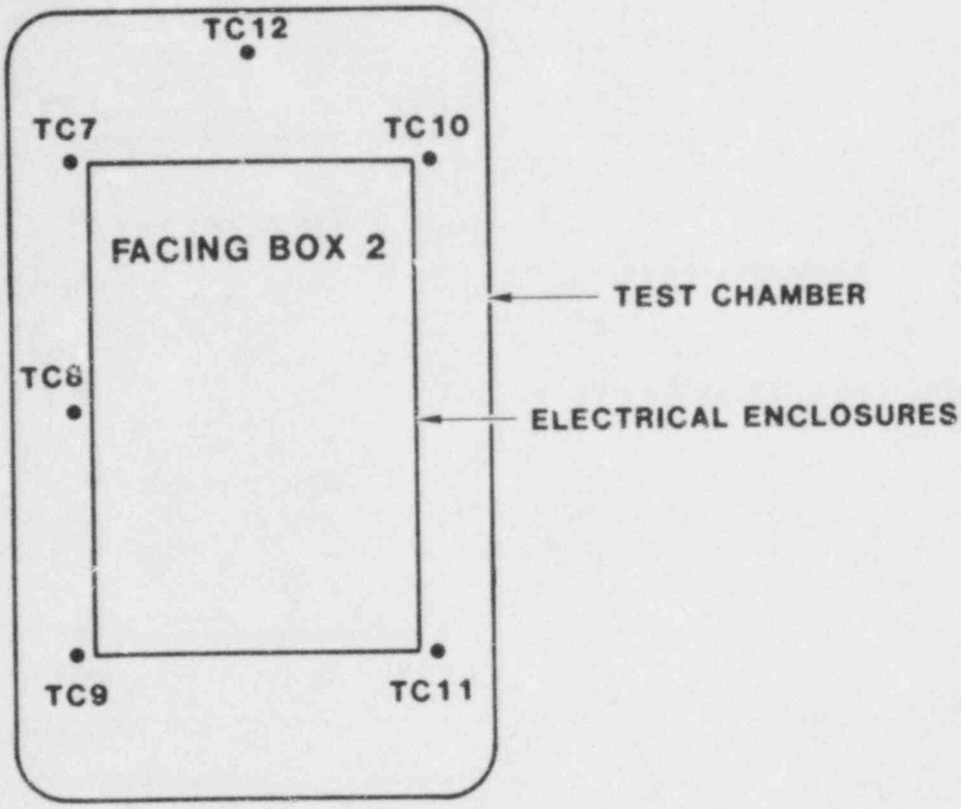

Figure 6

Placement of Phase I Thermocouples External to the Electrical Enclosures

3.3 Phase II Physical Configuration

Phase II tested 12 terminal blocks, 6 of one design, and 3 each of two other designs. Nine of the blocks (6 of one design and 3 of another design) were the same models as tested in the Phase I test. This selection provided commonality between the results of the two test phases, and permitted evaluation of the effect of the modified circuit design. Table 1 correlates the manufacturers and models with the Phase I and Phase II test identification numbers; Figure 7 shows schematically how the Phase II blocks were arranged in the electrical enclosures. Again, six of the blocks were of sectional design and six were of one-piece design. Three of the sectional terminal blocks, (TBs 5, 6, and 12) were reduced to 3 pole terminal blocks from 6 poles to allow room for installation of the ceramic standoffs.

The blocks were installed in two Hoffman NEMA-4 enclosures identical to those used in the Phase I test. Unlike the Phase I tests, the six blocks in each enclosure were mounted on individual mounting plates, that were electrically isolated from the enclosure mounting plate by 5 cm long ceramic standoffs. Figure 8 shows this arrangement during the assembly

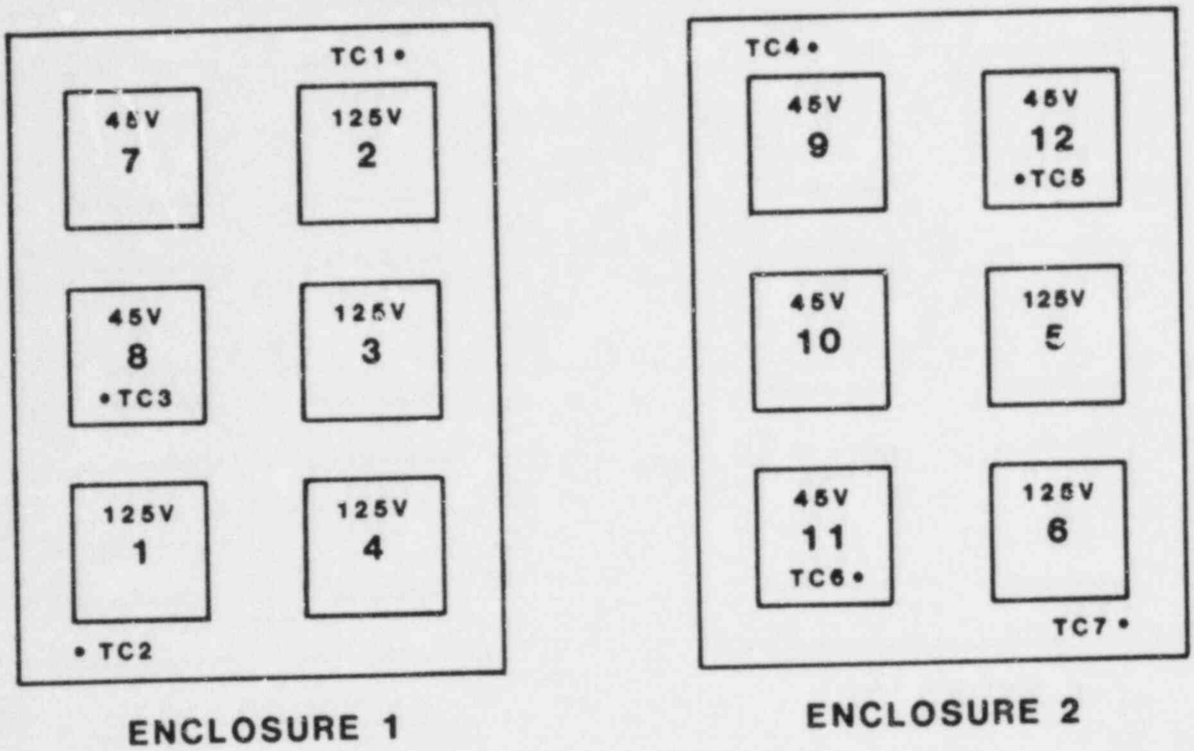

Figure 7

Phase II Terminal Block Arrangement and Identification, Thermocouple Location, and Block Voltage

process. The standoffs permitted each block's leakage current to ground to be separately measured while the other blocks remained powered. The enclosure mounting plate was connected to the enclosure mounting studs by four cadmium plated nuts; these nuts were discovered later to possibly affect the test results.

Except for terminal block 10, all terminal blocks were installed in an "as-received" condition, with no special cleaning or care taken to prevent fingerprints or other normal contaminants from being deposited on the surface. As in Phase I, this procedure was implemented to simulate normal installation procedures. Terminal block 10 was cleaned by first soaking briefly (a minute or so) in freon to remove any grease or other non-water soluble contaminants. It was then soaked in deionized water to remove any water soluble contaminants; and finally it was dipped briefly in clean freon as a drying agent. Thereafter, it was handled with gloves during the installation process to prevent reintroduction of contaminants.

The cables were brought into the electrical enclosure through one 5 cm (2") diameter and one 1.9 cm (3/4") diameter Anaconda nuclear grade, liquid tight metal hose, Type NWC. Thomas and Betts 90° elbow, liquid tight conduit terminators were used to penetrate the enclosure walls. As

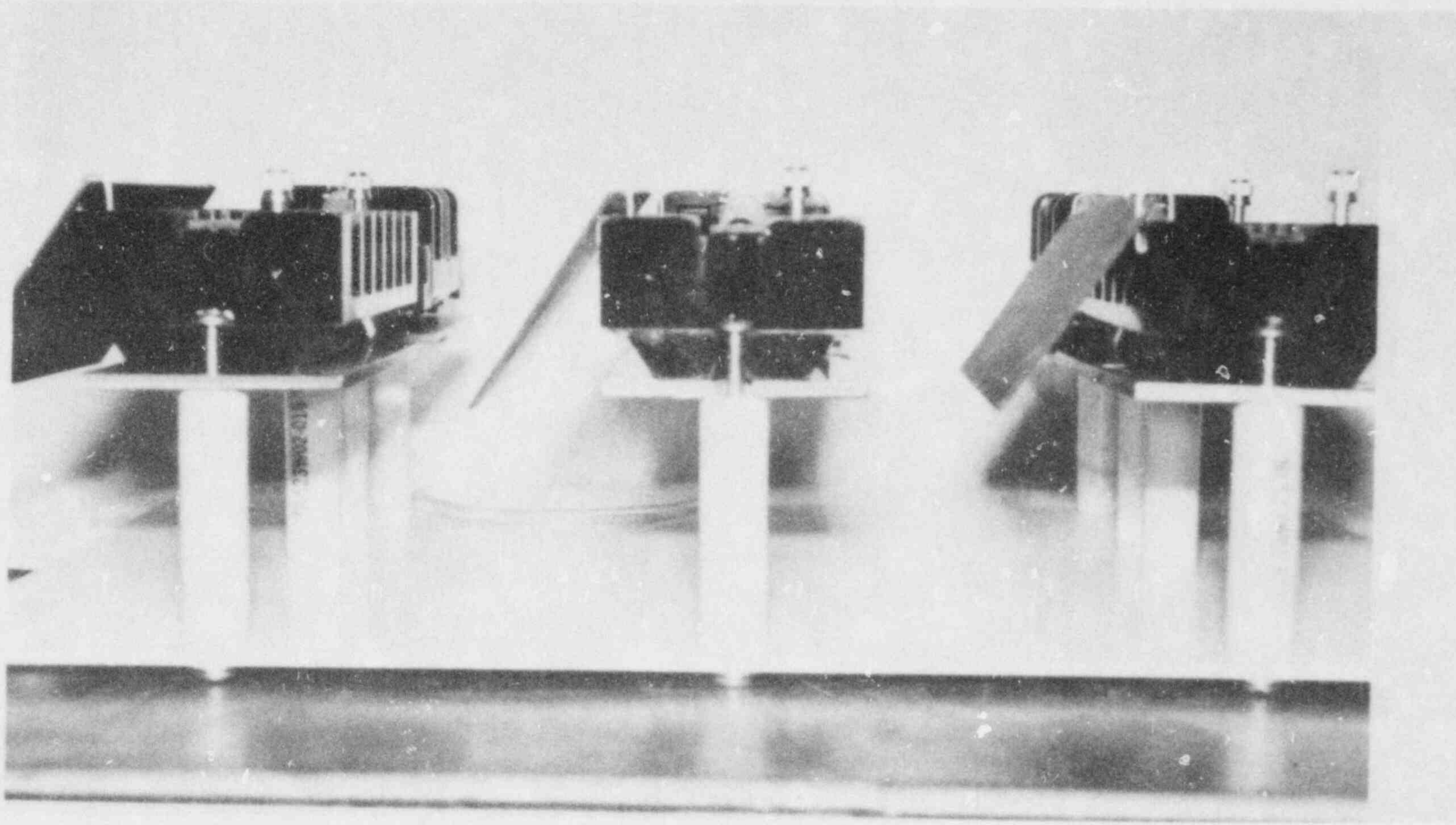

Figure 8

Phase II Terminal Blocks Mounted on Ceramic Standoffs to Provide Electrical Isolation Between Each Block's Ground Plate in Phase I tests, the conduit was routed up the exterior of the enclosures and terminated in the test chamber head approximately 30 cm below the steam inlet port and the spray header. Neither end of the conduit was sealed. The cables exited the chamber through the same type of compression feedthroughs used in the Phase I test. No splices existed in any cable inside the test chamber. Anaconda Flame-Guard-EP, 1 kv, 3-conductor, 12 AWG cable was the only type of cable used in the Phase II test. As in Phase I, standard crimp-type ring lugs were used to connect the cables to the terminal blocks for those terminal blocks requiring them.

The drain hole arrangements were identical to those in the Phase I test except that in Enclosure 2, four rather than three thermocouples were routed into the box through the drain hole. All thermocouples were the same type of thermocouples used in the Phase I test. In Enclosure 1, one thermocouple was wedged between two unpowered sections of terminal block 8, while the other two provided indication of enclosure interior temperatures. In Enclosure 2, one thermocouple was wedged between the phenolic end piece and one of the sections of terminal block 12, one was mounted under the screw of a spare pole on terminal block 11, and two thermocouples provided indication of the enclosure interior temperatures. Figure 7 notes the approximate thermocouple locations. Five thermocouples were placed around the exterior of the enclosures to monitor chamber temperature. Their placement was roughly equivalent to the Phase I thermocouple placement and is illustrated in Figure 9. The thermocouple data was monitored automatically by an Accurex Autodata 10 Datalogger.

No measurement of differential pressure between the chamber and the enclosure interior was made in Phase II. Table 3 summarizes the equipment used in the Phase II test. Calibration of the power supplies was not required since their outputs were monitored by calibrated instruments during the test.

3.4 Phase I Electrical Configuration

As illustrated in Figure 10, the Phase I experiments used a serpentine connection of alternate TB poles. This connection procedure was chosen since it is commonly used in industry terminal block qualification tests and, therefore, provided a degree of commonality between industry test results and TBST results. It has the advantage of reducing the number of cables that must penetrate the steam chamber. The disadvantage is that the measurement of leakage currents between individual TB poles is not possible.

Six blocks were energized at 45 Vdc and six blocks were energized at 125 Vdc. These values were chosen to be representative of plant instrumentation and control circuits. Late in the test, during the 105°C, 17 psia tail of environmental profile, the six blocks powered at 45 Vdc were powered at 4 Vdc for 72.8 hours to simulate the voltage levels experienced in RTD circuits.

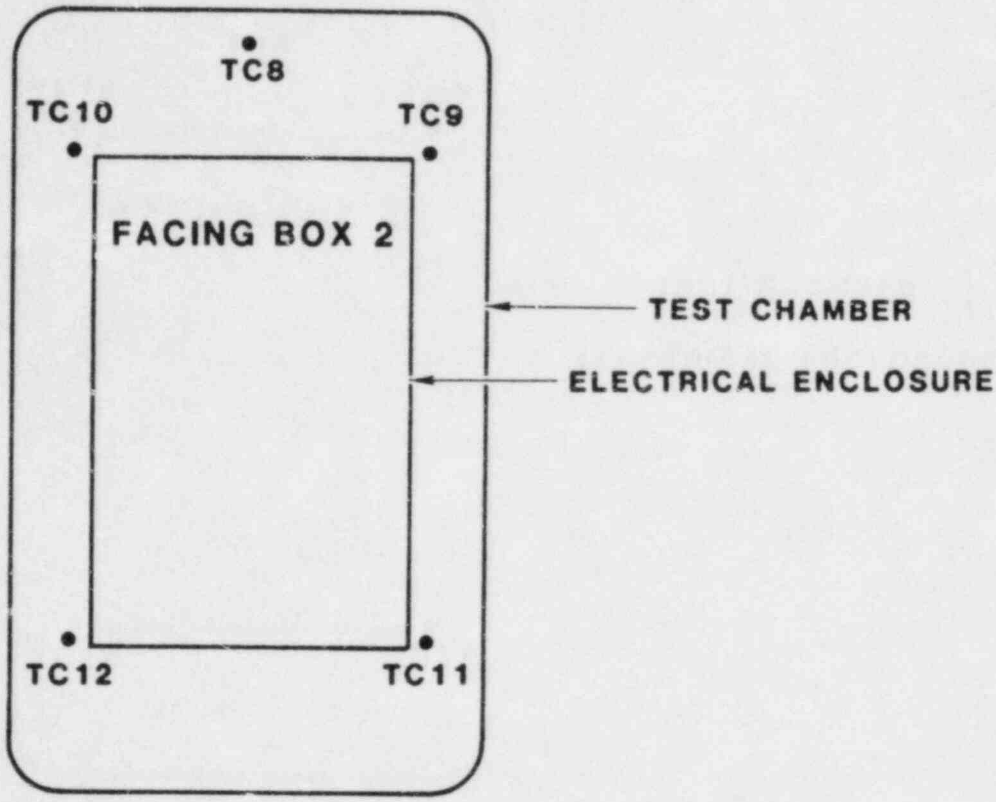

Figure 9

Phase II Placement of Thermocouples External to the Electrical Enclosure

Referring to Figure 10, R_D and R_L are the external load resistors in the load bank. R_D was used to monitor currents in each branch of the circuit and R_L was chosen so that the combined series resistance of R_D and R_L would limit the circuit current in each branch to 20 mA at 45 Vdc or 1 A at 125 Vdc. The R_L resistances were included in the leakage paths to limit current in these circuit branches as a precaution against the terminal block insulation resistance dropping to very low values. Table 4A summarizes the nominal values for each R_D and R_L group. Table 4B lists the actual values of each R_D and each R_D+R_L series combination used in the calculations. All resistors were 1% wire wound resistors.

The current in each branch of the circuit was determined by measuring the voltage across R_D. These measurements were accomplished by continuously scanning the voltages across each R_D on a rotational basis.

Table 3

Equipment Used in Phase II Test

Nomenclature	S/N and (Property No.)	Calibration Period
Accurex Autodata 10 Datalogger	3-797-1 (14892)	10/82 - 04/83
Accurex Autodata 10 Datalogger	3-210-1 (12793)	10/82 - 04/83
Magtrol Model 4612 Power Monitor	N/A	N/A
Magtrol Model 4612 Power Monitor	N/A	N/A
Magtrol Model 4612 Power Monitor	N/A	N/A
DCR-300 Power Supply	N/A	N/A
DCR-600 Power Supply	N/A	N/A
HP Model 895 Power Supply	N/A	N/A
Fluke Digital Multimeter	3318 (213043)	10/82 - 4/83
Sorenson A2000 Power Line Conditioner	N/A	N/A
Biddle Model RM170 Megohmmeter	578 (R14343)	8/82 - 2/83

Only one ground return path existed for all 12 Phase I terminal blocks. This condition resulted from the fact that all of the terminal blocks in each enclosure were mounted on the same mounting plate in the NEMA-4 enclosures, and that both enclosures were connected electrically via the chamber to ground. Thus, any measurements of leakage to ground had to be accomplished with only one block powered. Individual powering of each block was performed once during the test. These results are reported in Section 4.3.6. For the majority of the Phase I test all blocks were powered simultaneously, and hence only the pole-to-pole leakage current data is relevant.

The six blocks powered at 45 Vdc were connected in parallel to the same power supply. The blocks powered at 125 Vdc were energized in three parallel groups consisting of two blocks connected in series. Two of the groups were connected to one power supply and the third to a second power supply. This arrangement was necessary because of power supply current output limitations. Figure 11 shows a schematic of the entire circuit configuration.

3.5 Phase II Electrical Configuration

The electrical connections for a typical Phase II terminal block circuit used in the Phase II test are illustrated in Figure 12. Only one pole of the terminal block was energized. The two adjacent poles were connected via load resistors, $R_D + R_L$, to the low side of the power

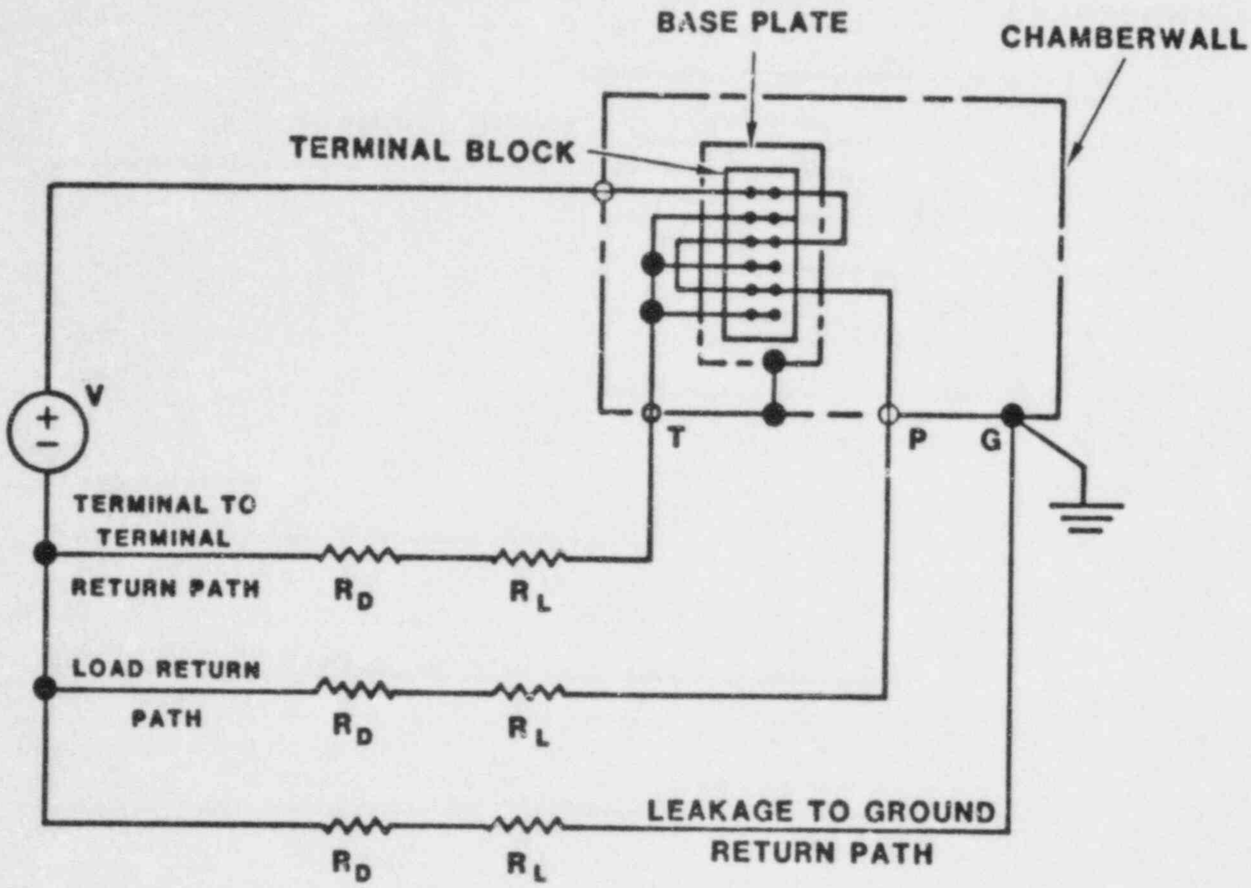

Figure 10

Illustration of Typical Phase I Electrical Connections

Table 4A

Nominal Resistance Values for Each
R_D and R_L Group
(ohms)

	R_D	R_L
45 Vdc	511	1750
125 Vdc	10	116.3

Table 4B

Actual Values for Each R_D and $R_D + R_L$
Series Combination Used in Phase I Test
(ohms)

Terminal Block No.	Load Branch R_D	Load Branch $R_D + R_L$	Leakage Branch R_D	Leakage Branch $R_D + R_L$
1	509.27	2250.5	512.2	2257.6
2	512.3	2254.2	507.36	2250.6
3	511.54	2254.1	509.83	2252.1
4	508.32	2250.5	511.04	2257.3
5	508.32	2250.5	511.42	2254.3
6	510.61	2251.0	507.24	2252.7
7	1.093*#	--	10.608	126.46
8	897.62*&	91797*&	10.06	126.34
9	1.093**#	--	10.08	126.38
10	896.27**&	91796**&	10.07	126.36
11	1.10***#	--	10.10	126.40
12	895.67***&	91796***&	10.12	126.43

* For Terminal Blocks 7 and 8
** For Terminal Blocks 9 and 10
*** For Terminal Blocks 11 and 12
\# Load Current Measurement
& Load Voltage Measurement

Note: All values are +/- 0.1% except for the load branch $R_D + R_L$ values for TBs 6 through 12 which are +/- 1.0%.

supply. Hereafter, the left adjacent pole is referred to as the A branch, and the right adjacent pole as the B branch. Each block's ground plate was connected through load resistors to the low side of the power supply. Since these ground plates were mounted on ceramic standoffs, they floated relative to the chamber ground. This arrangement eliminated the common ground problems experienced in the Phase I experiment. The ground return path is referred to as the G branch. The P branch is the powered connection through the terminal block. The Phase II electrical setup overcame shortcomings of the Phase I test by more realistically simulating actual operational connections, and by providing a direct means of measuring the pole-to-pole leakage current.

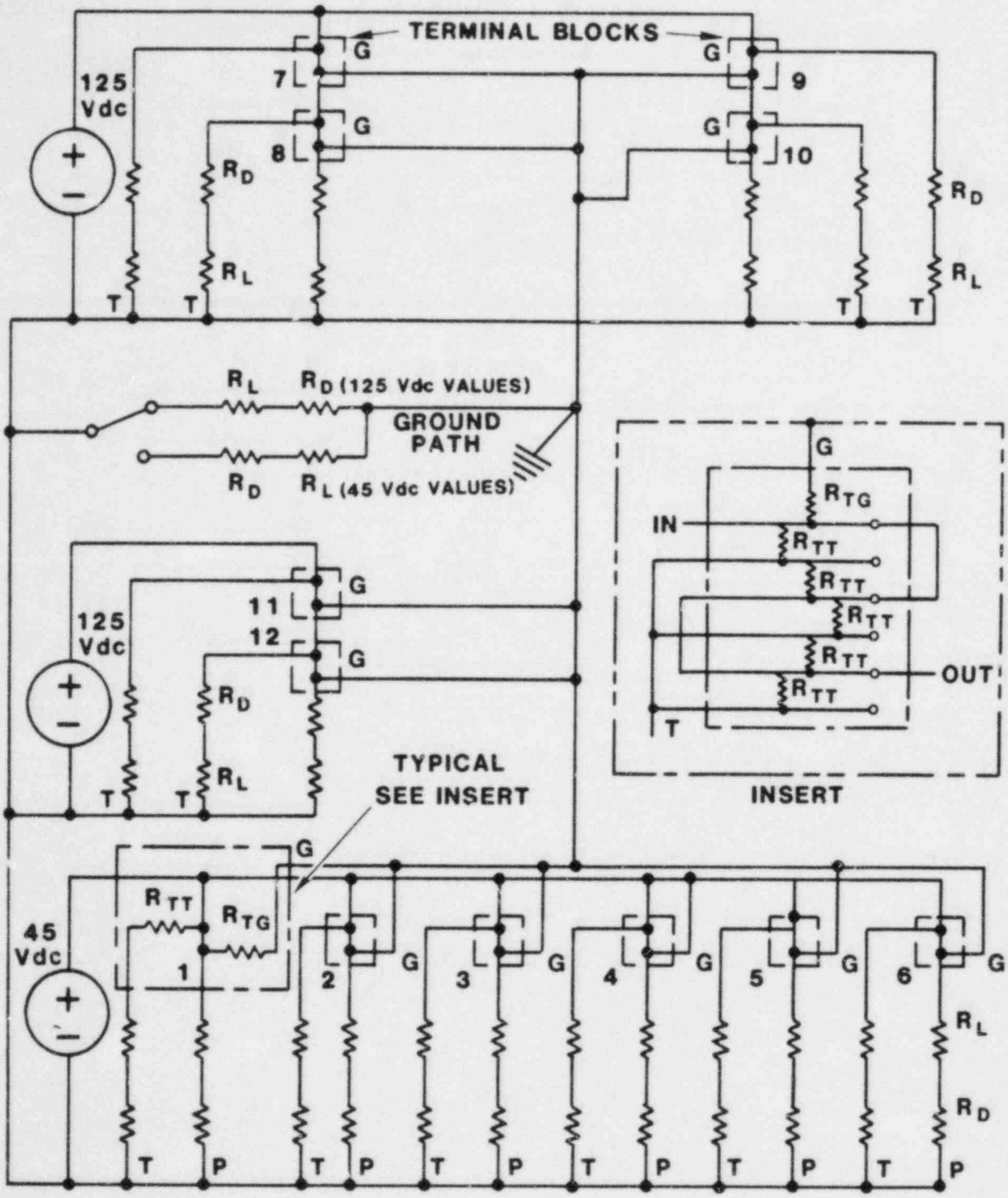

Figure 11

Complete Circuit Schematic for Phase I Test Showing 6 Terminal Blocks in Parallel Off the 45 Vdc Power Supply and 3 Parallel Sets of Two Blocks in Series Off the Two 125 Vdc Power Supplies. R_{TT} and R_{TG} are the terminal-to-terminal and terminal-to-ground insulation resistances, respectively.

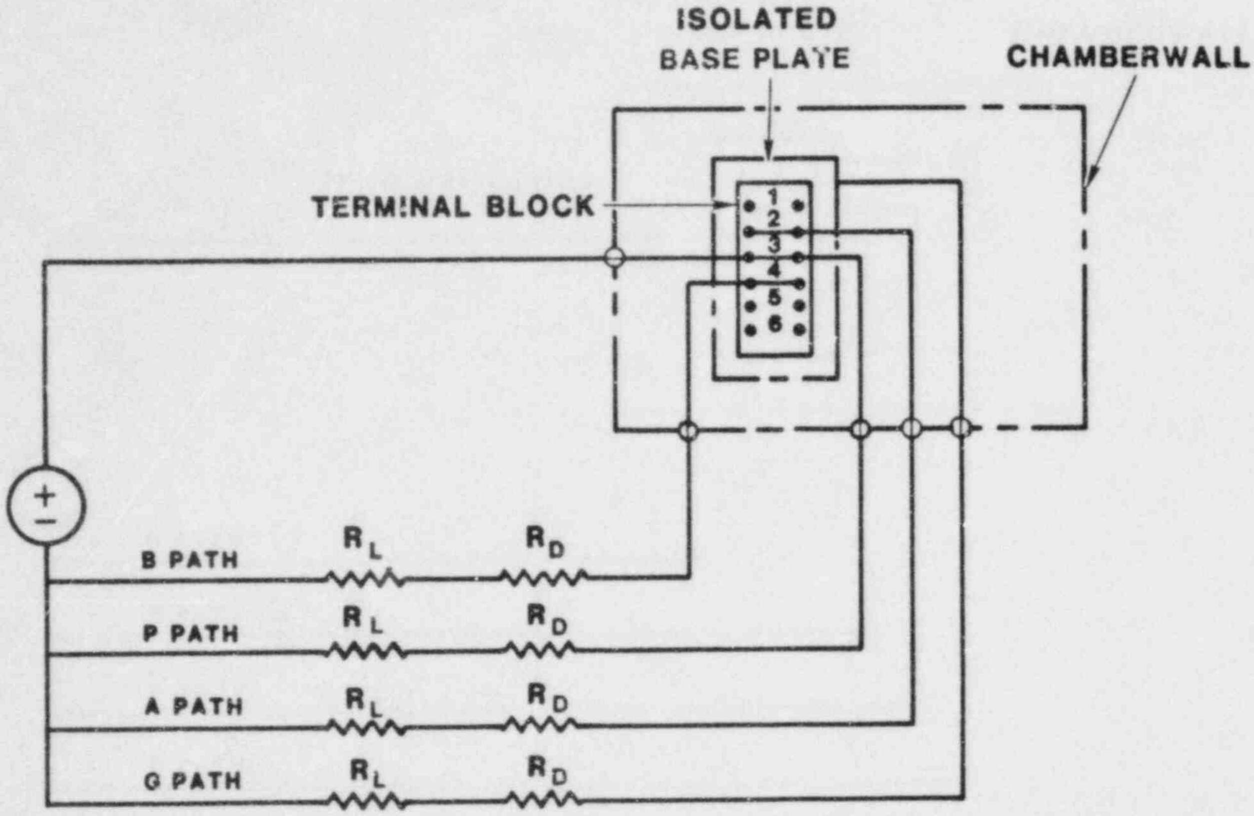

Figure 12

Illustration of Typical Phase II Electrical Connections

Similar to Phase I, five blocks were energized at 45 Vdc, 20 mA and six at 125 Vdc, 1 A. No 4 Vdc data was taken in Phase II. The nominal resistance values for R_D and R_L were the same as those used in Phase I and given in Table 4A. Table 5 summarizes the actual resistance values for each R_D and each $R_D + R_L$ series combination for the Phase II experiment.

The current in each circuit branch was determined by measuring the voltage across R_D. These measurements were accomplished by continuous scanning of the voltage across each R_D on a rotational basis. Two dataloggers were used; one measured the 45 Vdc circuits and one measured the 125 Vdc circuits.

Terminal block 11 was not wired with the standard Phase II circuit, but rather was connected in a 4-20 mA transmitter circuit. The transmitter was powered with 45 Vdc, Figure 13 illustrates the terminal block 11 circuit. Except for the connection of the shield on a pole of the terminal block, this circuit is typical of that found in nuclear plant installations.

As shown in Figure 13, the resistors R_{D1} and R_{D2} were 511-ohm nominal. They provided the external loop resistance for the transmitter. Table 5 shows the values for these resistors actually used in the calculations. These resistors also provided a means to measure the current in the circuit branches on the power supply and transmitter sides of the test chamber. The current differential in these two branches represents the terminal-to-terminal leakage current. The terminal-to-ground leakage current was obtained by measuring the voltage drop across R_{DG}. Once during the second 175°C plateau the transmitter was cycled through its differential pressure range; otherwise the transmitter was operated at its base output level of 4 mA.

As in Phase I, the six blocks powered at 45 Vdc were connected in parallel to the same power supply. The blocks powered at 125 Vdc were energized in three parallel groups consisting of two blocks connected in series. Two of the groups were connected to one power supply and the third to a second power supply. Figures 14 and 15 show the complete circuit schematic with all terminal blocks and power supplies represented. Unlike the circuit arrangement in Phase I, the low sides of the three power supplies were not tied together.

Table 5
Actual Values for Each R_D and $R_D + R_L$ Combination
Used in Phase II Tests

Terminal Block No.	Input	Load Branch R_D	Load Branch $R_D + R_L$	Leakage A Branch R_D	Leakage A Branch $R_D + R_L$	Leakage B Branch R_D	Leakage B Branch $R_D + R_L$	Leakage G Branch R_D	Leakage G Branch $R_D + R_L$
1	1.0	1.093*#	---	10.3	126.7	10.3	126.5	10.3	126.7
2	1.0	897.62*&	91797*&	10.2	126.6	10.3	126.7	10.3	126.7
3	1.0	1.093+#	---	10.4	126.6	10.3	126.6	10.3	126.6
4	1.0	896.27+&	91796+&	10.4	126.7	10.3	126.7	10.3	126.7
5	1.0	1.1@#	---	10.3	126.7	10.3	126.6	10.4	126.8
6	1.0	895.67@&	91796@&	10.4	126.8	10.3	126.7	10.3	126.5
7	1.12	508.3	2257	511.2	2253	507.3	2253	511.1	2254
8	1.11	509.9	2259	508.8	2256	510.4	2259	510.4	2254
9	1.13	507.9	2251	511.2	2254	511.9	2256	511.0	2261
10	1.15	508.6	2254	509.0	2252	508.5	2252	509.9	2252
11	1.15	509.2	---	---	---	513.0	---	508.9	2251
12	1.13	509.0	2253	512.7	2258	508.4	2250	507.6	2253

* For Terminal Blocks 1 and 2
\+ For Terminal Blocks 3 and 4
@ For Terminal Blocks 5 and 6
\# Load Current Measurements
& Load Voltage Measurements

Note: All values are +/- 0.1% except for the load branch $R_D + R_L$ values for TBs 1 through 6 which are +/- 1.0%.

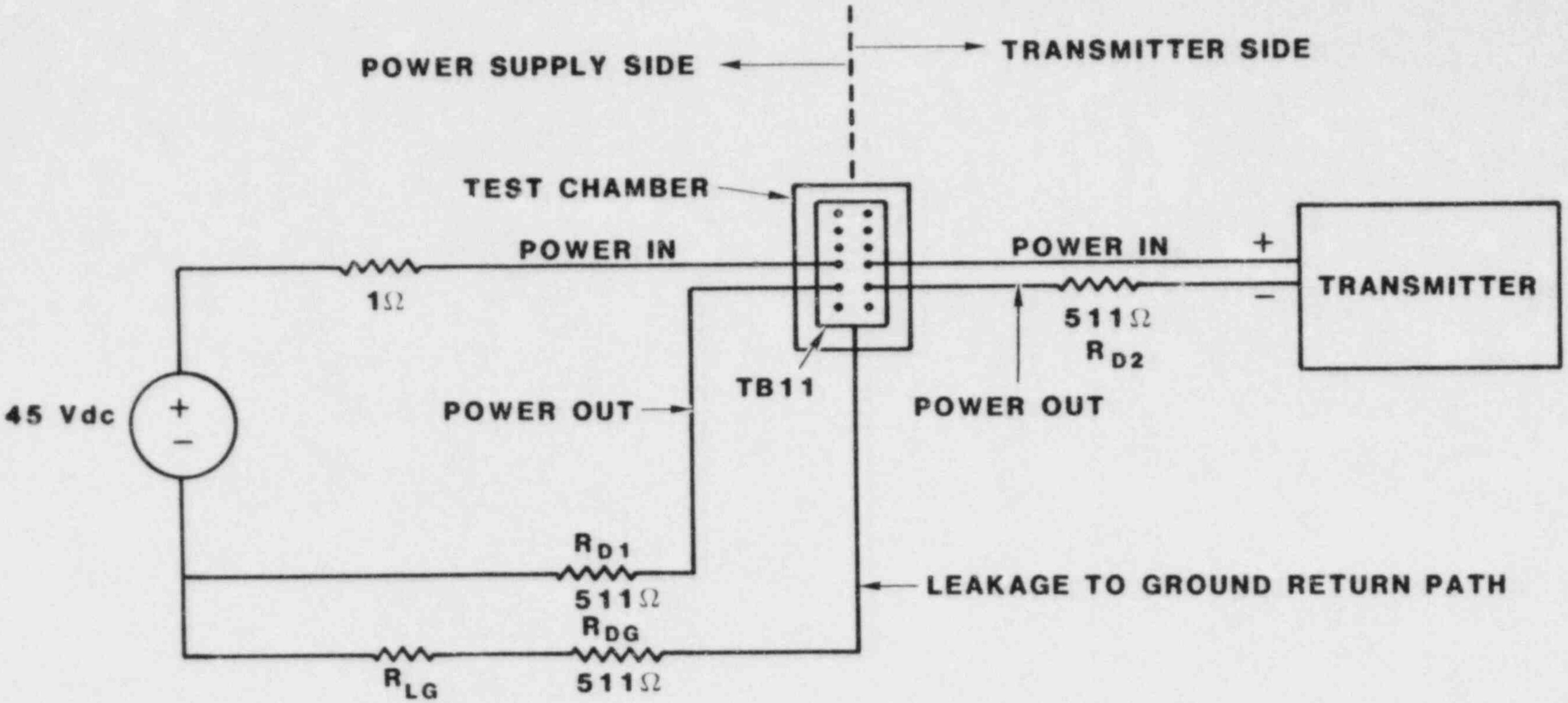

Figure 13

Transmitter Circuit Wired on Terminal Block 11

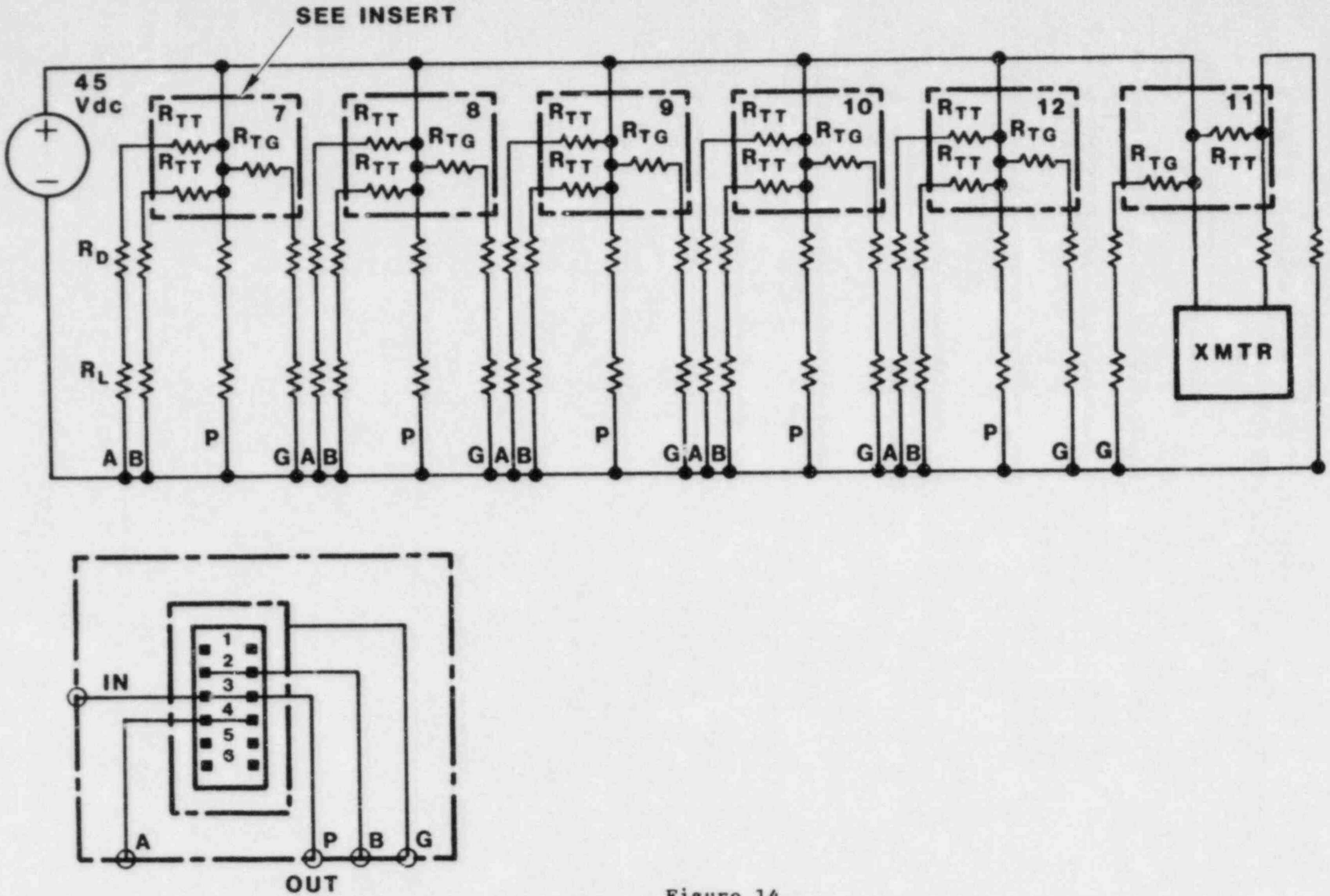

Figure 14

Detailed Circuit Schematic for Phase II 45 Vdc Terminal Blocks. R_{TT} and R_{TG} are the terminal-to-terminal and terminal-to-ground insulating resistances, respectively.

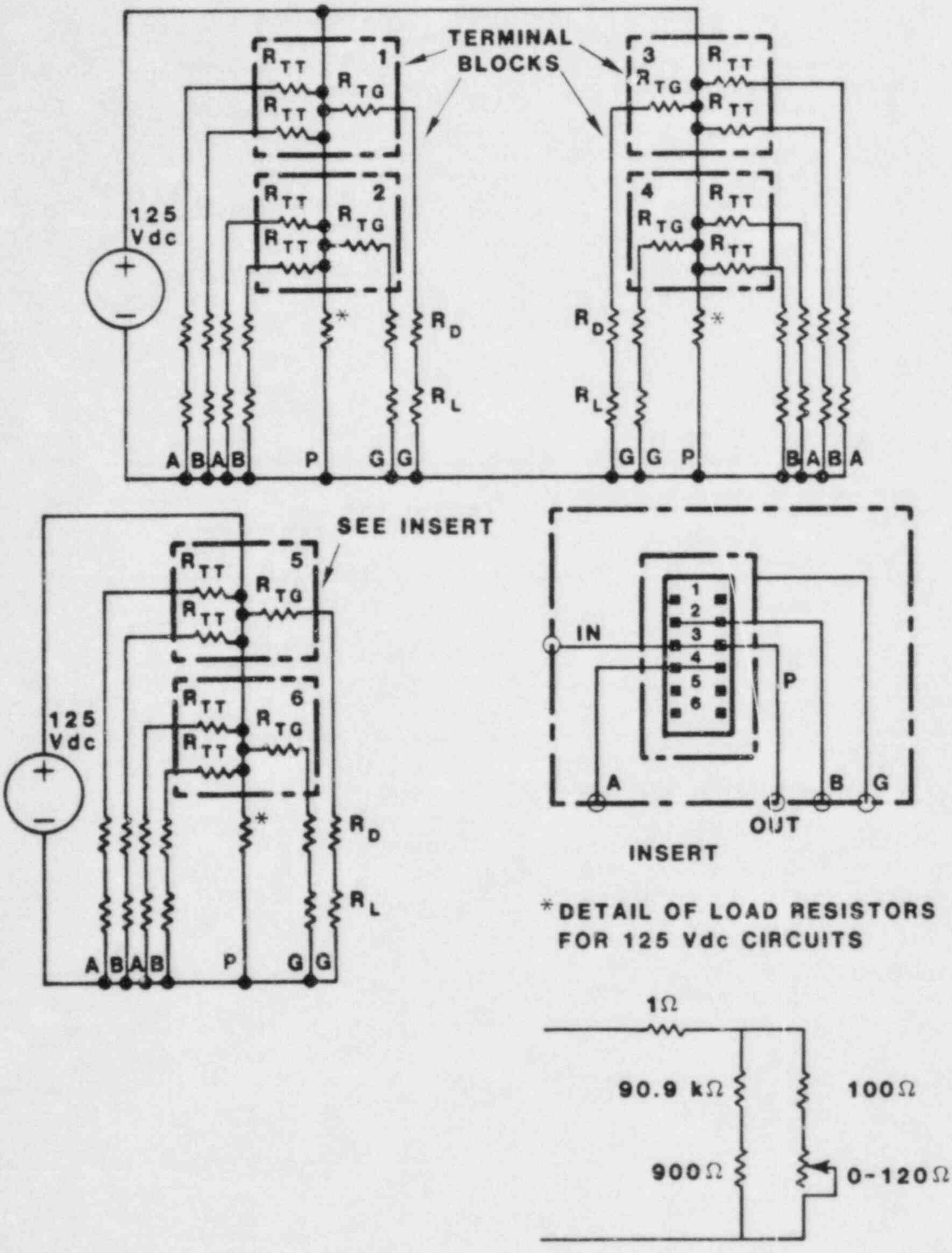

Figure 15

Detailed Circuit Schematic for Phase II 125 Vdc Terminal Blocks
R_{TT} and R_{TG} are the terminal-to-terminal and
terminal-to-ground insulation resistances, respectively.

4.0 RESULTS

4.1 Phase I Electrical Model

The serpentine connection of alternate poles used in Phase I did not provide a unique pole-to-pole resistive path. As Figure 16 illustrates, the serpentine connection of a six-pole terminal block actually provides 5 parallel resistive paths. Each of these paths, indicated R_1 through R_5 in Figure 16, is in turn a parallel combination of an infinite number of paths, i.e., a surface.*

In measuring the leakage currents the equivalent resistance of these 5 surfaces is actually measured. Without further data or assumptions the individual values of the surface equivalent resistances, R_1 through R_5 cannot be determined.

Figure 17 illustrates a simple circuit model for the Phase I electrical setup. R_{TT} is the terminal-to-terminal equivalent resistance representing the equivalent resistance for the parallel combination of R_1 through R_5. Similarly, R_{TG} is the terminal-to-ground equivalent resistance representing

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*The comment "surface" assumes that the surface resistance is many orders of magnitude less than the bulk resistance and therefore totally dominates the resistive behavior of the terminal block.

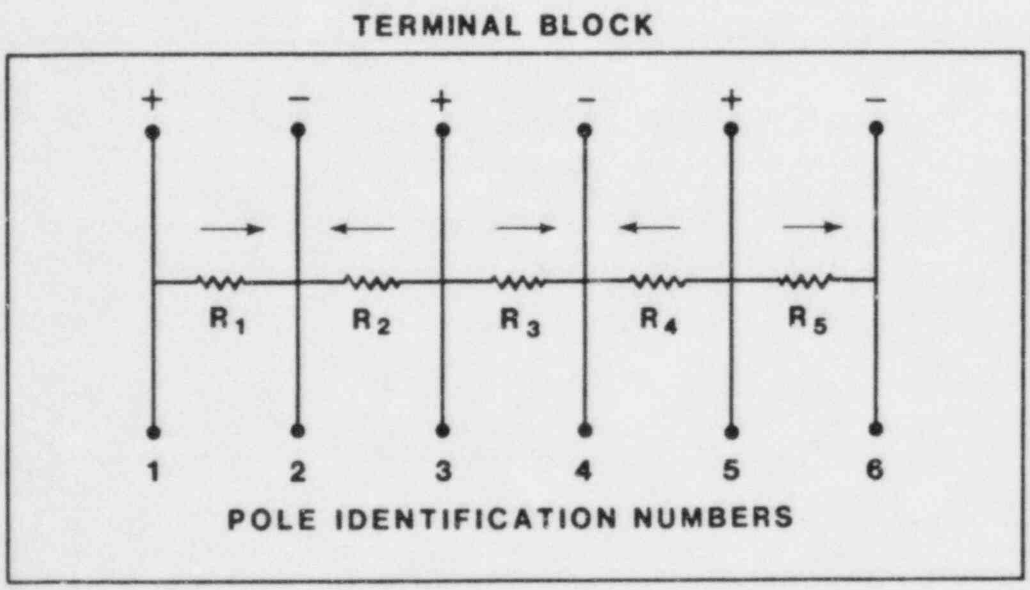

Figure 16

Phase I Schematic of Possible Resistive Paths on Six-Pole Terminal Block Connected in an Alternating Pole Serpentine

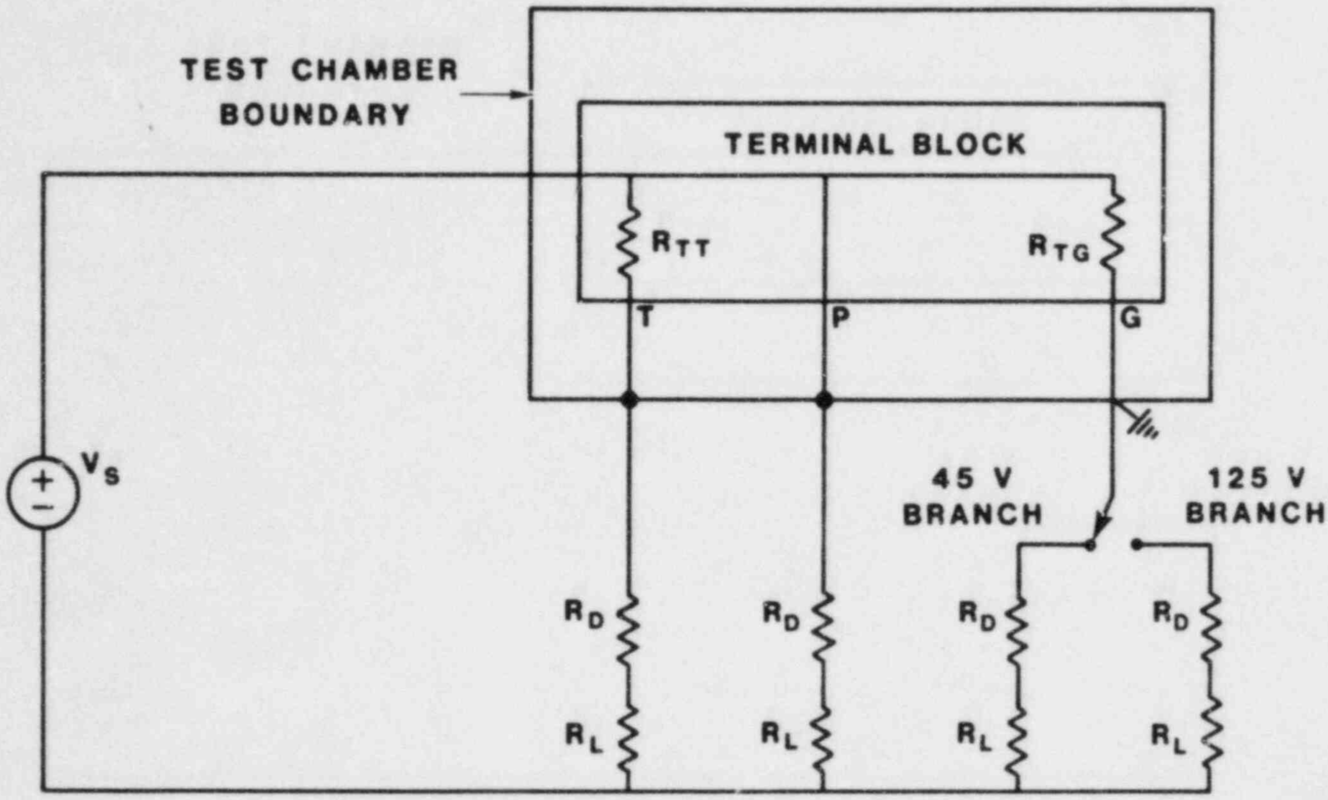

Figure 17

Electrical Circuit Model of the Phase I Tests

the parallel combination of each energized pole's resistance to ground. It is composed in the case of a 6-pole terminal block connected in an alternating pole serpentine, of at least 6 parallel paths to ground. Figure 17 also shows that the test chamber was connected to ground.

As mentioned in Section 3.4, this fact means that the G branch of the circuit was common to all terminal blocks as indicated Figure 11. The switch shown in Figure 17 allowed selection of an $R_D + R_L$ combination associated with either 45 Vdc power or 125 Vdc power. During the test the switch was normally in the 125 Vdc position; however, the current measured was representative of the total leakage from all 12 blocks to ground. Therefore, analysis of this data was not undertaken. Section 4.3.5 discusses the individual energizing of each block. For this special test, the power supplies that were turned off were removed from the circuit. In this configuration only the powered block contributed to the ground leakage current.

The P branch is the powered serpentine connection and hence there is no resistance internal to the terminal block larger than one or two ohms (which we ignore in this analysis). Knowing the power supply voltage, V_s, the values of the load bank resistances, R_D and R_L, and the voltage across R_D, V_D, a simple application of Ohm's Law determines the currents in each circuit branch, the potential, V_{TT}, across the insulation resistance, R_{TT}, and R_{TT} itself. The results are:

$$I_n = \frac{\Delta V_{Dn}}{R_{Dn}} \qquad (1)$$

where I is the current, ΔV_D is the measured voltage across R_D and n represents the specific branch under consideration. V_{TT}, the potential across R_{TT}, is

$$V_{TTn} = V_s - \Delta V_{Dn} \frac{R_{Dn} + R_{Ln}}{R_{Dn}} \qquad (2)$$

where V_s is the source voltage. Finally, the terminal-to-terminal equivalent resistance, R_{TT}, is

$$R_{TTn} = \frac{V_s R_{Dn}}{\Delta V_{Dn}} - (R_{Dn} + R_{Ln}) \qquad (3)$$

Equations 1, 2, and 3 are the equations used in the analysis of the Phase I data. Similar equations are used to calculated R_{TG}. Since R_{TT} and R_{TG} are surface resistances resulting from many interacting phenomena, the calculated values of R_{TT} or R_{TG} for each value of ΔV_D represent only their instantaneous values at the time of the measurement. Looking at the total population of readings, the average performance of the terminal blocks during the LOCA simulation can be constructed. However, many of the momentary variations in R_{TT} and R_{TG} seen on the continuous time strip chart recordings of leakage current are missed as a result of the discrete sampling by the datalogger. Also, due to the simplistic assumptions of the electrical model, the values of R_{TT} and R_{TG} should only be interpreted as order of magnitude values.

4.2 Phase II Electrical Model

Figure 18 is the circuit model used to analyze the Phase II data. The single pole energizing scheme used in Phase II permits us to characterize the insulation resistance for individual pole-to-pole and the cumulative pole-to-ground conduction paths. These paths are shown in Figure 18 as resistances R_{TTA}, R_{TTB} and R_{TG}. These resistances represent the equivalent resistance of the surface between poles and between the energized pole and ground. R_D is the resistance across which the voltage measurements were made and $R_D + R_L$ is the load resistance in each circuit branch. As for Phase I, with the values for each R_D, R_L and ΔV_D known, a simple applications of Ohm's Law yields the leakage current, the potential across the insulation resistance, and the insulation resistance for each path. The resulting equations are the same as for the Phase I model and are given by Equations (1), (2), and (3); these equations apply to the A, B, and G branches of the circuit shown in Figure 18.

V_s was calculated by determining the voltage drop across the $R_D + R_L$ series combination in the P branch. As a check, V_s was measured directly by the datalogger.

4.3 Phase I Data Discussion

4.3.1 Time-Weighted Average Data

Tables 6 shows the average values of terminal-to-terminal leakage current for the various temperature plateaus of the Phase I environmental profile. In order to account for the nonuniform sampling intervals, these average values are time weighted averages [13]. The weighting factor used is the length of the time interval bounded by the midpoints in time between the data point under consideration and its immediately

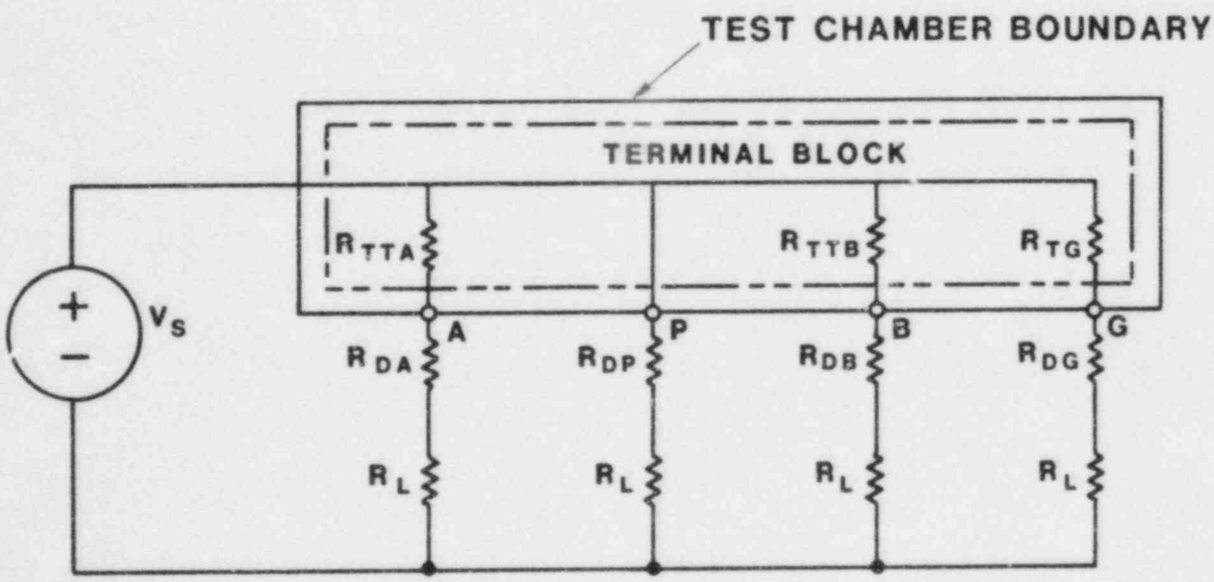

Figure 18

Electrical Circuit Model of the Phase II Tests previous and subsequent data points. For terminal blocks 1 through 6 (the 45 Vdc blocks) the 105°C period was subdivided to give a pre-4 Vdc period, a 4 Vdc period, and a post-4 Vdc period. To reflect these subdivisions, the 4 Vdc values are broken out into a separate column. The 45 Vdc values are tabulated in the first column in Tables 6 labeled 105°C. This column contains three entries: the two entries labeled "sub 1" and "sub 2" are the average values for the the pre-4 Vdc and post-4 Vdc subdivisions and the entry labeled "overall" is a combined average for these two 45 Vdc periods. Since this subdivision of the 105°C period is only germane to terminal blocks 1 through 6, terminal blocks 7 through 12 have only one entry under the first 105°C column which represents the average value of leakage current for the entire 105°C period.

Table 7 presents the data as average insulation resistance. These values were calculated from the average leakage currents tabulated in Table 6 by using Equation 3. The presentation of the data in Table 7 is identical to Table 6.

Figure 19 compares the average leakage current data for the Phase I terminal blocks. The data is presented in terms of insulation resistance (IR) in Figure 20. Each block generally follows the same general performance trend. The highest leakage currents were usually experienced during the second 172°C period. They decreased with decreasing temperature. This pattern was followed at both 45 Vdc and 125 Vdc. Insulation resistance varied from as low as 250 ohms for terminal block 3 at 161°C to as high as 1.3×10^6 ohms for terminal block 12 at 105°C. The general range for all blocks was from 10^3 to 10^5 ohms.

From Table 7 we see that the initial ambient insulation resistance values for the 45 Vdc terminal blocks are approximately two orders of magnitude below the initial ambient IR values for the 125 Vdc blocks. These low values are a result of an extraneous 2 to 4 millivolt signal experienced across measurement resistors in the 45 Vdc circuits that was not experienced in the 125 Vdc circuits. The only difference in these sets of circuits was the physical placement of the R_D and R_L resistors in the load bank. As Figure 11 shows, the R_D resistors in the 45 Vdc circuits were electrically located next to the low side of the power supply, while in the 125 Vdc circuits, the R_D resistors were separated electrically from the low side of the power supplies by the R_L resistors. This variation in assembly technique should not have introduced this "background" signal so another source was suspected. Several attempts to identify the source were made with no success. The effect on the high temperature data, however, was minimal since signals on the order of volts were generated by the leakage currents. Only the low level signals experienced during ambient temperature periods and the cooldown after the first 172°C period are significantly impacted. No attempt was made to compensate for this background signal computationally since its effect was limited to the low temperature periods.

TABLE 6

Terminal-to-Terminal Leakage Currents for Phase I Terminal Blocks
(mA)

TB Number Plot Symbol and Voltage	Ambient	172°C ○	95°C	172°C ●	161°C ▽	150°C ▲	122°C □	105°C ▽	105°C 4 Vdc ▽
1 ○ 45 Vdc	8.4E-03	5.8E+00	2.3E-02	7.7E+00	4.2E+00	3.4E+00	1.3E+00	Sub 1: 1.6E+00 Sub 2: 1.0E+00 Overall: 1.4E+00	2.0E-01
2 □ 45 Vdc	8.5E-03	4.9E+00	1.1E-01	1.7E+01	1.1E+01	5.2E+00	2.0E+00	Sub 1: 5.4E+00 Sub 2: 2.9E+00 Overall: 4.7E+00	3.2E-01
3 □ 45 Vdc	9.1E-03	4.6E+00	2.0E-02	1.7E+01	1.8E+01	1.6E+01	3.5E+00	Sub 1: 5.9E+00 Sub 2: 3.6E+00 Overall: 5.3E+00	5.6E-01
4 △ 45 Vdc	9.0E-03	6.3E+00	1.4E-02	9.1E+00	4.8E+00	3.5E+00	1.2E+00	Sub 1: 1.3E+00 Sub 2: 4.1E-01 Overall: 1.0E+00	8.8E-02
5 △ 45 Vdc	8.7E-03	5.6E+00	1.2E-02	8.8E+00	4.4E+00	3.0E+00	7.7E-01	Sub 1: 1.1E+00 Sub 2: 7.4E-01 Overall: 9.9E-01	9.3E-02
6 ▽ 45 Vdc	7.8E-03	3.6E+00	9.8E-03	4.3E+00	2.5E+00	1.7E+00	2.4E-01	Sub 1: 6.9E-01 Sub 2: 2.2E-01 Overall: 5.6E-01	6.3E-02

TABLE 6 (continued)

Terminal-to-Terminal Leakage Currents for Phase I Terminal Blocks
(mA)

TB Number Plot Symbol and Voltage	Ambient	172°C ○	95°C	172°C ●	161°C △	150°C ▲	122°C □	105°C ▽
7 ○ 125 Vdc	1.5E-04	8.7E+00	1.8E-02	6.2E+00	3.2E+00	2.1E+00	8.0E-01	7.0E-01
8 ○ 125 Vdc	1.3E-04	8.1E+00	2.2E-02	6.2E+00	3.6E+00	2.5E+00	9.5E-01	1.2E+00
9 □ 125 Vdc	1.9E-04	3.4E+01	2.9E-01	4.7E+01	2.7E+01	2.1E+01	1.5E+01	1.3E+01
10 △ 125 Vdc	2.6E-04	4.0E+00	5.5E-03	4.2E+00	1.5E+00	8.3E-01	4.2E-01	1.9E+00
11 ▽ 125 Vdc	3.3E-04	3.7E+00	4.0E-04	2.4E+00	6.8E-01	2.8E-01	2.5E-01	6.2E-01
12 ▽ 125 Vdc	2.3E-04	8.9E-01	1.3E-01	2.0E+00	8.0E-01	7.4E-01	5.3E-01	5.9E-01

TABLE 7

Terminal-to-Terminal Insulation Resistance for Phase I Terminal Blocks (kohms)

TB Number Plot Symbol and Voltage	Ambient	172°C ○	95°C	172°C ●	161°C △	150°C ▲	122°C □	105°C ▽	105°C 4 Vdc ▽
1 ○ 45 Vdc	5.4E+03	5.6E+00	2.0E+03	3.6E+00	8.5E+00	1.1E+01	3.2E+01	Sub 1: 2.7E+01 Sub 2: 4.1E+01 Overall: 3.0E+01	[illegible].0E+01
2 □ 45 Vdc	5.3E+03	7.0E+00	4.0E+02	3.7E-01	1.8E+00	6.4E+00	2.0E+01	Sub 1: 6.1E+00 Sub 2: 1.3E+01 Overall: 7.4E+00	1.1E+01
3 □ 45 Vdc	4.9E+03	7.6E+00	2.3E+03	4.4E-01	2.5E-01	5.9E-01	1.1E+01	Sub 1: 5.3E+00 Sub 2: 1.0E+01 Overall: 6.3E+00	5.4E+00
4 △ 45 Vdc	5.0E+03	4.9E+00	3.2E+03	2.7E+00	7.1E+00	1.1E+01	3.7E+01	Sub 1: 3.4E+01 Sub 2: 1.1E+02 Overall: 4.2E+01	4.6E+01
5 △ 45 Vdc	5.2E+03	5.8E+00	3.6E+03	2.9E+00	7.9E+00	1.3E+01	5.6E+01	Sub 1: 3.9E+01 Sub 2: 5.8E+01 Overall: 4.3E+01	4.4E+01
6 ▽ 45 Vdc	5.8E+03	1.0E+01	4.6E+03	8.2E+00	1.5E+01	2.4E+01	1.8E+02	Sub 1: 6.3E+01 Sub 2: 2.0E+02 Overall: 7.8E+01	6.6E+01

TABLE 7 (continued)

Terminal-to-Terminal Insulation Resistance for Phase I Terminal Blocks
(kohms)

TB Number Plot Symbol and Voltage	Ambient	172°C ○	95°C	172°C ●	161°C △	150°C ▲	122°C □	105°C ▽
7 ○ 125 Vdc	8.6E+05	1.5E+01	7.0E+03	2.1E+01	4.0E+01	6.2E+01	1.6E+02	1.8E+02
8 ○ 125 Vdc	1.0E+06	1.6E+01	5.9E+03	2.1E+01	3.5E+01	5.1E+01	1.3E+02	1.0E+02
9 □ 125 Vdc	6.8E+05	3.6E+00	4.4E+02	2.6E+00	4.5E+00	5.9E+00	8.5E+00	9.7E+00
10 △ 125 Vdc	4.9E+05	3.1E+01	2.3E+04	3.0E+01	8.7E+01	1.5E+02	3.0E+02	6.6E+01
11 ▽ 125 Vdc	3.9E+05	3.4E+01	3.2E+05	5.2E+01	1.9E+02	4.6E+02	5.0E+02	2.0E+02
12 ▽ 125 Vdc	5.6E+05	1.4E+02	1.0E+03	6.2E+01	1.6E+02	1.7E+02	2.4E+02	2.1E+02

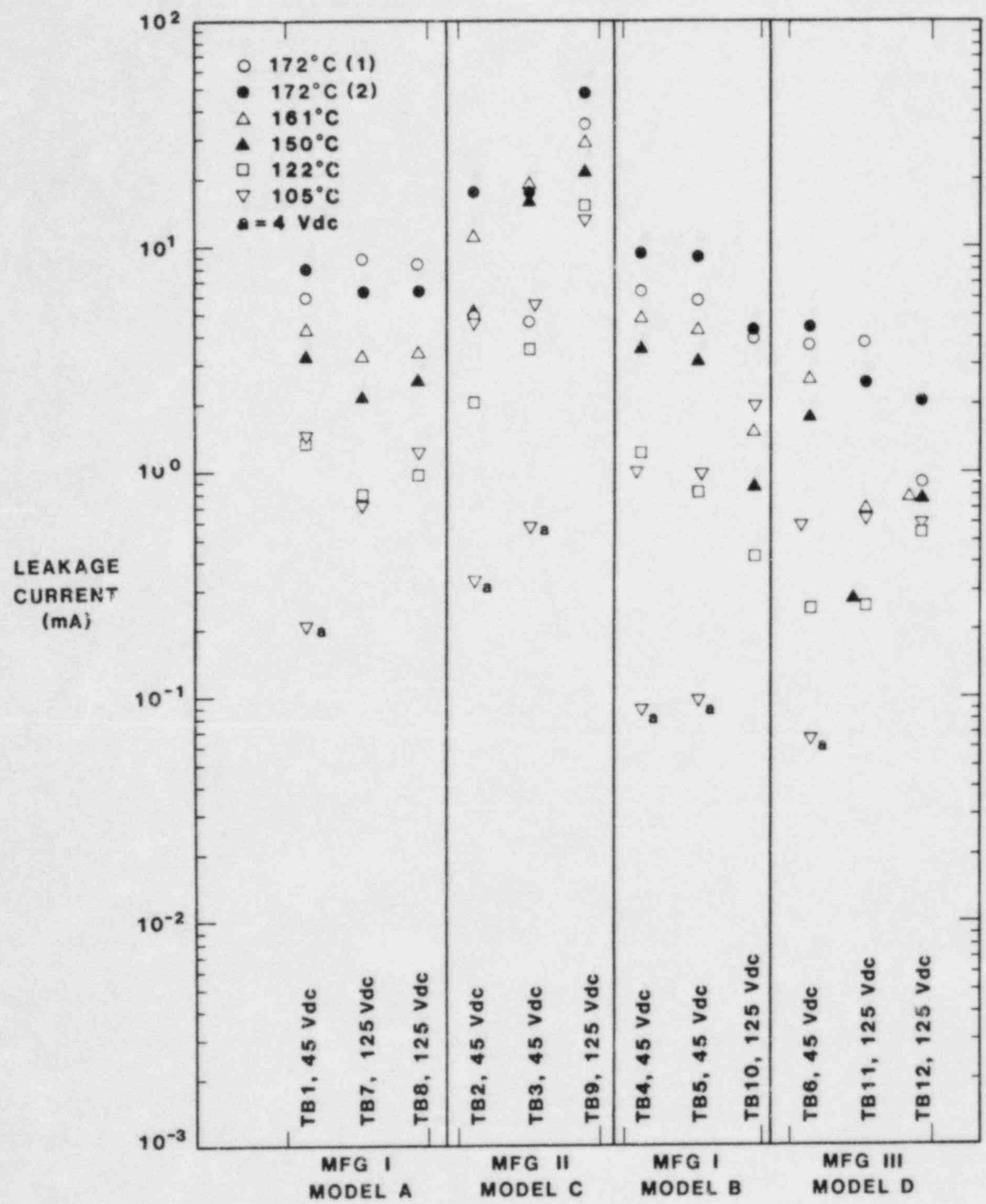

Figure 19

Terminal-to-Terminal Leakage Currents for Phase I Terminal Blocks

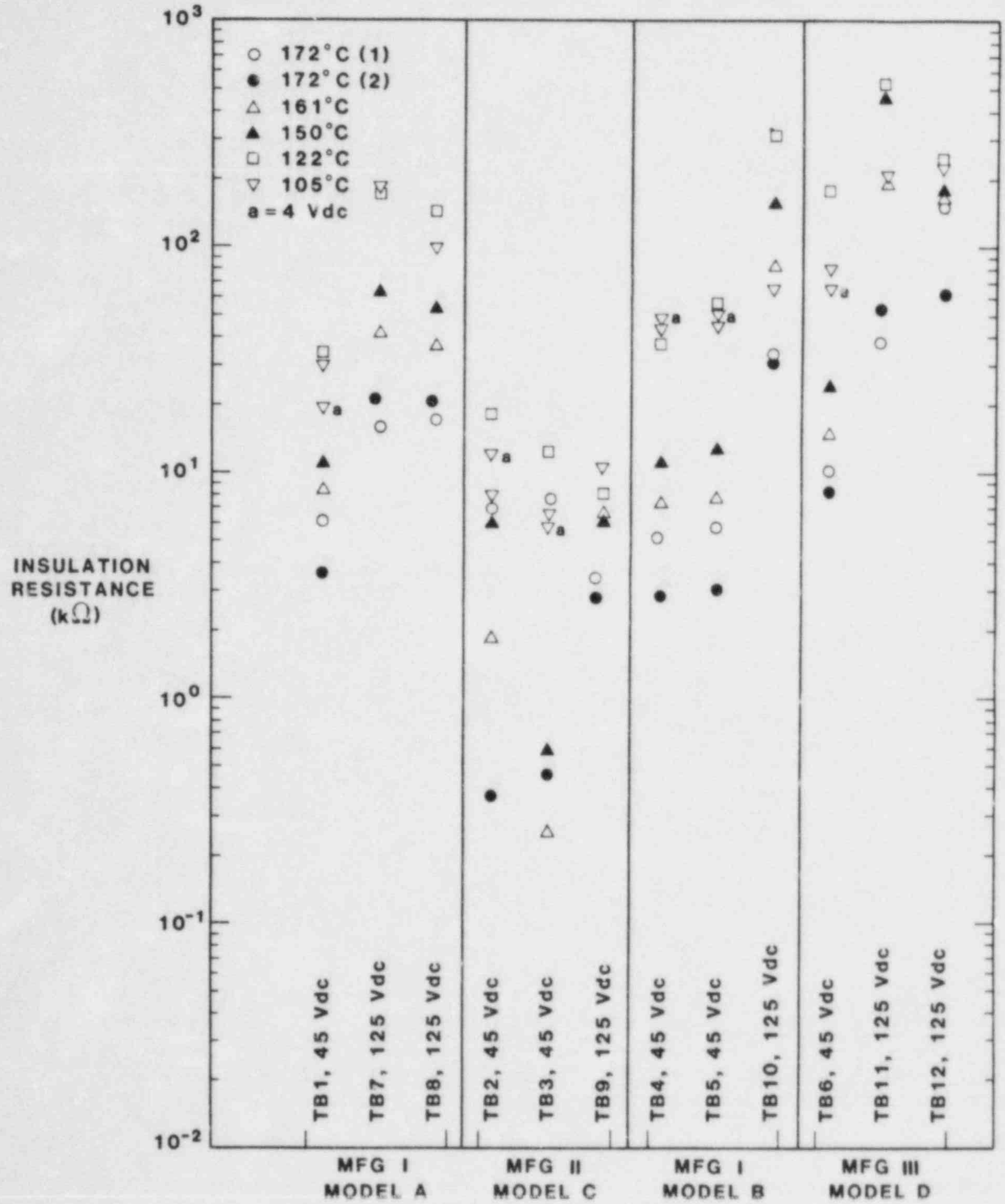

Figure 20

Terminal-to-Terminal Insulation Resistance for Phase I Terminal Blocks

4.3.2 Error Analysis

A traditional error analysis was originally performed for each data point, however the results gave standard deviations that were in some cases larger than the average value obtained for each plateau. This result was a consequence of the fact that the data was not normally distributed and was in some cases stratified in regions two orders of magnitude apart. We therefore adopted a quartile ranking of the data to provide some insight into the spread of the data. This quartile ranking method is explained in the next section.

Instrument error was found to be insignificant when compared to the variation in the data itself. The instrument error was 0.05% (voltage) to 0.1% (resistance) of the readings and was initially folded into the calculations of derived values to confirm that the propagated error from this source remained less than 0.5%. Since the spread in the data itself much exceeds this number, the instrumental error was neglected after this initial check on its propagation.

4.3.3 Quartile Data Presentation

To provide insight into the spread of the data, a quartile presentation method was used. Commonly referred to as a five-number summary table and/or a box and whisker plot [14], the data is presented as a group of five numbers: the median, the upper and lower quartiles, and the two extreme values. To pick these numbers requires the data be ordered and that they be uniformly distributed. Since the data points are unevenly spaced in time, a pseudo-frequency, β, normalized to the number of data points in the period is derived from the time weights associated with each data point. β is defined by the relation:

$$\beta = \frac{w_i}{\sum_{i=1}^{n} w_i} \cdot n$$

where w_i is the time weight for the i^{th} data point, and n is the number of data points in the period under consideration. The data point in the lower quartile position is the k^{th} data point in the ordered data set, where k is the integer index which most closely satisfies the expression:

$$\sum_{i=1}^{k} \beta_i = 0.25\ n$$

Similarly, the median and upper quartile data points are those points in the k^{th} position of the ordered data set where k respectively satisfies the expressions:

$$\sum_{i=1}^{k} \beta_i = 0.5\ n$$

and

$$\sum_{i=1}^{k} \beta_i = 0.75\ n$$

The ordered data set referred to is simply the data points for a given period arranged in ascending order, low to high value. Fifty percent of the time-weighted data lie between the lower and upper quartile, and the median divides the time-weighted data into two equal groups. This presentation, coupled with the time-weighted average and deviation presentation gives a reasonably clear view of the spread in the data. Appendix 1 presents the five number summaries for insulation resistance in tabular and graphical form, and the leakage current data in tabular form.

4.3.4 Temperature and Voltage Effects

Figures 21 through 24 present the data in a different format. They show the variation between terminal blocks at the various temperatures for 45 Vdc and 125 Vdc. At each temperature, we see a 1 to 2 order of magnitude spread between the various terminal blocks. At lower temperatures, (i.e., 105°C and 122°C) the insulation resistances are generally one order of magnitude greater than at the higher temperatures (i.e., 150°C, 161°C and 172°C). This observation is in agreement with general theories on conductivity of electrolytic solutions [15] that predict an inverse relationship of resistivity with temperature.

To illustrate more precisely the type behavior observed, Figures 25 and 26 present insulation resistance data for terminal block 1. Figure 25 is an expanded view of the insulation resistance observed during the first steam ramp and 172°C plateau in the Phase I test profile. The insulation resistance drops dramatically to the 6 kohm region and remains relatively constant throughout the temperature plateau. The temperature data shown is for thermocouple 5 which is measuring the interior temperature of the NEMA 4 enclosure housing terminal block 1. Figure 26 shows the behavior of terminal block 1's insulation resistance during the second 172°C temperature plateau and the 161°C plateau. Again, it is clear that a correlation with temperature exists. During the cooldown period between the two 172°C plateaus the insulation resistance returns to values on the order of one Mohm.

Because of scaling problems, the variations with temperature are more easily illustrated using leakage current data. Figure 27 shows the leakage currents for terminal blocks 1 and 2 and a temperature trace for thermocouple 5. Note that the leakage currents rise dramatically just after the steam is introduced, then return to essentially zero (considering the scale) for both terminal blocks at the minimum temperature point between the two 172°C plateaus.

We hypothesize that a moisture film on the terminal blocks is the most reasonable explanation for this transient type behavior. The conditions appropriate for film formation and disappearance can be identified by examining the temperatures of terminal blocks relative to the temperature and pressure environments of the test chamber. Figure 28 shows the temperature trace for thermocouples 1 and 3 through the first 30 minutes of the environmental exposure.* Figure 29 extends this plot through the first two 172°C plateaus of the environmental exposure. Thermocouple 1 measured the temperature of a spare pole on terminal block 6, and thermocouple 3 measured the interior temperature of the enclosure housing terminal block 6. As Figure 28 shows, the terminal block temperature lagged the environment temperature during the steam ramp and shortly thereafter, thus setting up the condition necessary for surface film formation on the terminal blocks. The leakage currents shown in Figure 27 rise dramatically during this initial period of time indicating increased conduction in the surface film. Returning to Figure 29, we see that during the cooldown period between the two 172°C plateaus the traces of thermocouples 1 and 3 cross, indicating that the environment is cooling more rapidly than the terminal blocks. The terminal block temperature dropped to 122°C, whereas the enclosure interior dropped to 114°C. The temperature outside the enclosure dropped to approximately 99°C. Furthermore, throughout the cooling process the terminal block temperature lagged the enclosure atmospheric temperature by several degrees Centigrade. This difference in temperatures is not unexpected due to the thermal mass of the terminal blocks and the available heat loss mechanisms. It is also reasonable to expect a water film on the terminal block to be at the temperature of the terminal block or fractionally below it. During the cooling process the steam atmosphere surrounding the terminal blocks will remain at saturation temperature and pressure. Since the atmosphere is cooler than the terminal block and its film, the vapor pressure of the film will be greater than the surrounding steam saturation pressure and the film will vaporize. The conductive film therefore disappears and the insulation resistance increases, as observed.

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*Thermocouples 1 and 3 in electrical enclosure 2 were chosen to illustrate these points since only data from thermocouple 5 in electrical enclosure 1 was digitized and readily available for plotting. Thermocouple 4 data, which is analogous to thermocouple 1, was recorded on a strip chart recorder in analog millivolt form. The relative behavior between thermocouple 1 and thermocouple 3 should be exactly the same as between thermocouple 4 and thermocouple 5.

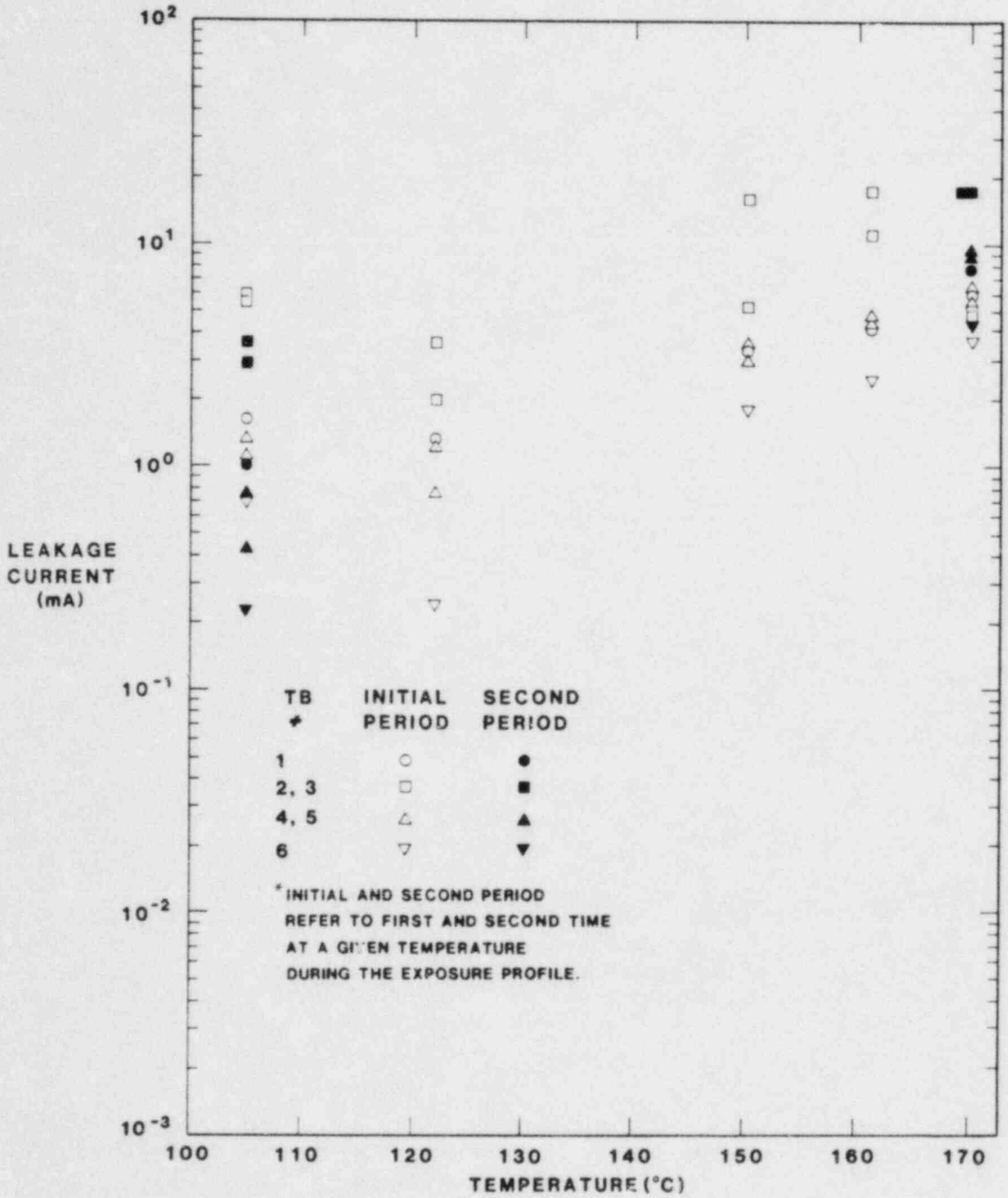

Figure 21

Temperature Variation of Leakage Currents for Phase I Terminal Blocks at 45 Vdc

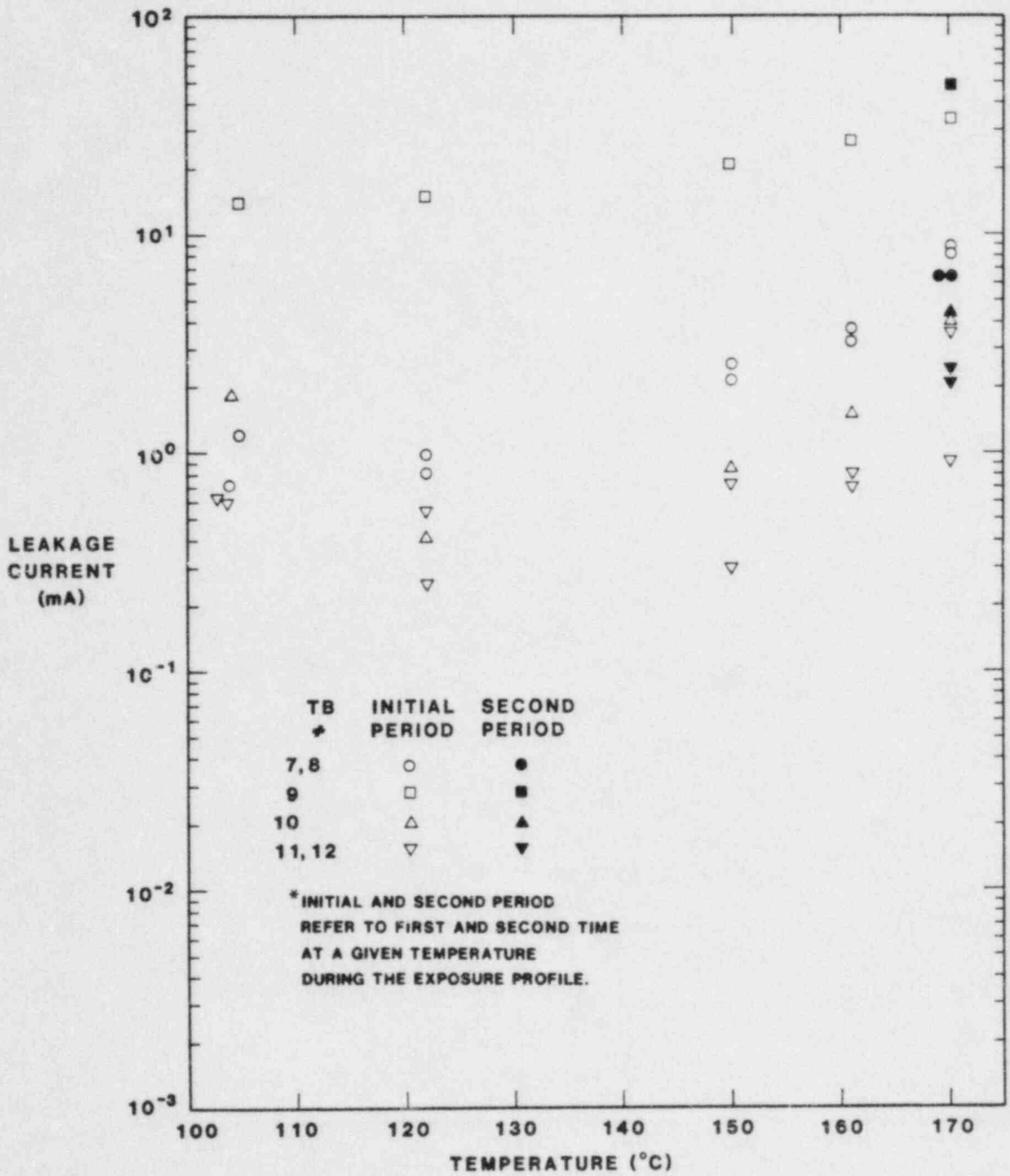

Figure 22

Temperature Variation of Leakage Currents for Phase I Terminal Blocks at 125 Vdc

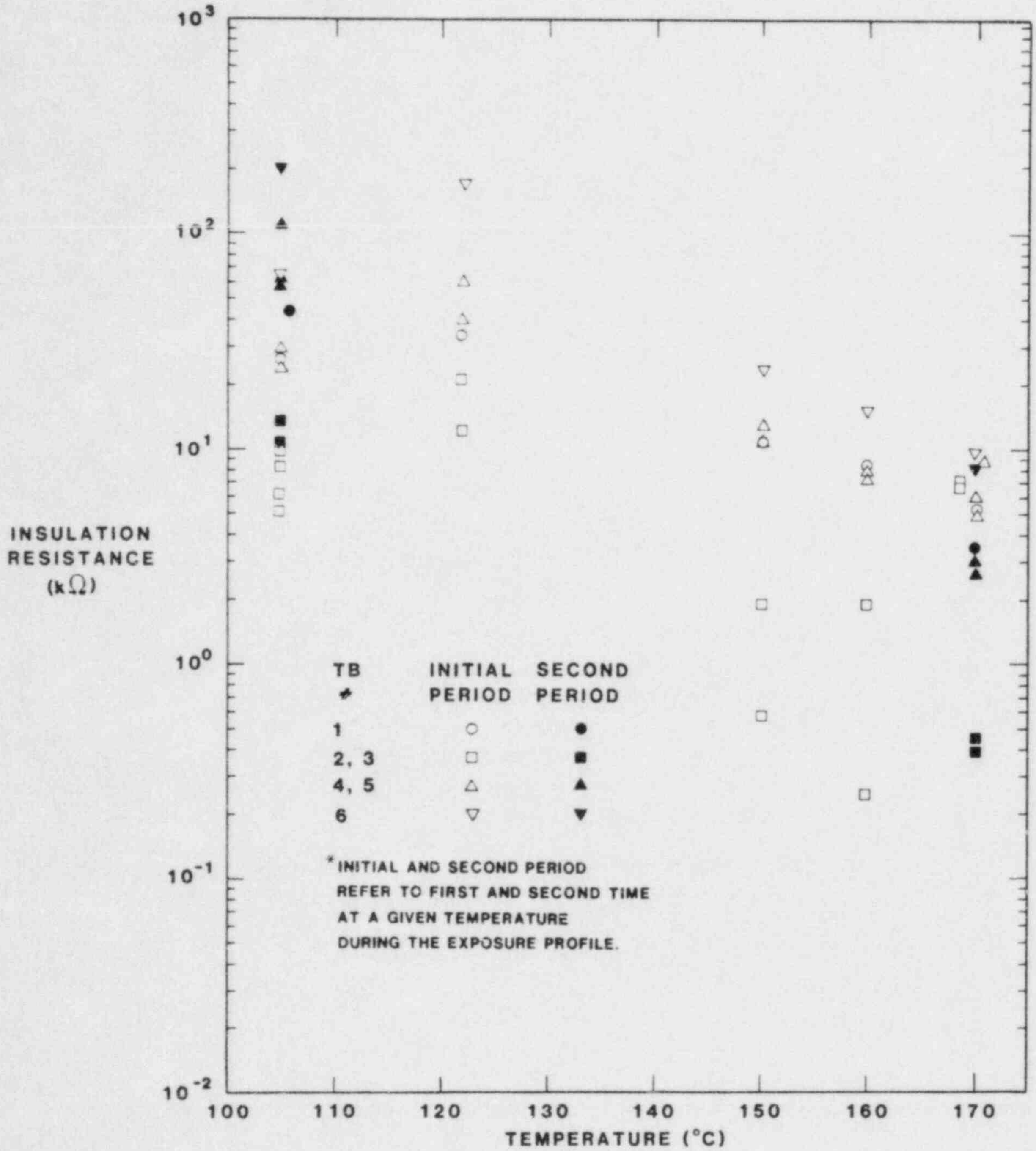

Figure 23

Temperature Variation of Insulation Resistance for Phase I Terminal Blocks at 45 Vdc

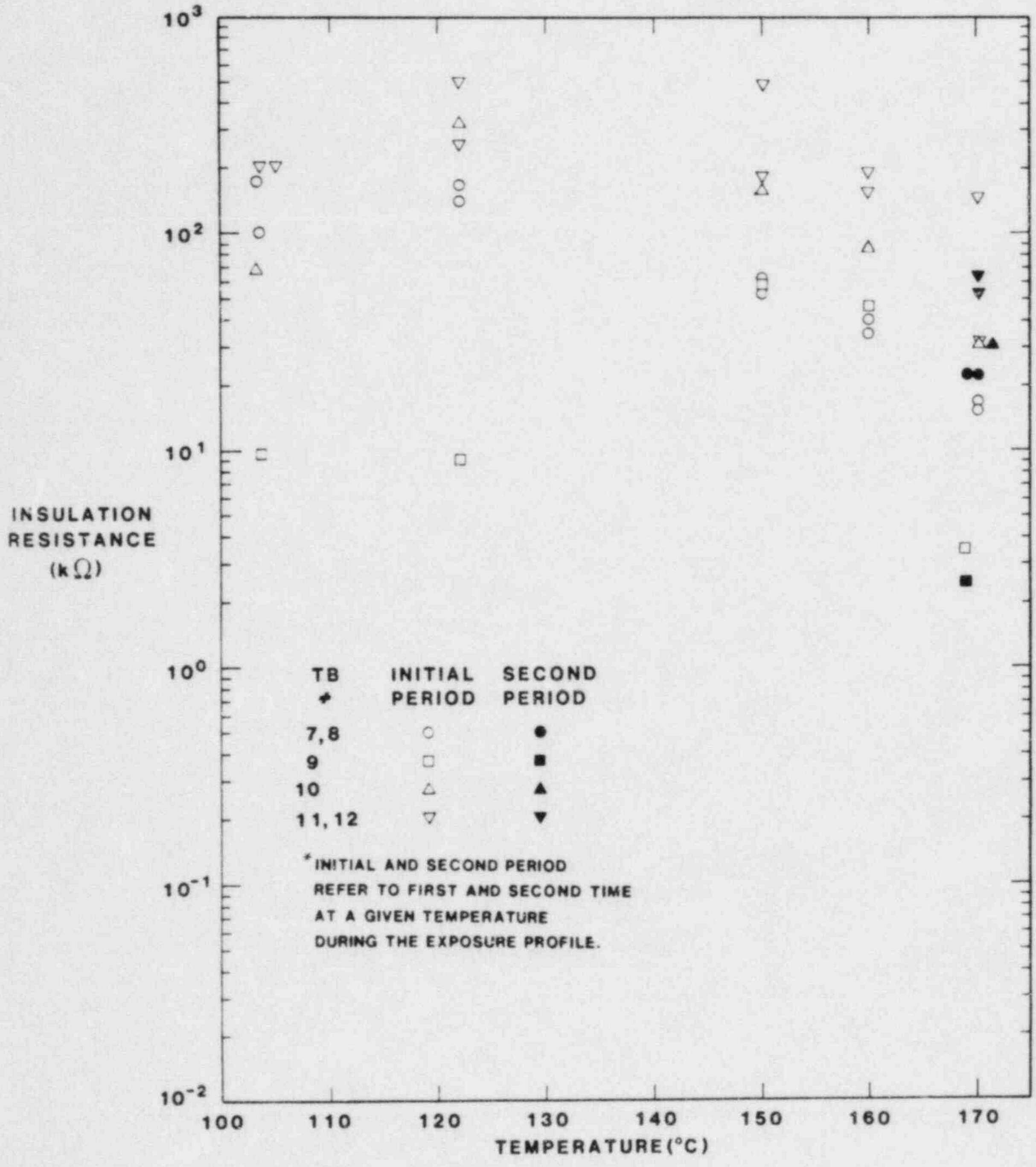

Figure 24

Temperature Variation of Insulation Resistance for Phase I Terminal Blocks at 125 Vdc

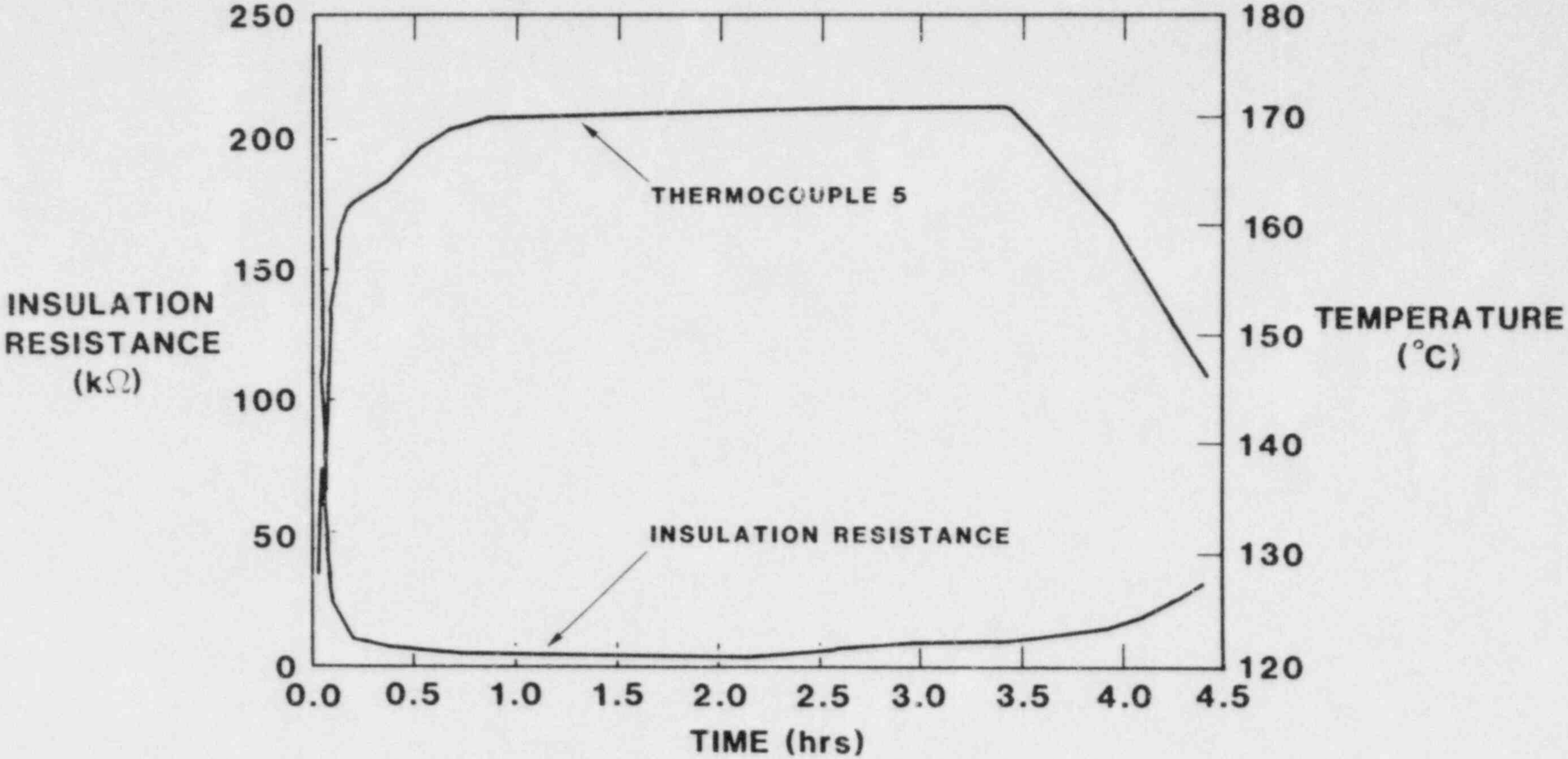

Figure 25

Insulation Resistance for Terminal Block 1 During First Steam Ramp and 172°C Plateau. Temperature trace is for thermocouple 5.

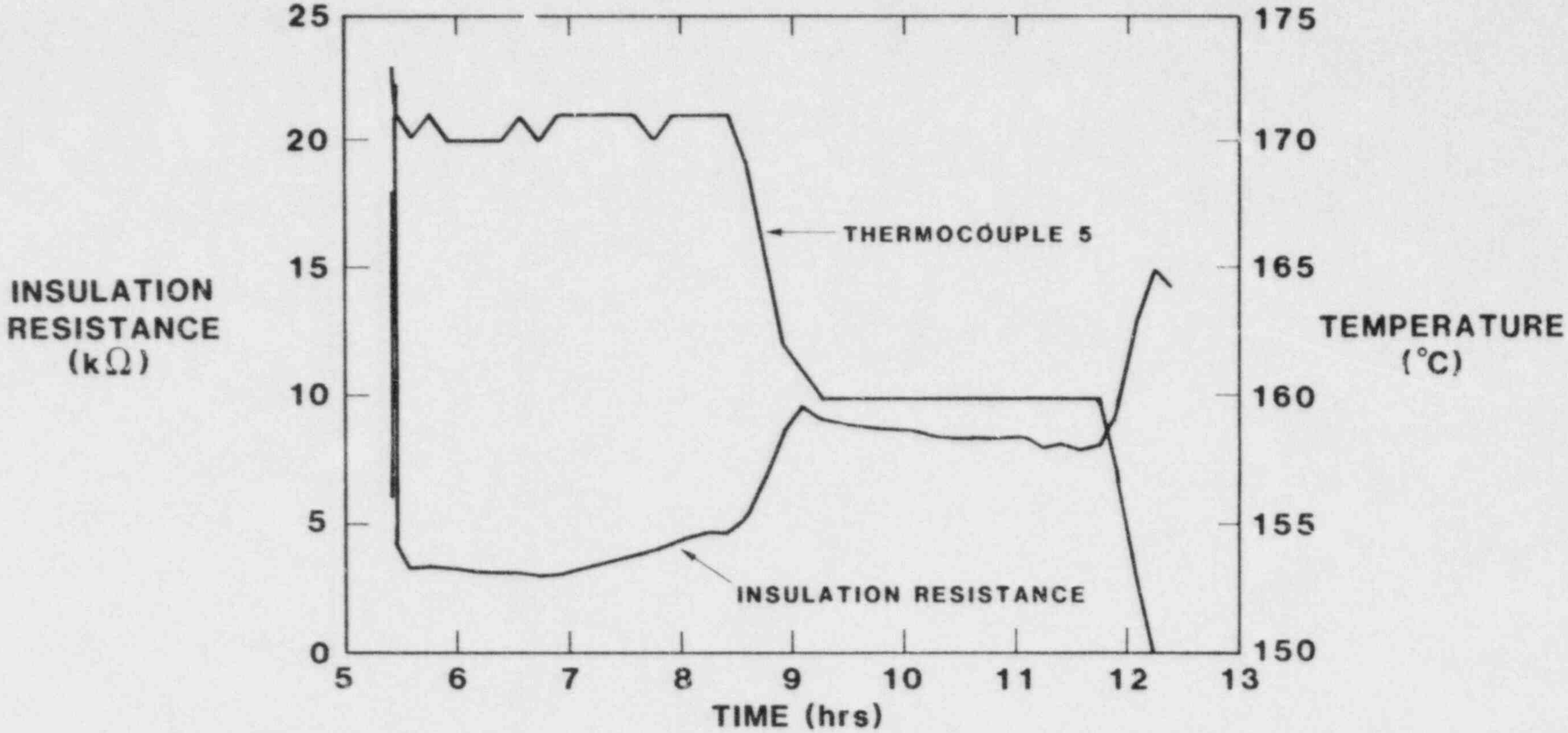

Figure 26

Insulation Resistance for Terminal Block 1 From Near the Beginning of the First 172°C Plateau Through the 161°C Plateau. Temperature trace is for thermocouple 5.

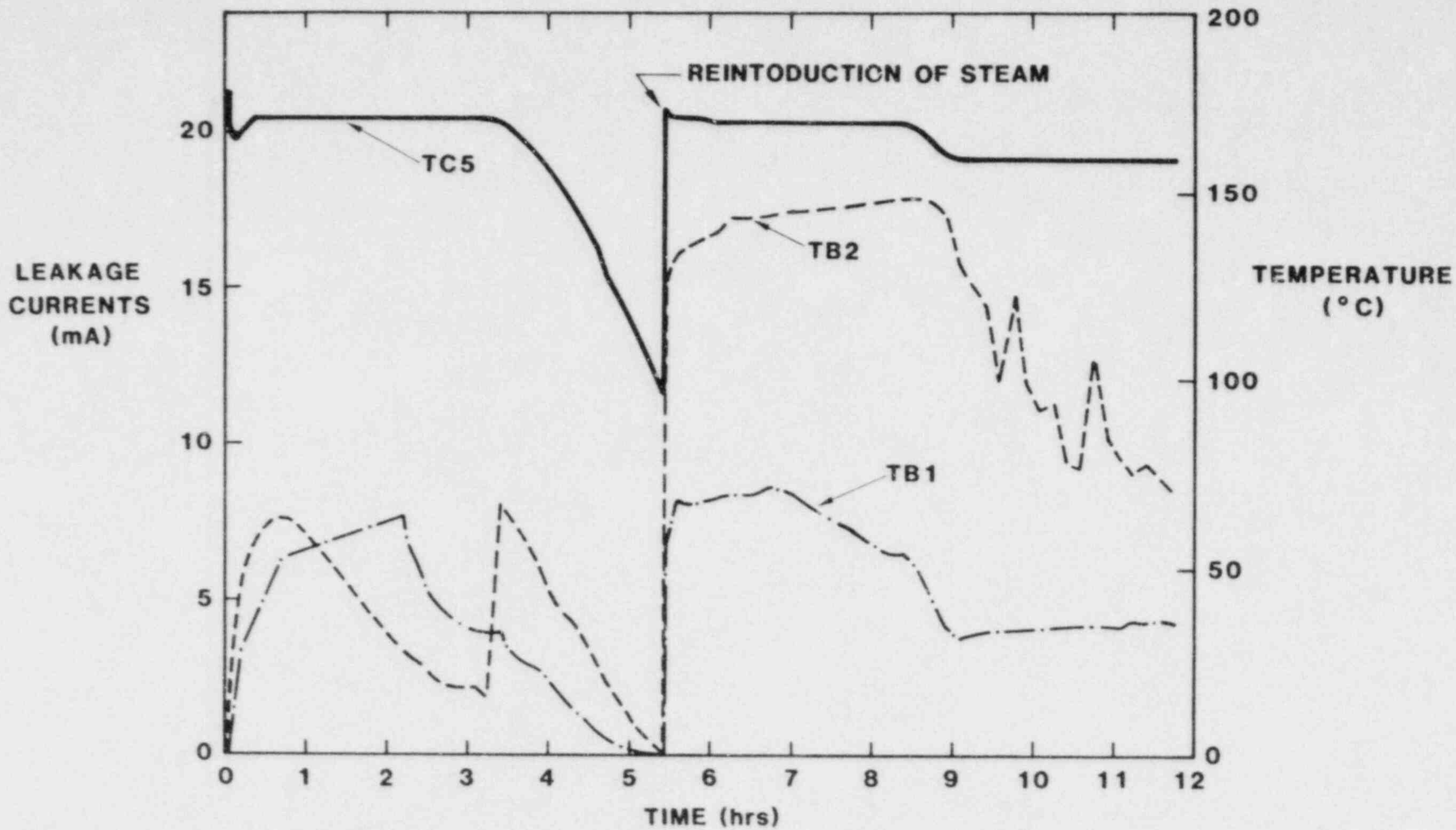

Figure 27

Leakage Currents for Terminal Blocks 1 and 2 During the First Two 172°C Temperature Plateaus of the Environmental Exposure. Temperature trace is for thermocouple 5.

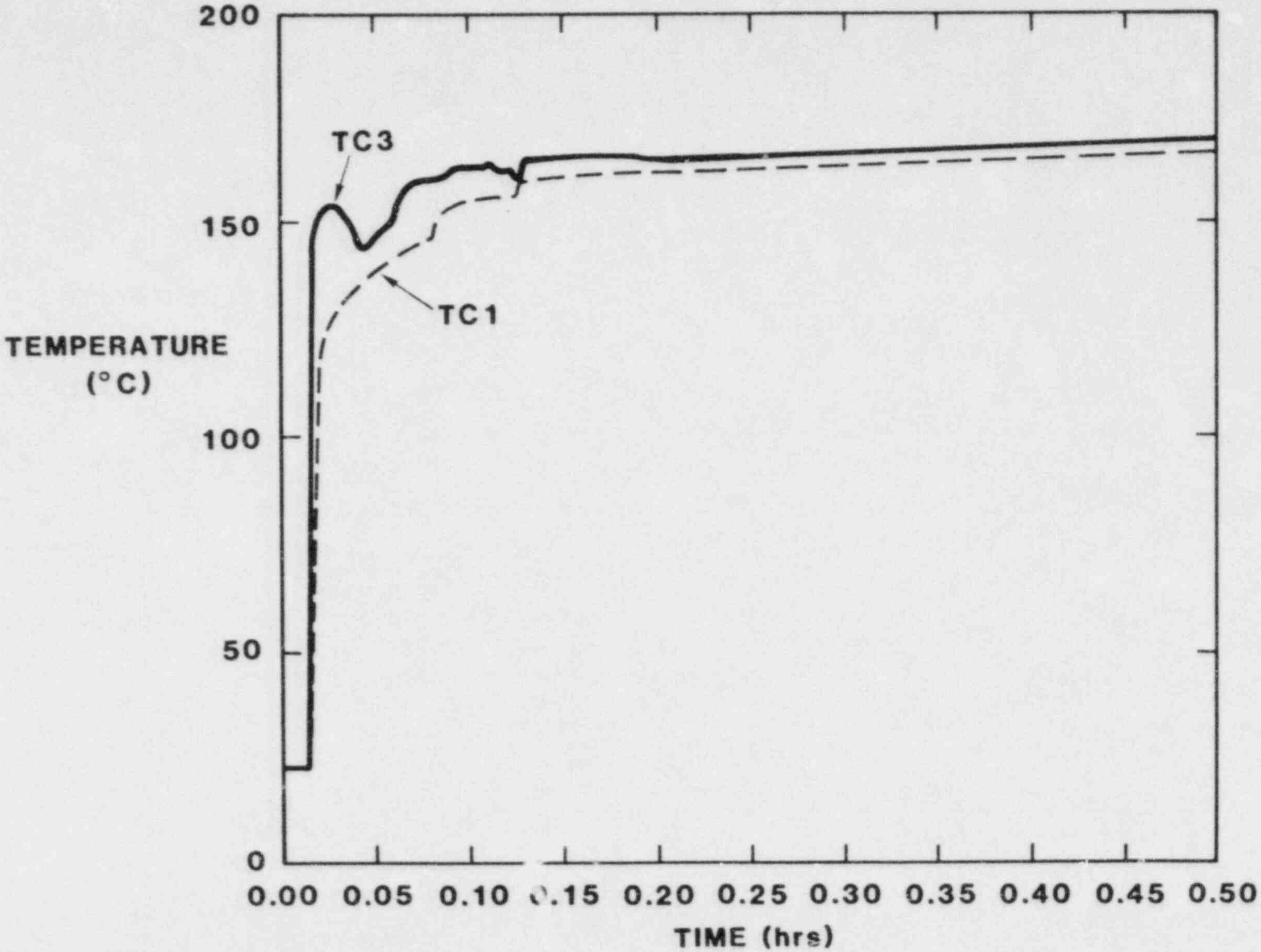

Figure 28

Enlarged View of the Temperature Traces for Thermocouples 1 and 3
During the First 30 Minutes of the Phase I Environmental Exposure

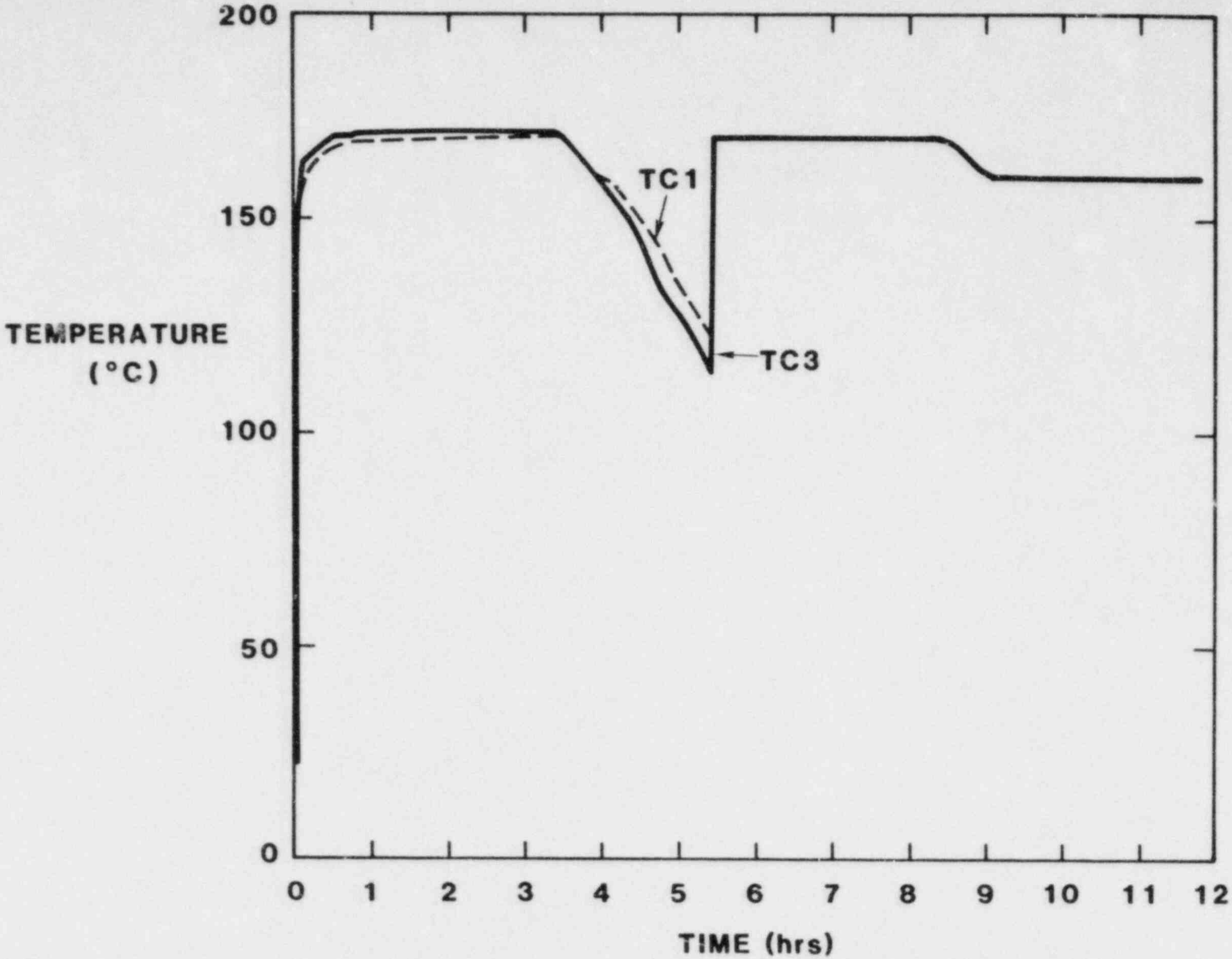

Figure 29

Temperature Traces for Thermocouples 1 and 3 During the First Two 172°C Temperature Plateaus of the Phase I Environmental Exposure

Since saturated steam conditions were maintained throughout the test, the temperature dependence could also have been interpreted as a pressure dependence. Pressure per se, though, is not the governing factor in film conduction, but it is important in determining the conditions necessary for film formation. If a system is superheated, and at equilibrium, films will not form and the performance of the terminal block will be relatively good. Similarly, if the terminal block temperature is above the dew point in an air environment the same condition will exists. Alternately, if the terminal block temperature is below the dew point in an air environment, or if films have formed due to a cool terminal block being surrounded with steam and the system remains at saturation, films will form and remain on the surface of the terminal block.

The implications of the film hypothesis are that test environmental conditions should accurately reflect the expected accident conditions. Initially, in an accident one would expect cool terminal blocks to be surrounded with steam and thus moisture films would form. If saturated conditions then prevailed or superheated conditions existed only for a short time, the films can be expected to remain on the terminal blocks. Thus, test conditions which do not reflect the dominant pressure and temperature conditions anticipated in an accident may bias the results of the test. Tests which employ superheated conditions throughout much of the test may bypass the dominant failure mechanism of terminal blocks and may not give results indicative of terminal block performance in many of the postulated accident conditions.

All of the terminal blocks tested in Phase I except terminal blocks 6, 11, and 12 satisfactorily withstood the temperature environment. Other than corrosion products on the terminals resulting from the steam environment, no apparent physical damage occurred as a result of the environmental exposure. Terminal blocks 6, 11, and 12 experienced a temperature effect. Their inter-terminal barriers* softened almost to the liquid melt point, and flowed from between the terminals. The melted material covered some of the lower posts of the terminals, encasing the wires and drooping below the terminal block in large globules. Surprisingly, as Figures 20 shows, the terminal-to-terminal insulation resistances for terminal blocks 6, 11, and 12 were among the highest measured. We have no reasonable hypothesis to explain this behavior. We can speculate that the phase change of the inter-terminal barrier material prevented in someway the formation of a continuous film between terminals, or that the changing geometry somehow affected the process of conduction between adjacent terminals. However, we have no basis to support these hypotheses.

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*The inter-terminal barriers for terminal blocks 6, 11, and 12 are formed from a different material than that used to make the insulation of each of terminal block section. The base material is a phenolic and the inter-barrier material is a polypropylene.

Except for the first two 172°C plateaus, Figure 30 illustrates the changes in the terminal-to-terminal insulation resistance through time for terminal block 1. One of the first things to note is that IR does not remain constant. There are periods when IR improves dramatically and then deteriorates just as dramatically. One of the major causes of these changes is a power gradient. Two illustrations of this fact occurred at hour 121 where power was reapplied after 25 hours without power, and at hours 166.4 and 238.2 where transitions to and from 4 Vdc occurred. Note that when voltage is increased rapidly (e.g., switching power on or change from 4 to 45 Vdc) the insulation resistance drops and then slowly over a period of minutes to hours recovers to some higher value. Note, too, that these higher values, themselves, are also not constant with time and show fluctuations with a period of several hours. Also, note that at the same temperature, the mean IR level at 4 Vdc is less than that at 45 Vdc. One possible explanation for this voltage dependent behavior is that at lower voltage levels (e.g., 4 Vdc) the leakage current is lower and the Joule heating of the film due to the leakage current is reduced. Hence, slightly lower film temperatures reduce film vaporization and tend to create conditions that increase surface conductivity via a more complete film structure on the surface. As the driving potential increases, more leakage current flows, more Joule heating occurs, and more film is vaporized, tending to destroy a uniform film structure and thus creating a higher resistance. The net effect is that surface resistance increases with increasing applied voltage. The mechanical nature of this effect (i.e., the physical disruption of low resistance paths) would probably tend to dominate the increase in film conductivity due to higher temperatures. The magnitude of this voltage phenomenon varied for the different types of terminal blocks tested but was observable in all Phase I terminal blocks. Figures 31 and 32 summarize the data as a function of applied voltage for two different temperatures. For both temperatures, increasing the voltage increased the IR values. Note that for 172°C, 4 Vdc data was not obtained. The voltage dependence of IR was not observed during Phase II testing (see Section 4.4.3).

4.3.5 Terminal Blocks Powered Individually

Once during the Phase I test, while the terminal blocks were at 105°C, each terminal block was powered individually with all other blocks off. This procedure allowed a measurement of the insulation resistance to ground to be made since the only ground leakage current came from the single energized block. The procedure used was to de-energize all blocks and then repower each one individually. To account for the low IRs resulting from the rapid application of voltage to the blocks, approximately 1 to 2 minutes was allowed to elapse before the data was taken. Table 8 summarizes the results of these measurements. For comparison, the 105°C, terminal-to-terminal time-weighted average values from Tables 6 and 7 are included in Table 8. Note that the time-weighted average values of IR are from 0.7 to 5.2 times the IRs measured with the blocks individually powered. Except for terminal blocks 11 and 12, these lower values of IR are a manifestation of the repowering behavior. Though the initial, extremely low IR transient was allowed to dissipate,

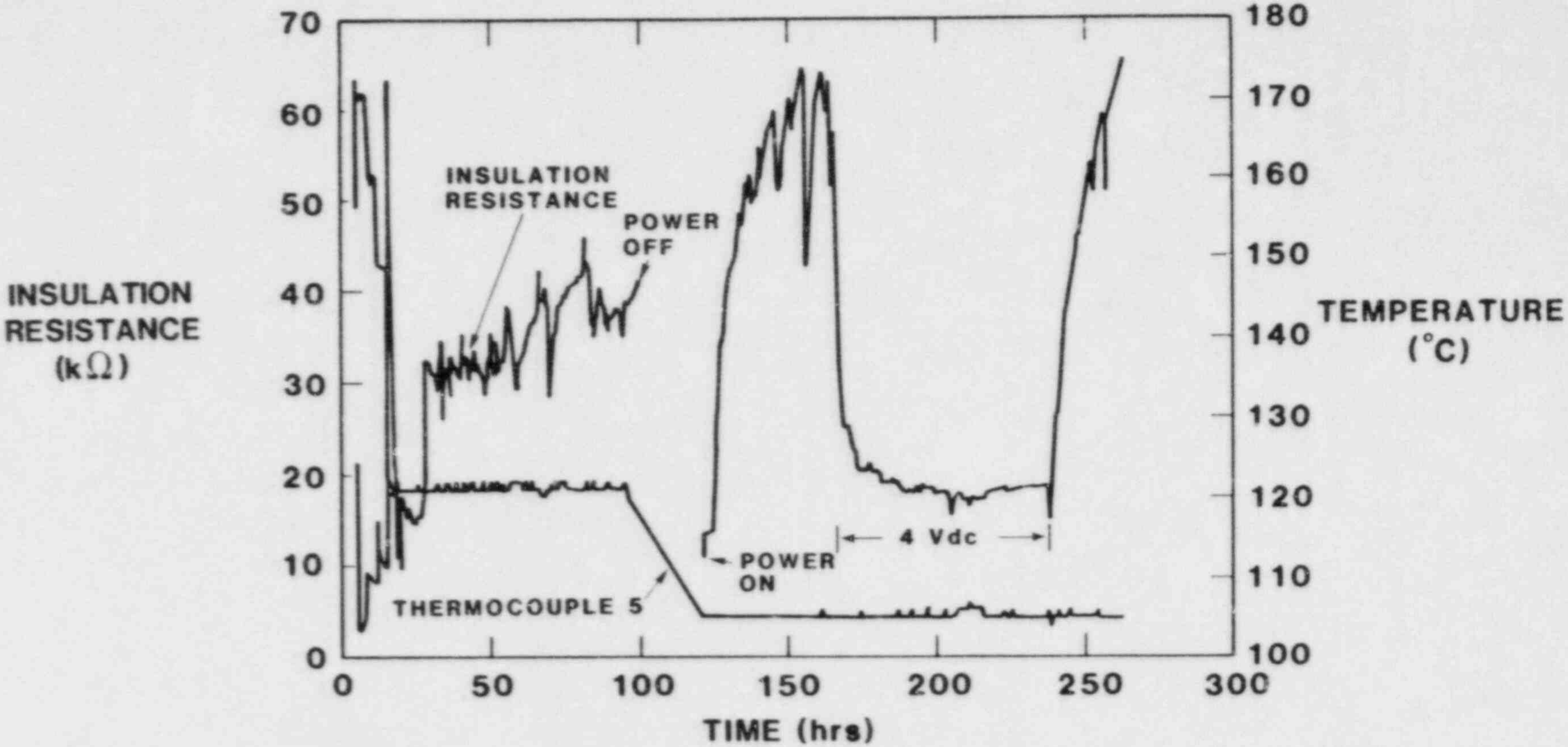

Figure 30

Insulation Resistance for Terminal Block 1 From the Second 172°C Plateau to End of Test. Temperature trace is for thermocouple 5.

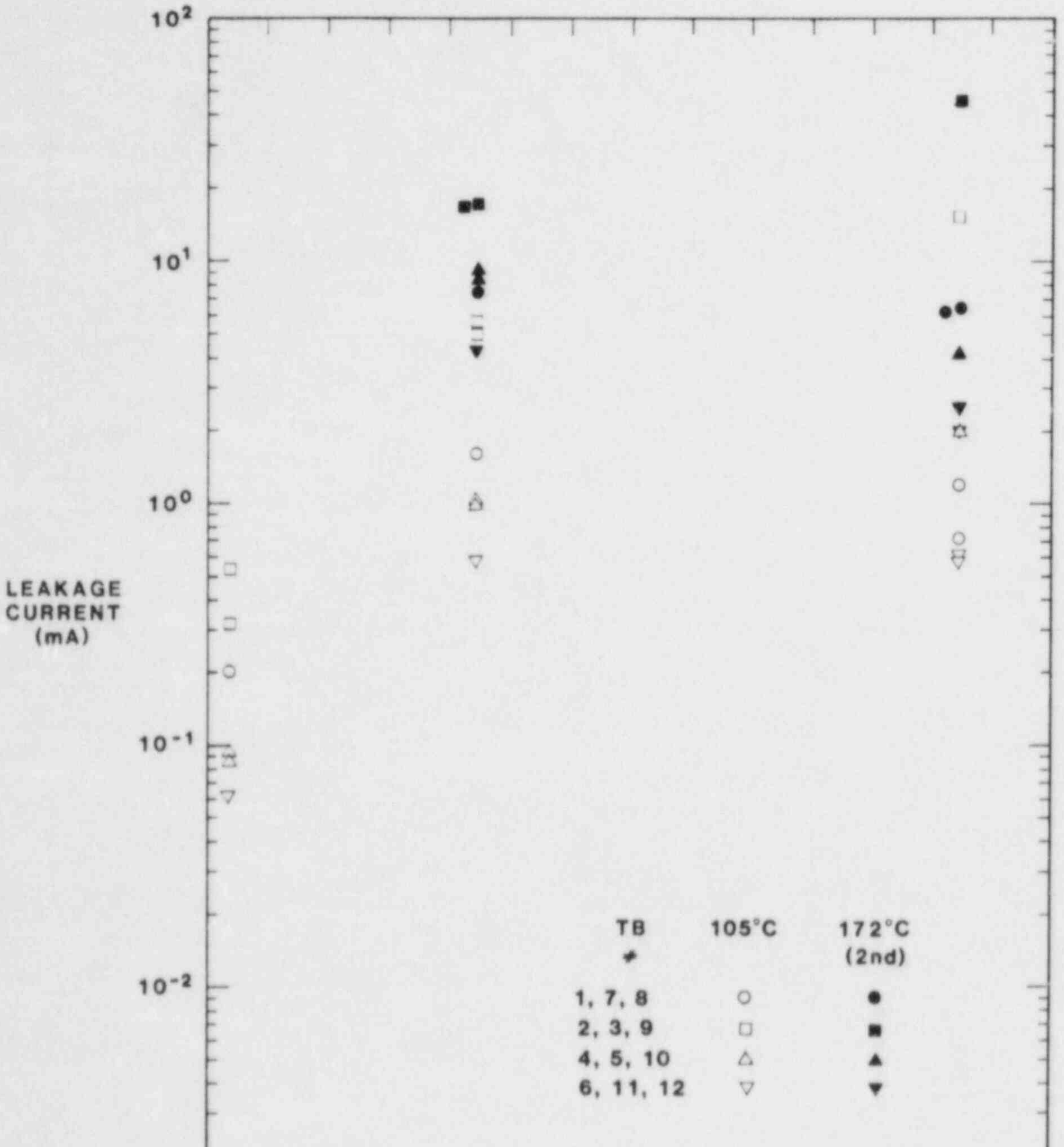

Figure 31

Leakage Currents as a Function of Applied Voltage for Phase I Terminal Blocks

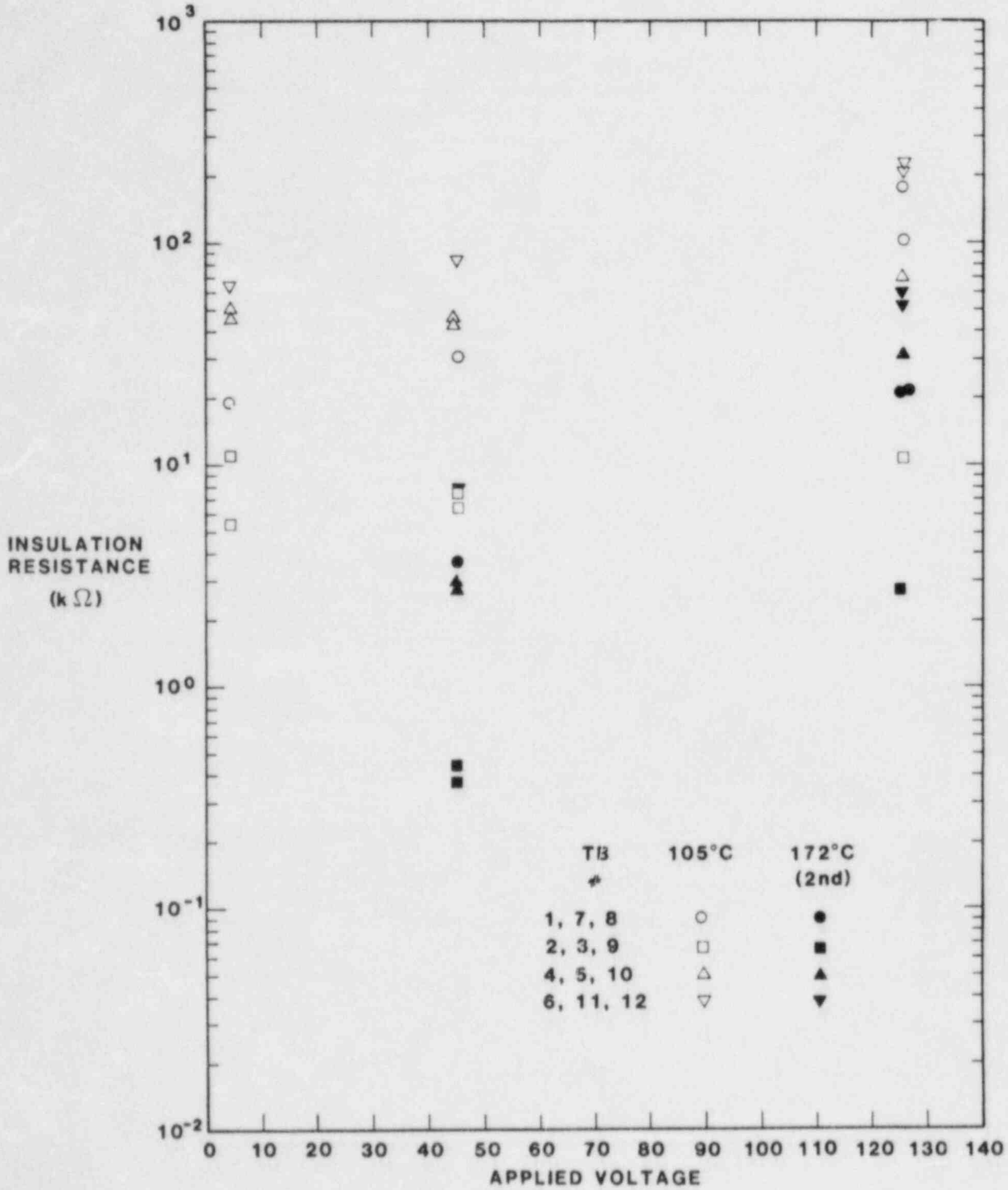

Figure 32

Insulation Resistance as a Function of Applied Voltage for Phase I Terminal Blocks

Table 8

Insulation Resistances and Leakage Currents for Phase I Terminal Blocks Powered Individually (Temperature = 105°C)

	--Insulation Resistance-- (kohms)				------Leakage Currents----- (mA)		
Terminal Block	TT Weighted Average&	TT*	TG**	TT/TG	TT Weighted Average&	TT*	TG**
1	30	12	19	0.63	1.4	3.06	2.08
7	180	44	58	0.76	0.70	2.86	2.18
8	100	32	24	1.33	1.2	3.98	5.17
4	42	12	4.8	0.25	1.0	3.03	6.36
5	43	15	5.7	2.63	0.99	2.56	5.66
10	66	22	4.6	4.78	1.9	5.80	27.04
2	7.4	1.6	4.9	0.33	4.7	11.63	6.27
3	6.3	1.2	2.9	0.41	5.3	12.9	8.82
9	9.7	4.1	4.2	1.0	13	29.4	29.1
6	78	37	14	2.64	0.56	1.15	2.86
11	200	260	12	21.6	0.62	0.483	10.8
12	210	240	16	15	0.59	0.527	7.62

* TT = Terminal-to-Terminal

** TG = Terminal-to-Ground

& From Tables 6 and 7

the 1 to 2 minutes allowed before taking the data was insufficient to obtain equilibrium values of IR. Thus, these data are not indicative of either the lowest or highest IR values observed after repowering; however, they do indicate what typically might be expected shortly after applying power. There is also a correlation between the equilibrium and short-term IR values: The blocks with the lowest equilibrium IR values also have the lowest short-term IR values.

Besides providing another illustration of the repowering behavior, the primary reason for individually powered measurements was to crudely quantify the terminal-to-ground behavior of the Phase I terminal blocks. Except for terminal blocks 11 and 12, we see that the terminal-to-terminal (TT) and terminal-to-ground (TG) values remain within a factor of 5 of one another. We would expect that similar behavior occurred throughout the test, and thus the terminal-to-terminal data reported for the entire test also give an indication of the terminal-to-ground behavior. This conclusion was validated in the Phase II tests where the observed terminal-to-terminal path IR values were on the order of the terminal-to-ground IR values.

4.3.6 Condensate Sample Conductivity Analysis

Samples of test chamber condensate were taken at sporadic intervals throughout the test and their conductivity measured. These measurements may vary considerably from the film conductivity because of (a) temperature differences between the film and the condensate sample, (b) the presence of contaminants from the chamber, steam system, and piping that accumulate in the bottom of the chamber and are not present on the terminal blocks, and (c) the presence of contaminants in the terminal block film (e.g., salt from fingerprints) that are either not present or are extremely dilute in the condensate sample. Table 9 summarizes the conductivity measurements for the Phase I condensate samples.

Table 9
Conductivity of Phase I Condensate Samples

Sample ID			Conductivity (μmho/cm)
82-9-9	17:00	(After first steam ramp)	215
82-9-9	20:10	(After second steam ramp)	75
82-9-10	15:57	(122°C)*	210
82-9-14	16:04	(104°C)*	16
82-20-9	14:00		10

*Temperature of chamber at time sample taken. Sample temperature at measurement time was not recorded, but was at least 10°C to 20°C cooler.

4.3.7 Enclosure Pressure Equilibration

Section 3.2 indicated that one of the NEMA-4 enclosures in the Phase I test set-up was fitted with a 0.635 cm (1/4") diameter stainless steel line that penetrated the test chamber boundary and connected with a differential pressure gauge. Figure 33 reproduces the differential pressure trace observed during the first steam ramp. A maximum differential pressure of 0.65 psid was observed 0.4 seconds after the first response of the gauge was noted. Within 6 seconds the differential pressure returned to zero with all but approximately 0.1 psid of the equilibration occurring within the first 1.3 seconds. The relatively slow equilibration of the last 0.1 psid probably represents two phenomena: (1) the response time of the gauge at very low psid and (2) the continued pressurization of the chamber, but at a slower rate. The pressure behavior in the second steam ramp was similar to the initial steam ramp behavior. The maximum differential pressure reached in the second steam ramp was 0.6 psid. Calculations by Stone [16] predict a maximum differential pressure of 4 psid during a 10-second linear rise to 60 psig for a box with only a 1/4" drain hole and no conduit entries. The differences between measured and calculated differential pressure

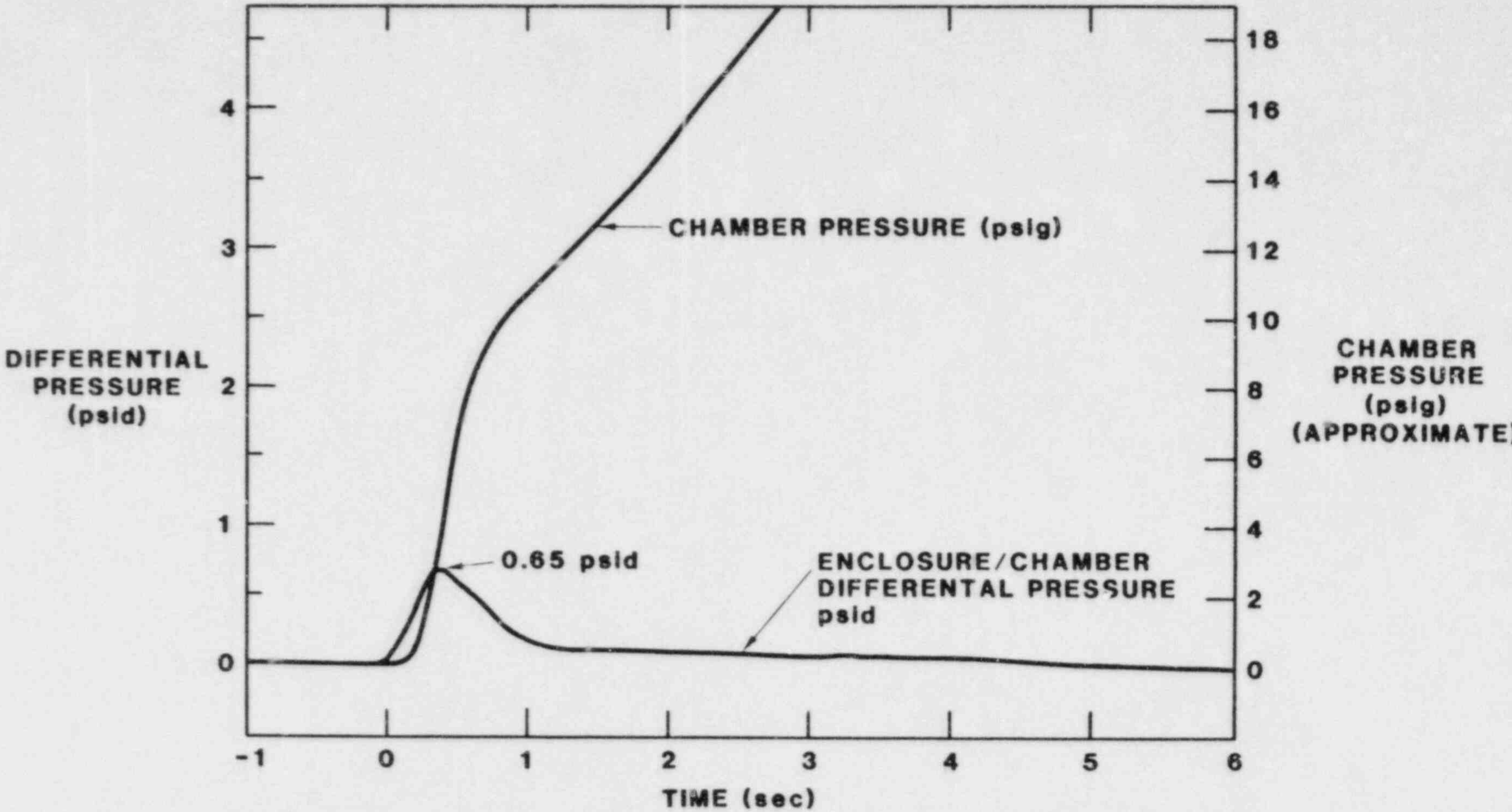

Figure 33

Enclosure/Chamber Differential Pressure Trace for the First Steam Ramp of the Phase I Test can easily be attributed to (1) the additional inlets associated with the conduit/cable entry points, (2) differences in the actual and assumed rate of external pressurization of the enclosure, and (3) calculational and/or measurement errors. Considering the possible sources of error, the agreement between measured and calculated values is reasonably good. Since the installation of the terminal blocks in the enclosures was similar to actual installations (i.e., cable entering in unsealed conduit and a 1/4" drain hole), we believe the experimental behavior closely simulates a worst case response for an actual plant installation. Certainly, this result is not surprising since one would expect the box to rapidly equilibrate.

4.4 Phase II Data Discussion

4.4.1 Time-Weighted Average Data

Tables 10, 11, and 12 summarize the averaged values* of leakage current for the A (left adjacent pole), B (right adjacent pole), and G (ground plate) leakage paths. (The A, B, and G nomenclature are defined in more detail in Section 3.5). Tables 13, 14, and 15 present the data as insulation resistance. These values were calculated from the averaged leakage current values in the same manner used for the Phase I IRs. Like the Phase I profile, the Phase II environmental profile was subdivided into periods which correspond to the various temperatures plateaus achieved during the exposure. The data was further subdivided to eliminate the unpowered periods within each temperature period. Averaged data for the powered subperiods are included in the tables as well as an overall cumulative average value for all powered portions of the temperature period. Since chemical spray was not a noticeable factor in the terminal block leakage currents, the data presentation in Table 10 through 15 does not segregate chemical spray and non-spray periods. This segregation is done separately in Section 4.5.1.

4.4.1.1 General Behavior

Figures 34 through 39 illustrate that the averaged data for any single terminal block varied over 1/2 to 1 1/2 orders of magnitude during the 105°C to 175°C steam exposure. During the cooldown periods the insulation resistance shows a recovery to reasonable operating values (e.g., 10^7 to 10^8 ohm range). However, these values are only on the order of 1 to 10 percent of the initial IR values. This behavior observed in Phase II testing supports the hypothesis made in Section 4.3.4 concerning film formation and disappearance. The post-test ambient temperature measurements indicate a return to approximately the same level of leakage current as experienced during each of the mid-test cooldown periods. This observation has several implications. First,

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*As in Phase I, the average values are time weighted averages to account for nonuniform sampling intervals.

because of the similarity in IR values observed during the cooldown periods and the post-test measurements, the conductivity experienced during these periods may have been the result of the same conduction mechanism. Second, since the post-test conductivity was more than the pre-test conductivity, some permanent surface damage may have occurred during the test. The post-test chemical analysis of selected terminal blocks discussed in Section 4.4.5 indicates the presence of graphitized carbon which supports the conclusion that some permanent surface damage may have occurred. Visually, the post-test blocks appeared degraded on the surface.

4.4.1.2 Behavior of Terminal Block in Transmitter Circuit

As discussed in Section 3.5, terminal block 11 was used to connect a transmitter circuit. The leakage current between the high and low terminal block poles, as determined by the voltage drop across the transmitter, was determined by measuring the circuit current on the transmitter side and the power supply side of the terminal block and subtracting these values. The leakage current to ground was measured in the same manner as the other circuits. These results are tabulated in the various tables and graphs as the A and G paths, respectively.

Figure 40 illustrates the typical behavior experienced by the transmitter circuit. This figure shows the total circuit current measured on the power supply side of the terminal block. This total circuit current would have been the signal received in the control room had this circuit been an actual plant circuit. During the period shown which encompasses the unanticipated cooldown the transmitter was operating at its base signal level of approximately 4 mA. The difference between the 4 mA level and the actual current trace represents the terminal-to-terminal leakage current. The maximum error shown in Figure 40 is 2.7 mA which was experienced when the power to the circuit was turned on after being off for a few minutes. Thereafter the leakage current decreases to about 0.6 mA at which point the environmental temperature changed to 161°C. During this temperature plateau the leakage current stabilized at approximately 1 mA. When the unanticipated cooldown occurred the leakage current dropped immediately to almost zero and the circuit current equalled the output of the transmitter. When the steam was reintroduced after the cooldown the leakage currents again rose to the 1.5 to 2 mA level. This behavior is a clear graphical illustration of the recovery phenomena experienced during the cooldown periods. At the output level of the transmitter, the 0.6 and 2.7 mA leakage currents translate to signal errors of 15 and 68 percent, respectively. The two points clearly illustrated by Figure 40 are the recovery behavior of the terminal blocks and the dramatic effect terminal blocks can have on low current, high impedance circuits. These results also validate the data obtained from the other experimental circuits in the test, showing that their results are representative of what may typically be expected in actual circuit configurations.

TABLE 10

Averaged Leakage Currents A for Phase II Terminal Blocks
(mA)

TB Number Plot Symbol and Voltage	Ambient ○	175°C ○	95°C ◇	175°C ●	161°C △	95°C ◆	149°C ▲	121°C □	105°C ▽	Ambient ●
1 ◇ 125 Vdc	4.2E-04	2.0E+00	4.4E-03	Sub 1: 2.9E+00 Sub 2: 7.6E-01 Overall: 2.4E+00	4.9E-01	5.0E-02	9.6E+00	Failed Open	Failed Open	Failed Open
2 ○ 125 Vdc	3.4E-04	1.3E+00	1.3E-03	Sub 1: 1.2E+00 Sub 2: 8.2E-01 Overall: 1.2E+00	5.1E-01	3.7E-03	6.4E-01	Sub 1: 2.4E-01 Sub 2: 1.7E-01 Overall: 1.8E-01	1.4E-01	3.0E-03
3 ○ 125 Vdc	2.5E-04	6.8E-01	2.8E-03	Sub 1: 1.1E+00 Sub 2: 6.3E-01 Overall: 1.0E+00	3.4E-01	2.6E-03	7.6E-01	Sub 1: 2.3E-01 Sub 2: 2.7E-01 Overall: 2.7E-01	Sub 1: 1.5E-01 Sub 2: 1.3E-01 Overall: 1.3E-01	1.9E-03
4 ○ 125 Vdc	2.1E-04	3.3E+00	1.1E-02	Sub 1: 7.7E+00 Sub 2: 5.1E+00 Overall: 7.2E+00	3.4E+00	1.1E-01	5.3E+00	Sub 1: 2.9E+00 Sub 2: 1.5E+00 Overall: 1.6E+00	Sub 1: 6.2E-01 Sub 2: 8.7E-01 Overall: 8.6E-01	1.8E-01
5 □ 125 Vdc	3.4E-04	7.3E-01	2.0E-03	Sub 1: 1.2E+00 Sub 2: 3.1E-01 Overall: 9.6E-01	2.0E-01	1.3E-03	8.8E-01	Sub 1: 1.2E+00 Sub 2: 1.7E+00 Sub 3: 4.8E-01 Overall: 5.4E-01	Sub 1: 3.5E-01 Sub 2: 3.2E-01 Overall: 3.2E-01	1.3E-02
6 □ 125 Vdc	2.8E-04	1.0E+00	3.6E-03	Sub 1: 3.3E+01 Sub 2: 1.4E+01 Overall: 2.7E+01	1.0E+01	1.2E+00	8.4E+01	Sub 1: 8.7E+01 Sub 2: 1.8E+01 Sub 3: 4.4E+00 Overall: 7.0E+00	5.6E+00	8.2E-01

TABLE 10 (continued)

Averaged Leakage Currents A for Phase II Terminal Blocks
(mA)

TB Number Plot Symbol and Voltage	Ambient ○	175°C ○	95°C ◇	175°C ●	161°C △	95°C ◆	149°C ▲	121°C □	105°C ▽	Ambient ●
7 ◇ 45 Vdc	1.9E-05	2.3E-01	2.9E-04	Sub 1: 7.0E-01 Sub 2: 6.8E-01 Overall: 6.9E-01	7.8E-01	4.1E-02	4.5E-01	Sub 1: 6.9E-01 Sub 2: 2.6E-01 Overall: 3.0E-01	Sub 1: 4.5E-01 Sub 2: 1.9E-01 Sub 3: 7.1E-02 Overall: 1.9E-01	6.6E-04
8 ◇ 45 Vdc	1.9E-05	1.5E+00	1.3E-04	Sub 1: 2.5E+00 Sub 2: 9.6E-01 Overall: 2.0E+00	3.0E-01	1.2E-03	7.8E-01	Sub 1: 2.2E+00 Sub 2: 2.0E-01 Overall: 4.1E-01	Sub 1: 1.4E-01 Sub 2: 4.4E-02 Sub 3: 2.9E-02 Sub 4: 1.3E-01 Overall: 3.5E-02	7.7E-04
9 ○ 45 Vdc	1.7E-05	8.9E-01	6.6E-04	Sub 1: 1.6E+00 Sub 2: 1.2E+00 Overall: 1.5E+00	6.9E-01	5.2E-03	1.1E+00	Sub 1: 1.3E+00 Sub 2: 8.5E-01 Overall: 9.0E-01	Sub 1: 6.2E-01 Sub 2: 2.9E-01 Sub 3: 1.2E+00 Overall: 3.4E-01	2.1E-03
10 ○ 45 Vdc	2.1E-05	8.8E-01	9.8E-04	Sub 1: 1.4E+00 Sub 2: 7.5E-01 Overall: 1.2E+00	4.1E-01	1.7E-03	6.8E-01	Sub 1: 1.9E-01 Sub 2: 2.0E-01 Overall: 1.[illegible]-01	Sub 1: 4.3E-01 Sub 2: 1.3E-01 Sub 3: 2.5E-01 Overall: 1.4E-01	9.8E-04
11 ○ 45 Vdc	1.5E-03	2.2E+00	1.4E-03	Sub 1: 3.1E+00 Sub 2: 1.7E+00 Overall: 2.6E+00	7.4E-01	3.7E-03	1.5E+00	Sub 1: 1.0E+00 Sub 2: 4.7E-01 Overall: 5.3E-01	Sub 1: 1.9E-01 Sub 2: 1.0E+00 Overall: 2.3E-01	3.8E-03
12 □ 45 Vdc	1.8E-05	7.1E-01	5.3E-03	Sub 1: 1.1E+01 Sub 2: 8.2E+00 Overall: 9.8E+00	2.3E+00	4.6E-02	1.7E+01	Sub 1: 1.8E+01 Sub 2: 7.8E+00 Overall: 8.9E+00	Sub 1: 4.7E+00 Sub 2: 1.5E+00 Overall: 1.6E+00	5.3E-02

TABLE II

Averaged Leakage Currents B for Phase II Terminal Blocks
(mA)

TB Number Plot Symbol and Voltage	Ambient	175°C	95°C	175°C	161°C	95°C	149°C	121°C	105°C	Ambient
	○	○	◇	●	△	◆	▲	□	▽	●
1 ◇ 125 Vdc	2.7E-04	5.3E+00	2.4E-03	Sub 1: 1.1E+01 Sub 2: 3.3E+00 Overall: 9.5E+00	8.0E-01	5.2E-01	5.6E+01	Failed Open	Failed Open	Failed Open
2 ○ 125 Vdc	2.9E-04	1.6E+00	1.6E-03	Sub 1: 1.5E+00 Sub 2: 9.5E-01 Overall: 1.4E+00	6.3E-01	4.0E-03	8.6E-01	Sub 1: 2.7E-01 Sub 2: 2.2E-01 Overall: 2.2E-01	1.7E-01	3.8E-03
3 ○ 125 Vdc	2.7E-04	1.0E+00	3.5E-03	Sub 1: 1.3E+00 Sub 2: 7.9E-01 Overall: 1.2E+00	5.0E-01	5.7E-03	9.1E-01	Sub 1: 2.3E-01 Sub 2: 1.7E-01 Overall: 1.8E-01	Sub 1: 2.1E-01 Sub 2: 1.7E-01 Overall: 1.7E-01	2.0E-03
4 ○ 125 Vdc	2.4E-04	1.9E+00	6.7E-03	Sub 1: 1.7E+00 Sub 2: 1.1E+00 Overall: 1.6E+00	6.9E-01	7.4E-03	1.0E+00	Sub 1: 4.2E-01 Sub 2: 2.6E-01 Overall: 2.7E-01	Sub 1: 4.9E-01 Sub 2: 1.7E-01 Overall: 1.7E-01	2.4E-03
5 □ 125 Vdc	3.8E-04	7.1E+00	4.2E-01	Sub 1: 6.4E+00 Sub 2: 2.8E+00 Overall: 5.3E+00	2.5E+00	1.9E-01	2.6E+00	Sub 1: 2.4E+00 Sub 2: 7.7E+00 Sub 3: 1.1E+00 Overall: 1.4E+00	Sub 1: 9.4E-01 Sub 2: 5.5E-01 Overall: 5.5E-01	1.8E-02
6 □ 125 Vdc	3.2E-04	4.3E+00	2.6E-01	Sub 1: 1.3E+02 Sub 2: 5.1E+01 Overall: 1.1E+02	5.9E+01	4.0E+00	1.7E+02	Sub 1: 3.0E+02 Sub 2: 1.5E+02 Sub 3: 1.1E+01 Overall: 2.4E+01	8.3E+00	1.1E+00

TABLE 11 (continued)

Averaged Leakage Currents B for Phase II Terminal Blocks
(mA)

TB Number Plot Symbol and Voltage	Ambient ○	175°C ○	95°C ◇	175°C ●	161°C △	95°C ◆	149°C ▲	121°C □	105°C ▽	Ambient ●
7 ◇ 45 Vdc	7.0E-06	2.6E-01	3.7E-05	Sub 1: 9.2E-01 Sub 2: 1.2E+00 Overall: 1.0E+00	9.9E-01	3.1E-02	6.2E-01	Sub 1: 2.8E-01 Sub 2: 7.4E-02 Overall: 9.7E-02	Sub 1: 1.4E-02 Sub 2: 1.9E-02 Sub 3: 8.9E-03 Overall: 1.8E-02	1.6E-03
8 ◇ 45 Vdc	6.3E-06	7.2E-01	1.8E-04	Sub 1: 2.7E+00 Sub 2: 2.5E+00 Overall: 2.6E+00	7.1E-01	3.3E-03	2.3E+00	Sub 1: 4.5E+00 Sub 2: 5.2E-01 Overall: 9.6E-01	Sub 1: 1.0E+00 Sub 2: 1.2E-01 Sub 3: 7.2E-02 Sub 4: 7.1E-02 Overall: 7.5E-02	3.0E-03
9 ○ 45 Vdc	6.7E-06	8.5E-01	4.3E-04	Sub 1: 1.5E+00 Sub 2: 1.2E+00 Overall: 1.4E+00	4.8E-01	1.8E-03	1.0E+00	Sub 1: 5.3E-01 Sub 2: 4.8E-01 Overall: 4.9E-01	Sub 1: 4.7E-01 Sub 2: 1.8E-01 Sub 3: 8.7E-01 Overall: 2.2E-01	2.3E-03
10 ○ 45 Vdc	8.7E-06	7.8E-01	1.1E-03	Sub 1: 1.3E+00 Sub 2: 7.0E-01 Overall: 1.1E+00	3.9E-01	1.6E-03	6.9E-01	Sub 1: 1.6E-01 Sub 2: 1.5E-01 Overall: 1.5E-01	Sub 1: 2.7E-01 Sub 2: 7.3E-02 Sub 3: 2.1E-01 Overall: 8.1E-02	6.4E-04
11	No B Path on Terminal Block 11									
12 □ 45 Vdc	7.2E-06	5.7E-01	2.5E-02	Sub 1: 6.4E+00 Sub 2: 2.4E+00 Overall: 5.0E+00	1.1E+00	5.7E-03	1.5E+00	Sub 1: 3.9E-01 Sub 2: 6.1E-01 Overall: 5.8E-01	Sub 1: 7.8E-01 Sub 2: 4.3E-01 Overall: 4.3E-01	3.2E-02

TABLE 12

Averaged Leakage Currents G for Phase II Terminal Blocks
(mA)

TB Number Plot Symbol and Voltage	Ambient ◯	175°C ○	95°C ◇	175°C ●	161°C △	95°C ◆	149°C ▲	121°C □	105°C ▽	Ambient ⬤
1 ◇ 125 Vdc	3.6E-04	1.1E+01	9.5E-03	Sub 1: 6.2E+00 Sub 2: 1.9E+00 Overall: 5.3E+00	8.3E-01	8.7E-02	2.5E+01	Failed Open	Failed Open	Failed Open
2 ○ 125 Vdc	2.9E-04	4.6E-01	3.8E-03	Sub 1: 1.8E+00 Sub 2: 1.6E+00 Overall: 1.7E+00	1.1E+00	8.6E-02	1.5E+00	Sub 1: 2.6E+00 Sub 2: 9.4E-01 Overall: 1.1E+00	5.4E-01	2.0E-01
3 ○ 125 Vdc	2.6E-04	9.8E-01	1.1E-03	Sub 1: 1.9E+00 Sub 2: 1.7E+00 Overall: 1.9E+00	6.6E-01	1.8E-02	1.5E+00	Sub 1: 6.2E-01 Sub 2: 5.8E-01 Overall: 5.8E-01	Sub 1: 4.7E-01 Sub 2: 4.1E-01 Overall: 4.1E-01	1.3E-02
4 ○ 125 Vdc	1.3E-04	1.1E+00	2.8E-03	Sub 1: 1.6E+00 Sub 2: 1.3E+00 Overall: 1.5E+00	8.7E-01	2.1E-02	1.2E+00	Sub 1: 4.4E-01 Sub 2: 2.6E-01 Overall: 2.8E-01	Sub 1: 2.7E-01 Sub 2: 1.3E-01 Overall: 1.4E-01	1.7E-03
5 □ 125 Vdc	2.1E-04	7.0E+00	1.3E-02	Sub 1: 1.6E+01 Sub 2: 1.9E+01 Overall: 1.7E+01	7.0E+01	8.2E-01	6.5E+01	Sub 1: 8.9E+01 Sub 2: 9.9E+01 Sub 3: 6.8E+00 Overall: 1.2E+01	Sub 1: 3.9E+00 Sub 2: 5.1E+00 Overall: 5.1E+00	4.5E-01
6 □ 125 Vdc	3.0E-04	2.2E+01	1.2E+00	Sub 1: 1.3E+02 Sub 2: 6.1E+01 Overall: 1.1E+02	6.6E+01	4.0E+00	1.4E+02	Sub 1: 3.1E+02 Sub 2: 1.7E+02 Sub 3: 8.6E+00 Overall: 2.2E+01	7.4E+00	8.6E-01

TABLE 12 (continued)

Averaged Leakage Currents G for Phase II Terminal Blocks
(mA)

TB Number Plot Symbol and Voltage	Ambient ○	175°C ○	95°C ◇	175°C ●	161°C △	95°C ◆	149°C ▲	121°C □	105°C ▽	Ambient ●
7 ◇ 45 Vdc	6.1E-06	1.2E+00	6.3E-03	Sub 1: 3.0E+00 Sub 2: 3.0E+00 Overall: 3.0E+00	1.8E+00	9.2E-02	2.5E+00	Sub 1: 2.7E+00 Sub 2: 1.4E+00 Overall: 1.5E+00	Sub 1: 2.9E-01 Sub 2: 7.3E-01 Sub 3: 1.0E+00 Overall: 7.4E-01	2.3E-01
8 ◇ 45 Vdc	3.3E-06	1.9E+00	8.9E-05	Sub 1: 3.0E+00 Sub 1: 2.0E+00 Overall: 7E+00	9.6E-01	1.8E-03	1.2E+00	Sub 1: 3.5E+00 Sub 2: 2.7E-01 Overall: 6.2E-01	Sub 1: 2.5E-01 Sub 2: 5.9E-02 Sub 3: 4.1E-02 Sub 4: 6.7E-02 Overall: 4.3E-02	8.4E-05
9 ○ 45 Vdc	1.1E-06	5.7E-01	3.2E-04	Sub 1: 1.4E+00 Sub 2: 1.0E+00 Overall: 1.3E+00	4.2E-01	2.0E-03	8.0E-01	Sub 1: 2.8E-01 Sub 2: 3.1E-01 Overall: 3.0E-01	Sub 1: 3.1E-01 Sub 2: 1.2E-01 Sub 3: 5.9E-01 Overall: 1.4E-01	4.0E-04
10 ○ 45 Vdc	3.1E-06	4.2E-01	2.5E-04	Sub 1: 9.5E-01 Sub 2: 4.8E-01 Overall: 7.9E-01	2.6E-01	1.9E-03	4.5E-01	Sub 1: 1.6E-01 Sub 2: 8.6E-02 Overall: 9.4E-02	Sub 1: 2.1E-01 Sub 2: 4.8E-02 Sub 3: 2.2E-01 Overall: 5.7E-02	2.0E-05
11 ○ 45 Vdc	6.8E-06	1.2E+00	1.6E-03	Sub 1: 2.2E+00 Sub 2: 1.4E+00 Overall: 1.9E+00	7.1E-01	7.7E-03	1.4E+00	Sub 1: 6.2E-01 Sub 2: 5.5E-01 Overall: 5.5E-01	Sub 1: 4.3E-01 Sub 2: 9.4E-01 Overall: 4.5E-01	2.6E-02
12 □ 45 Vdc	2.6E-06	1.5E+00	6.7E-03	Sub 1: 5.8E+00 Sub 2: 4.5E+00 Overall: 5.4E+00	2.0E+00	2.1E-02	4.8E+00	Sub 1: 1.4E+00 Sub 2: 1.6E+00 Overall: 1.5E+00	Sub 1: 2.3E+00 Sub 2: 1.6E+00 Overall: 1.6E+00	2.1E-02

TABLE 13

Averaged Insulation Resistance A for Phase II Terminal Blocks (kohms)

TB Number Plot Symbol and Voltage	Ambient ○	175°C ○	95°C ◇	175°C ●	161°C △	95°C ◆	149°C ▲	121°C □	105°C ▽	Ambient ●
1 ◇ 125 Vdc	3.0E+05	6.3E+01	2.9E+04	Sub 1: 4.4E+01 Sub 2: 1.7E+02 Overall: 5.2E+01	2.6E+02	2.5E+03	1.3E+01	Failed Open	Failed Open	Failed Open
2 ○ 125 Vdc	3.7E+05	9.7E+01	9.7E+04	Sub 1: 1.0E+02 Sub 2: 1.5E+02 Overall: 1.1E+02	2.5E+02	3.4E+04	2.0E+02	Sub 1: 5.3E+02 Sub 2: 7.3E+02 Overall: 7.0E+02	8.9E+02	4.3E+04
3 ○ 125 Vdc	5.2E+05	1.9E+02	4.5E+04	Sub 1: 1.1E+02 Sub 2: 2.0E+02 Overall: 1.2E+02	3.7E+02	4.8E+04	1.7E+02	Sub 1: 5.4E+02 Sub 2: 4.6E+02 Overall: 4.7E+02	Sub 1: 8.6E+02 Sub 2: 9.9E+02 Overall: 9.9E+02	6.7E+04
4 ○ 125 Vdc	5.9E+05	3.8E+01	1.1E+04	Sub 1: 1.6E+01 Sub 2: 2.5E+01 Overall: 1.7E+01	3.7E+01	1.1E+03	2.4E+01	Sub 1: 4.3E+01 Sub 2: 8.3E+01 Overall: 7.7E+01	Sub 1: 2.1E+02 Sub 2: 1.5E+02 Overall: 1.5E+02	6.9E+02
5 □ 125 Vdc	3.8E+05	1.7E+02	6.2E+04	Sub 1: 1.0E+02 Sub 2: 4.1E+02 Overall: 1.3E+02	6.2E+02	9.6E+04	1.4E+02	Sub 1: 1.1E+02 Sub 2: 7.5E+01 Sub 3: 2.6E+02 Overall: 2.3E+02	Sub 1: 3.7E+02 Sub 2: 4.0E+02 Overall: 4.0E+02	1.0E+04
6 □ 125 Vdc	4.6E+05	1.3E+02	3.5E+04	Sub 1: 3.7E+00 Sub 2: 9.2E+00 Overall: 4.5E+00	1.2E+01	1.0E+02	1.4E+00	Sub 1: 1.3E+00 Sub 2: 7.0E+00 Sub 3: 2.9E+01 Overall: 1.8E+01	2.3E+01	1.5E+02

TABLE 13 (continued)

Averaged Insulation Resistance A for Phase II Terminal Blocks
(kohms)

TB Number Plot Symbol and Voltage	Ambient ○	175°C ○	95°C ◇	175°C ●	161°C △	95°C ◆	149°C ▲	121°C □	105°C ▽	Ambient ●
7 ◇ 45 Vdc	2.3E+06	1.9E+02	1.6E+05	Sub 1: 6.2E+01 Sub 2: 6.4E+01 Overall: 6.3E+01	5.6E+01	1.1E+03	9.8+01	Sub 1: 6.3E+01 Sub 2: 1.7E+02 Overall: 1.5E+02	Sub 1: 9.8E+01 Sub 2: 2.4E+02 Sub 3: 6.3E+02 Overall: 2.4E+02	6.8E+04
8 ◇ 45 Vdc	2.4E+06	2.7E+01	3.4E+05	Sub 1: 1.6E+01 Sub 2: 4.5E+01 Cverall: 2.1E+01	1.5E+02	3.8E+04	5.5E+01	Sub 1: 1.8E+01 Sub 2: 2.3E+02 Overall: 1.1E+02	Sub 1: 3.2E+02 Sub 2: 1.0E+03 Sub 3: 1.5E+03 Sub 4: 3.6E+02 Overall: 1.3E+03	5.8E+04
9 ○ 45 Vdc	2.7E+06	4.8E+01	6.8E+04	Sub 1: 2.5E+01 Sub 2: 3.5E+01 Overall: 2.8E+01	6.3E+01	8.6E+03	3.7E+01	Sub 1: 3.2E+01 Sub 2: 5.0E+01 Overall: 4.8E+01	Sub 1: 7.0E+01 Sub 2: 1.5E+02 Sub 3: 3.6E+01 Overall: 1.3E+02	2.2E+04
10 ○ 45 Vdc	2.1E+06	4.9E+01	4.6E+04	Sub 1: 3.0E+01 Sub 2: 5.8E+01 Overall: 3.6E+01	1.1E+02	2.7E+04	6.4E+01	Sub 1: 2.3E+02 Sub 2: 2.3E+02 Overall: 2.3E+02	Sub 1: 1.0E+02 Sub 2: 3.4E+02 Sub 3: 1.8E+02 Overall: 3.2E+02	4.6E+04
11 ○ 45 Vdc	3.0E+04	1.8E+01	3.1E+04	Sub 1: 1.2E+01 Sub 2: 2.4E+01 Overall: 1.5E+01	5.9E+01	1.2E+04	2.7E+01	Sub 1: 4.1E+01 Sub 2: 9.4E+01 Overall: 8.3E+01	Sub 1: 2.3E+02 Sub 2: 4.3E+01 Overall: 1.9E+02	1.2E+04
12 [45 Vdc	2.5E+06	6.1E+01	8.5E+03	Sub 1: 2.0E+00 Sub 2: 3.2E+00 Overall: 2.3E+00	1.7E+01	9.7E+02	3.4E-01	Sub 1: 2.4E-01 Sub 2: 3.5E+00 Overall: 2.8E+00	Sub 1: 7.3E+00 Sub 2: 2.7E+01 Overall: 2.6E+01	8.5E+02

TABLE 14

Averaged Insulation Resistance B for Phase II Terminal Blocks
(kohms)

TB Number Plot Symbol and Voltage	Ambient ○	175°C ○	95°C ◇	175°C ●	161°C △	95°C ◆	149°C ▲	121°C □	105°C ▽	Ambient ●
1 ◇ 125 Vdc	4.7E+05	2.4E+01	5.2E+04	Sub 1: 1.1E+01 Sub 2: 3.8E+01 Overall: 1.3E+01	1.6E+02	2.4E+02	2.1E+00	Failed Open	Failed Open	Failed Open
2 ○ 125 Vdc	4.3E+05	8.1E+01	7.9E+04	Sub 1: 8.5E+01 Sub 2: 1.3E+02 Overall: 9.1E+01	2.0E+02	3.2E+04	1.5E+02	Sub 1: 4.6E+02 Sub 2: 5.8E+02 Overall: 5.7E+02	7.6E+02	3.3E+04
3 ○ 125 Vdc	4.7E+05	1.3E+02	3.6E+04	Sub 1: 1.0E+02 Sub 2: 1.6E+02 Overall: 1.1E+02	2.5E+02	2.2E+04	1.4E+02	Sub 1: 5.5E+02 Sub 2: 7.4E+02 Overall: 7.2E+02	Sub 1: 6.0E+02 Sub 2: 7.5E+02 Overall: 7.5E+02	6.2E+04
4 ○ 125 Vdc	5.3E+05	6.6E+01	1.9E+04	Sub 1: 7.3E+01 Sub 2: 1.2E+02 Overall: 8.0E+01	1.8E+02	1.7E+04	1.2E+02	Sub 1: 3.0E+02 Sub 2: 4.9E+02 Overall: 4.7E+02	Sub 1: 2.6E+02 Sub 2: 7.4E+02 Overall: 7.2E+02	5.2E+04
5 □ 125 Vdc	3.3E+05	1.8E+01	3.0E+02	Sub 1: 2.0E+01 Sub 2: 4.5E+01 Overall: 2.4E+01	5.2E+01	6.6E+02	4.8E+01	Sub 1: 5.2E+01 Sub 2: 1.6E+01 Sub 3: 1.2E+02 Overall: 9.3E+01	Sub 1: 1.4E+02 Sub 2: 2.3E+02 Overall: 2.3E+02	7.0E+03
6 □ 125 Vdc	3.9E+05	2.9E+01	4.8E+02	Sub 1: 8.6E-01 Sub 2: 2.4E+00 Overall: 1.1E+00	2.0E+00	3.2E+01	6.3E-01	Sub 1: 2.9E-01 Sub 2: 7.1E-01 Sub 3: 1.1E+01 Overall: 5.2E+00	1.5E+01	1.2E+02

TABLE 14 (continued)

Averaged Insulation Resistance B for Phase II Terminal Blocks
(kohms)

TB Number Plot Symbol and Voltage	Ambient ○	175°C ○	95°C ◇	175°C ●	161°C △	95°C ◆	149°C ▲	121°C □	105°C ▽	Ambient ●
7 ◇ 45 Vdc	6.4E+06	1.7E+02	1.2E+06	Sub 1: 4.7E+01 Sub 2: 3.7E+01 Overall: 4.3E+01	4.3E+01	1.5E+03	7.1E+01	Sub 1: 1.6E+02 Sub 2: 6.0E+02 Overall: 4.6E+02	Sub 1: 3.3E+03 Sub 2: 2.4E+03 Sub 3: 5.1E+03 Overall: 2.5E+03	2.7E+04
8 ◇ 45 Vdc	7.1E+06	6.0E+01	2.4E+05	Sub 1: 1.4E+01 Sub 2: 1.6E+01 Overall: 1.5E+01	6.1E+01	1.4E+04	1.7E+01	Sub 1: 7.7E+00 Sub 2: 8.5E+01 Overall: 4.5E+01	Sub 1: 4.1E+01 Sub 2: 3.8E+02 Sub 3: 6.2E+02 Sub 4: 6.3E+02 Overall: 6.0E+02	1.5E+04
9 ○ 45 Vdc	6.7E+06	5.0E+01	1.0E+05	Sub 1: 2.7E+01 Sub 2: 3.5E+01 Overall: 3.0E+01	9.1E+01	2.6E+04	4.2E+01	Sub 1: 8.2E+01 Sub 2: 9.1E+01 Overall: 9.0E+01	Sub 1: 9.4E+01 Sub 2: 2.4E+02 Sub 3: 4.9E+01 Overall: 2.0E+02	2.0E+04
10 ○ 45 Vdc	5.1E+06	5.6E+01	4.2E+04	Sub 1: 3.3E+01 Sub 2: 6.2E+01 Overall: 3.9E+01	1.1E+02	2.8E+04	6.3E+01	Sub 1: 2.8E+02 Sub 2: 2.9E+02 Overall: 2.9E+02	Sub 1: 1.6E+02 Sub 2: 6.1E+02 Sub 3: 2.1E+02 Overall: 5.5E+02	7.0E+04
11	No B Path on Terminal Block 11									
12 □ 45 Vdc	6.2E+06	7.7E+01	1.8E+03	Sub 1: 4.8E+00 Sub 2: 1.7E+01 Overall: 6.7E+00	3.7E+01	7.9E+03	2.7E+01	Sub 1: 1.1E+02 Sub 2: 7.2E+01 Overall: 7.5E+01	Sub 1: 5.5E+01 Sub 2: 1.0E+02 Overall: 1.0E+02	1.4E+03

TABLE 15

Averaged Insulation Resistance G for Phase II Terminal Blocks
(kohms)

TB Number Plot Symbol and Voltage	Ambient ○	175°C ○	95°C ◇	175°C ●	161°C △	95°C ◆	149°C ▲	121°C □	105°C ▽	Ambient ●
1 ◇ 125 Vdc	3.6E+05	1.2E+01	1.3E+04	Sub 1: 2.0E+01 Sub 2: 6.8E+01 Overall: 2.4E+01	1.5E+02	1.5E+03	4.9E+00	Failed Open	Failed Open	Failed Open
2 ○ 125 Vdc	4.3E+05	2.7E+02	3.3E+04	Sub 1: 7.1E+01 Sub 2: 7.8E+01 Overall: 7.3E+01	1.1E+02	1.5E+03	8.4E+01	Sub 1: 4.9E+01 Sub 2: 1.4E+02 Overall: 1.2E+02	2.3E+02	6.5E+02
3 ○ 125 Vdc	4.9E+05	1.3E+02	1.2E+05	Sub 1: 6.6E+01 Sub 2: 7.5E+01 Overall: 6.8E+01	1.9E+02	7.0E+03	8.5E+01	Sub 1: 2.0E+02 Sub 2: 2.2E+02 Overall: 2.2E+02	Sub 1: 2.7E+02 Sub 2: 3.1E+02 Overall: 3.1E+02	9.5E+03
4 ○ 125 Vdc	9.8E+05	1.1E+02	4.5E+04	Sub 1: 7.9E+01 Sub 2: 9.4E+01 Overall: 8.2E+01	1.4E+02	5.9E+03	1.0E+02	Sub 1: 2.9E+02 Sub 2: 4.8E+02 Overall: 4.5E+02	Sub 1: 4.7E+02 Sub 2: 9.4E+02 Overall: 9.2E+02	7.6E+04
5 □ 125 Vdc	5.9E+05	1.8E+01	1.0E+04	Sub 1: 7.6E+00 Sub 2: 6.7E+00 Overall: 7.3E+00	1.7E+00	1.6E+02	1.8E+00	Sub 1: 1.3E+00 Sub 2: 1.1E+00 Sub 3: 1.9E+01 Overall: 1.0E+01	Sub 1: 3.2E+01 Sub 2: 2.5E+01 Overall: 2.5E+01	2.8E+02
6 □ 125 Vdc	4.2E+05	5.6E+00	1.1E+02	Sub 1: 8.4E-01 Sub 2: 1.9E+00 Overall: 1.0E+00	1.8E+00	3.2E+01	7.9E-01	Sub 1: 2.7E-01 Sub 2: 6.2E-01 Sub 3: 1.5E+01 Overall: 5.5E+00	1.7E+01	1.5E+02

TABLE 15 (continued)

Averaged Insulation Resistance G for Phase II Terminal Blocks
(kohms)

TB Number Plot Symbol and Voltage	Ambient ○	175°C ○	95°C ◇	175°C ●	161°C △	95°C ◆	149°C ▲	121°C □	105°C ▽	Ambient ●
7 ◇ 45 Vdc	7.4E+06	3.6E+01	7.2E+03	Sub 1: 1.3E+01 Sub 2: 1.3E+01 Overall: 1.3E+01	2.2E+01	4.9E+02	1.6E+01	Sub 1: 1.4E+01 Sub 2: 3.0E+01 Overall: 2.7E+01	Sub 1: 1.5E+02 Sub 2: 5.9E+01 Sub 3: 4.2E+01 Overall: 5.8E+01	2.0E+02
8 ◇ 45 Vdc	1.4E+07	2.1E+01	5.0E+05	Sub 1: 1.3E+01 Sub 2: 2.0E+01 Overall: 1.5E+01	4.5E+01	2.5E+04	3.5E+01	Sub 1: 1.1E+01 Sub 2: 1.7E+02 Overall: 7.0E+01	Sub 1: 1.8E+02 Sub 2: 7.6E+02 Sub 3: 1.1E+03 Sub 4: 6.7E+02 Overall: 1.0E+03	5.3E+05
9 ○ 45 Vdc	4.1E+07	7.7E+01	1.4E+05	Sub 1: 3.1E+01 Sub 2: 4.1E+01 Overall: 3.3E+01	1.0E+02	2.2E+04	5.4E+01	Sub 1: 1.6E+02 Sub 2: 1.4E+02 Overall: 1.5E+02	Sub 1: 1.4E+02 Sub 2: 3.9E+02 Sub 3: 7.4E01 Overall: 3.2E02	1.1E+05
10 ○ 45 Vdc	1.5E+07	1.0E+02	1.8E+05	Sub 1: 4.5E+01 Sub 2: 9.1E+01 Overall: 5.5E+01	1.7E+02	2.4E+04	9.8E+01	Sub 1: 2.8E+02 Sub 2: 5.2E+02 Overall: 4.8E+02	Sub 1: 2.1E+02 Sub 2: 9.4E+02 Sub 3: 2.1E+02 Overall: 7.8E+02	2.3E+06
11 ○ 45 Vdc	6.7E+06	3.6E+01	2.8E+04	Sub 1: 1.8E+01 Sub 2: 2.9E+01 Overall: 2.1E+01	6.1E+01	5.8E+03	3.0E+01	Sub 1: 7.0E+01 Sub 2: 8.0E+01 Overall: 7.9E+01	Sub 1: 1.0E+02 Sub 2: 4.6E+01 Overall: 9.7E+01	1.8E+03
12 □ 45 Vdc	1.7E+07	2.8E+01	6.7E+03	Sub 1: 5.4E+00 Sub 2: 7.7E+00 Overall: 6.1E+00	2.0E+01	2.1E+03	7.0E+00	Sub 1: 3.0E+01 Sub 2: 2.7E+01 Overall: 2.7E+01	Sub 1: 1.7E+01 Sub 2: 2.6E+01 Overall: 2.6E+01	2.1E+03

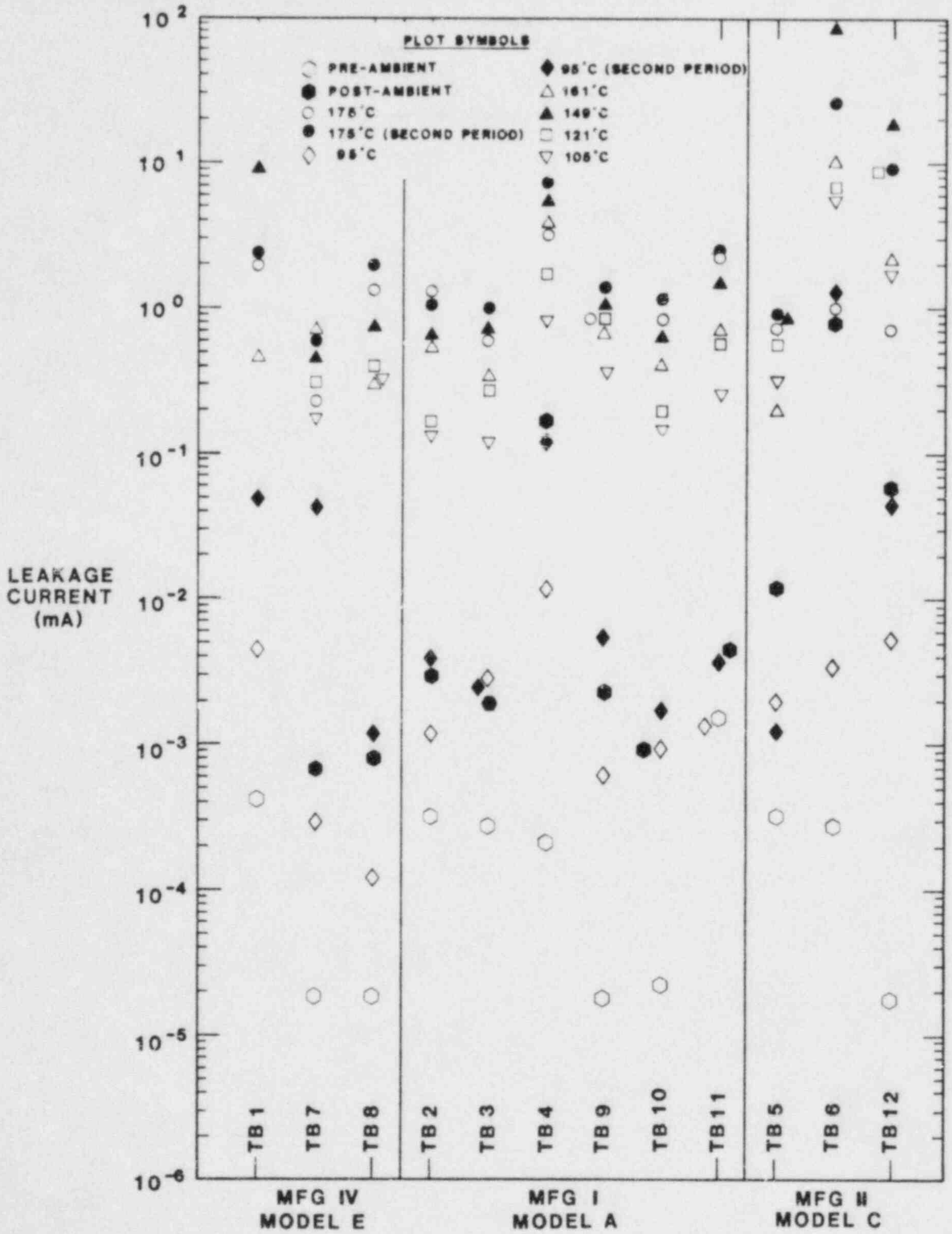

Figure 34

Leakage Currents A for Phase II Terminal Blocks

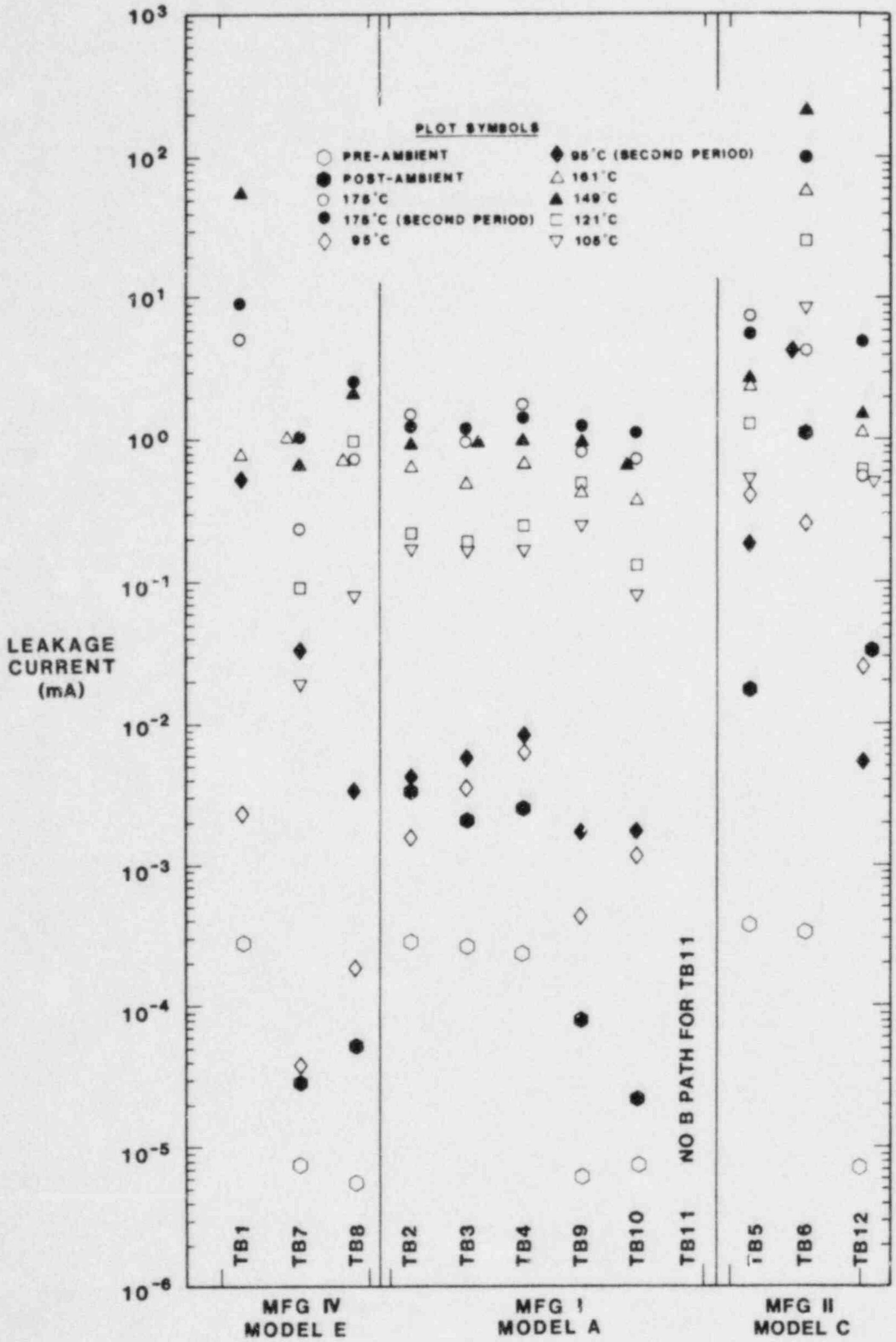

Figure 35

Leakage Currents B for Phase II Terminal Blocks

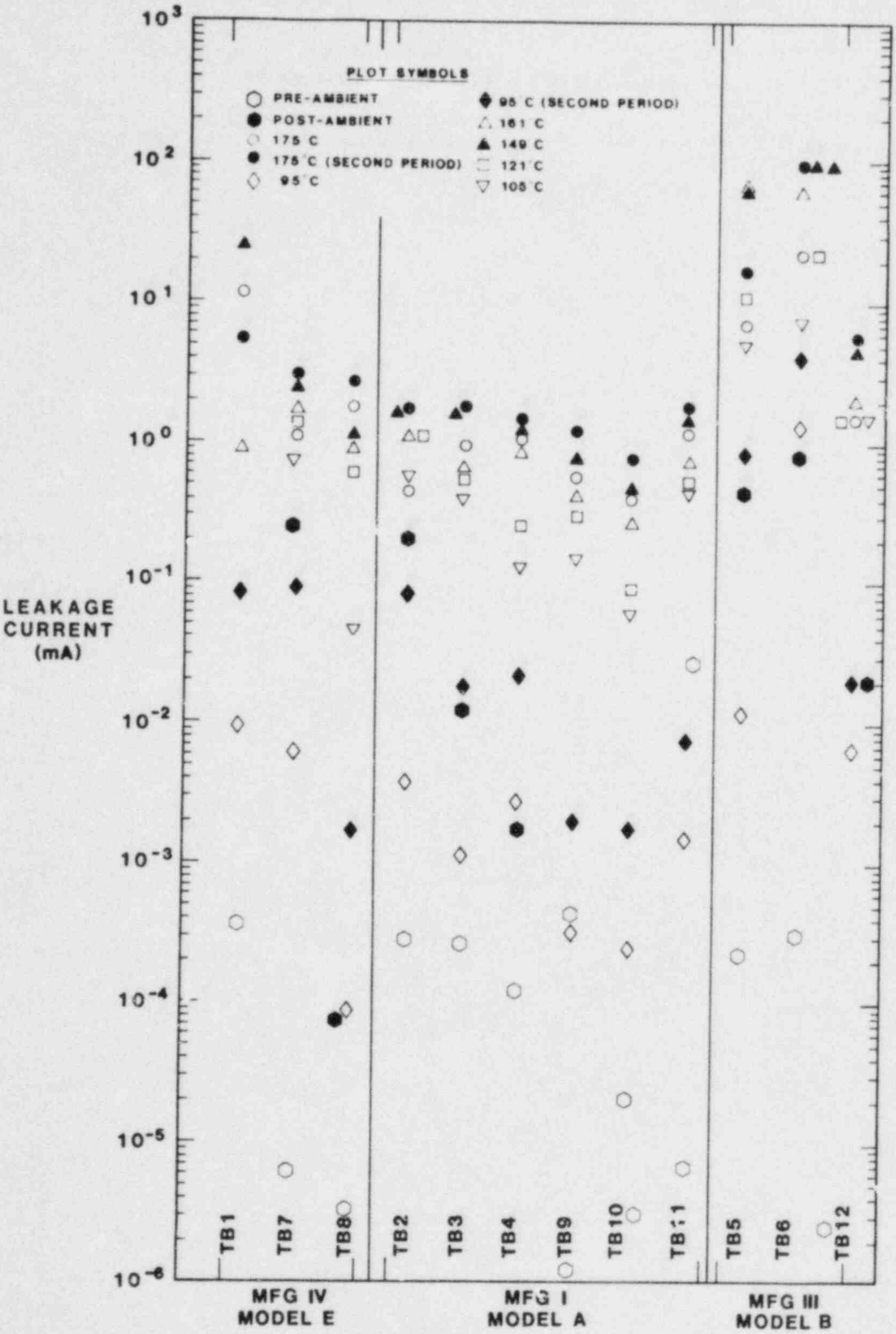

Figure 36

Leakage Currents G for Phase II Terminal Blocks

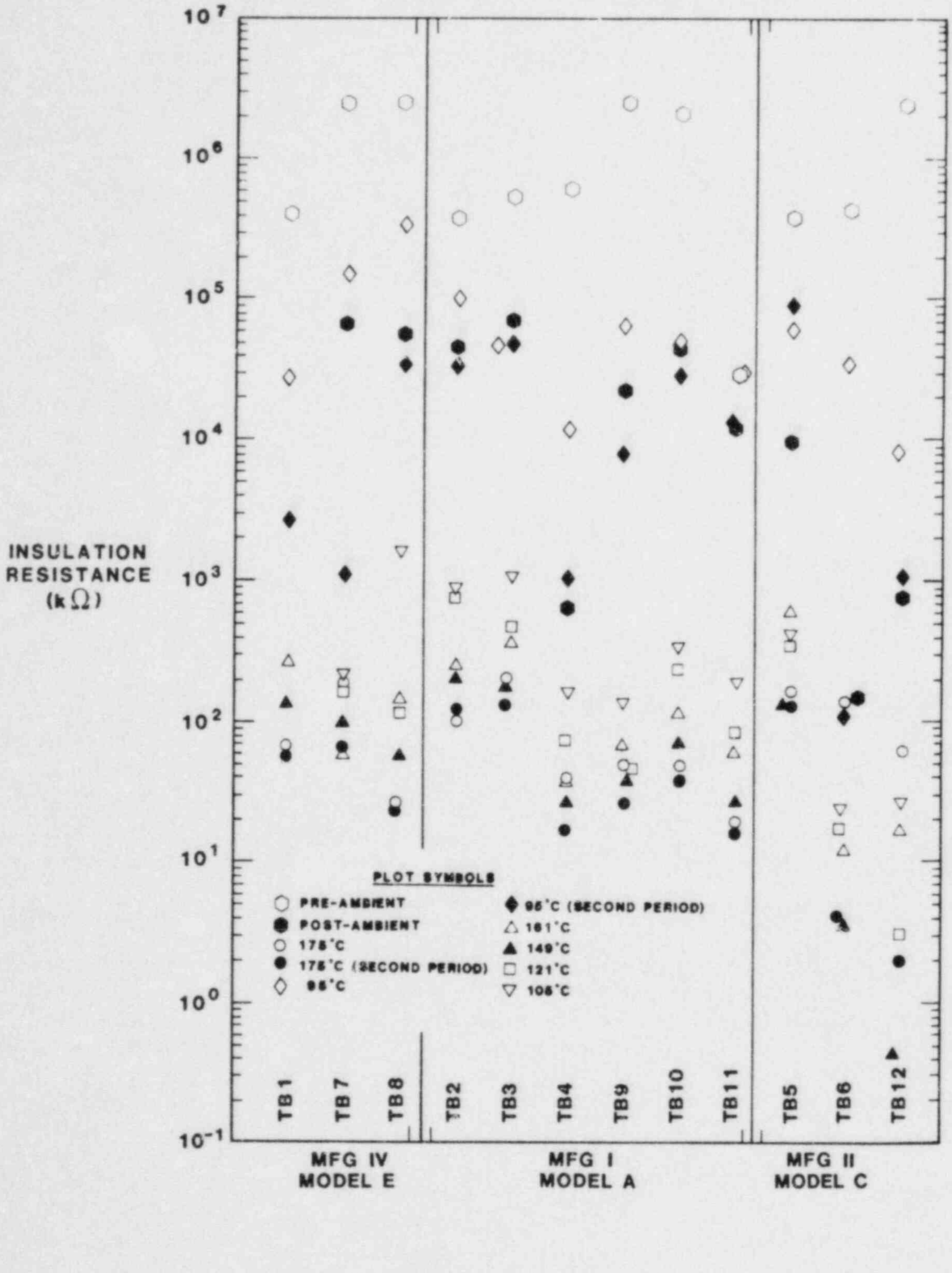

Figure 37

Insulation Resistance A for Phase II Terminal Blocks

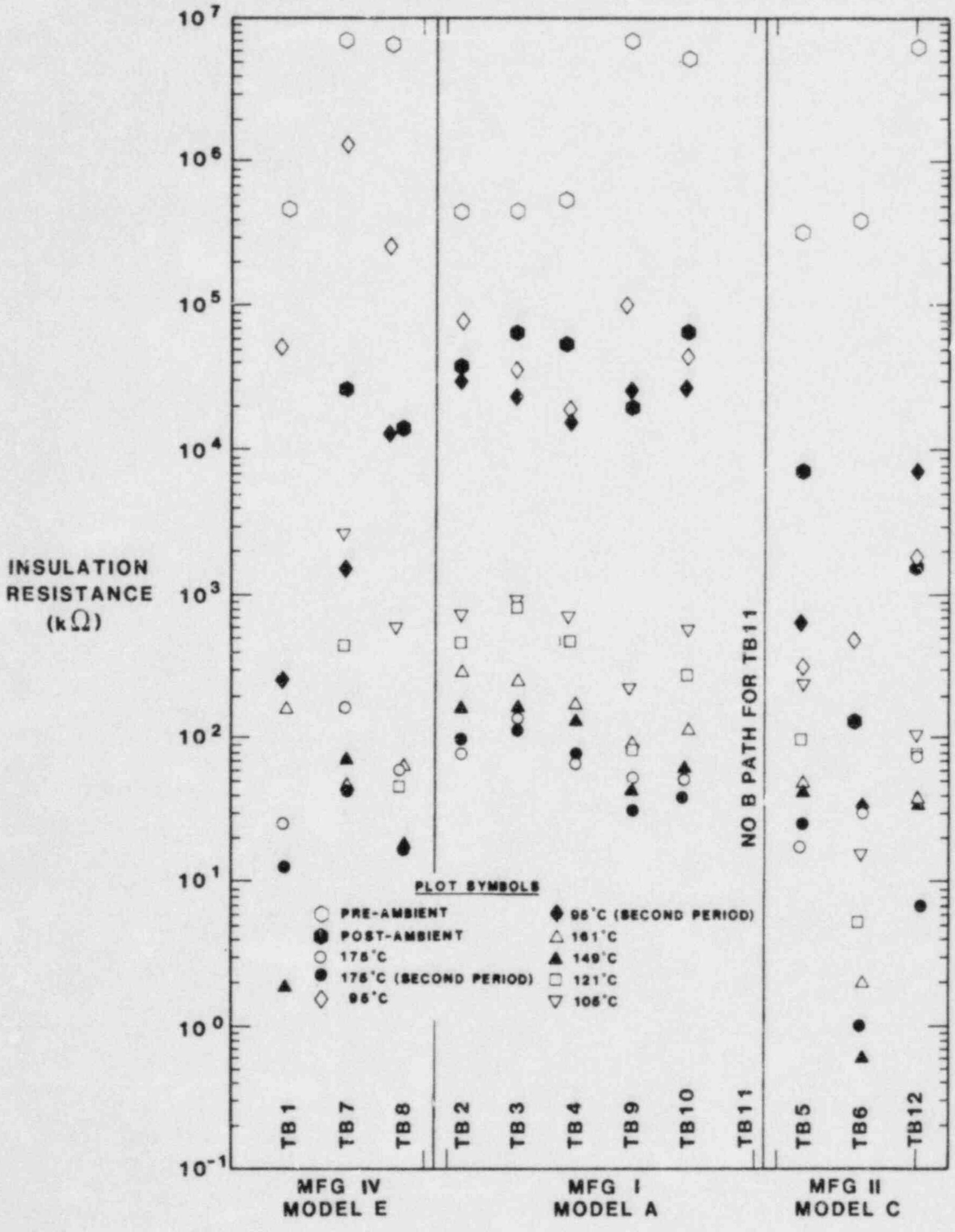

Figure 38

Insulation Resistance B for Phase II Terminal Blocks

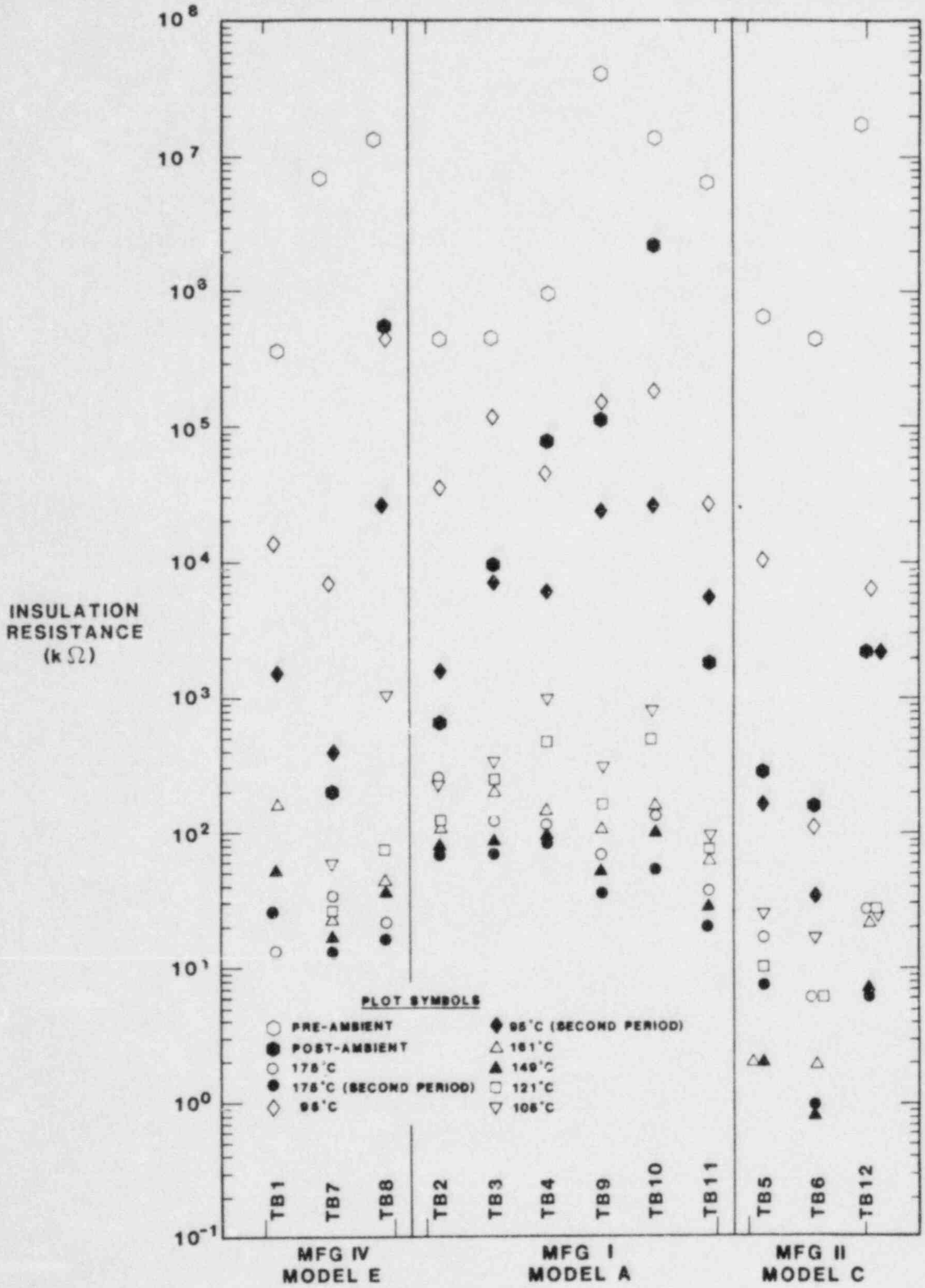

Figure 39

Insulation Resistance G for Phase II Terminal Blocks

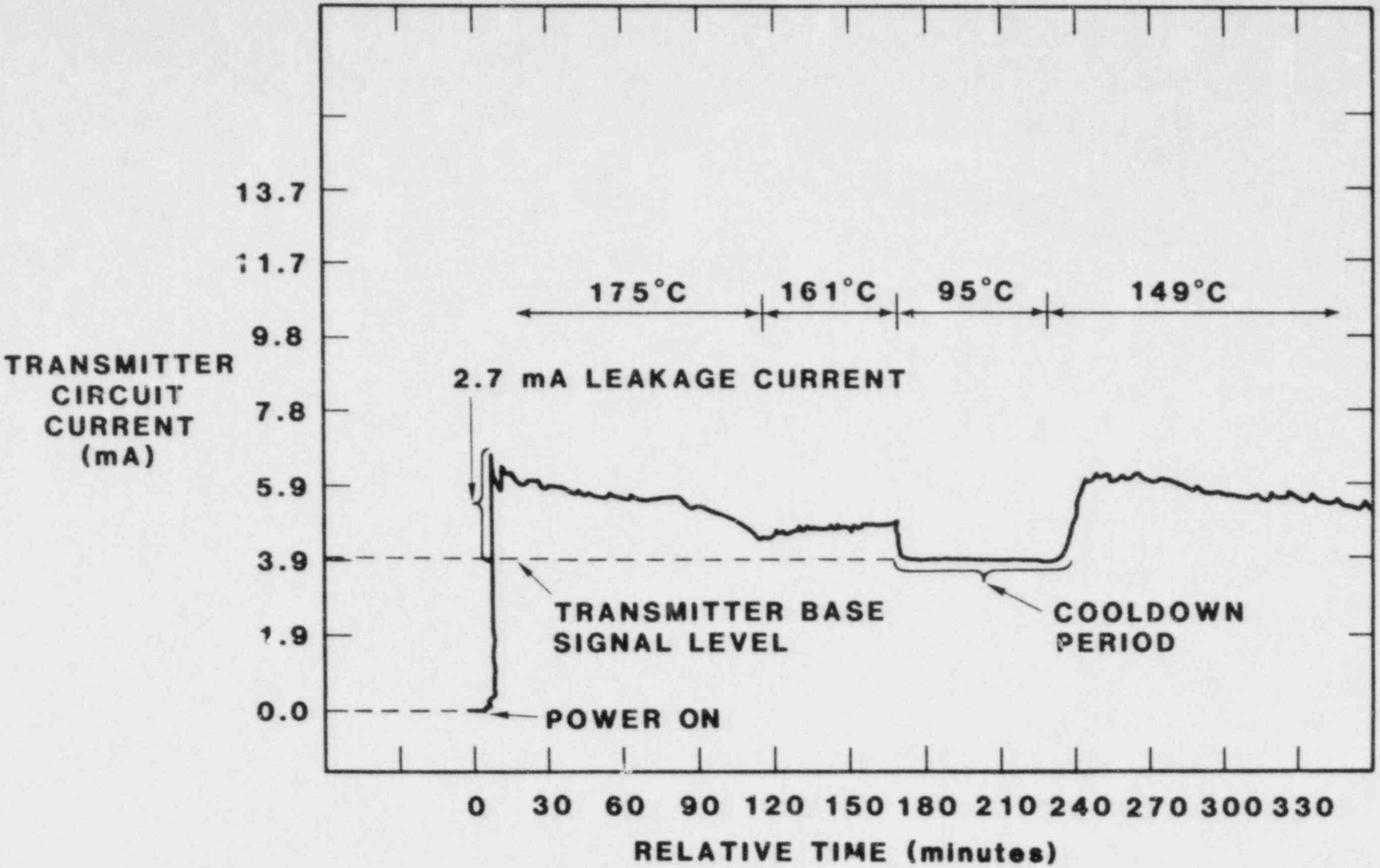

Figure 40

Trace of Total Circuit Current for the Transmitter Circuit During Second 175°C, 161°C, Unanticipated Cooldown, and 149°C Temperature Intervals

4.4.1.3 Design Effects

In Phase II, terminal blocks 1, 7, and 8 (Mfg IV, Model E) and 5, 6, and 12 (Mfg II, Model C) were of sectional design, whereas terminal blocks 2, 3, 4, 9, 10, and 11 (Mfg I, Model A) were of one-piece design. Figures 34 through 39 show about one to two orders of magnitude difference between the performance of terminal blocks 5, 6, and 12 and the one-piece blocks, the one piece blocks being better (see Section 4.4.4.3 for further discussion of TBs 5, 6, and 12). The performance of TBs 1, 7, and 8 was comparable to the performance of the one-piece terminal blocks. Thus, there was not a consistent pattern in the performance of the sectional and one-piece terminal blocks pointing to the superiority of one design over the other. This result was surprising since analytically we hypothesized that the modular construction of the sectional blocks would provide more convoluted surface area and thin gaps which could act as a capillary to hold water. We believed that the proximity of this water to the conduction paths could potentially enhance the formation and maintenance of the moisture film.

4.4.2 Quartile Data Presentation

The error analysis for Phase II was identical to that conducted for Phase I. Sections 4.3.2 and 4.3.3 provide a discussion of the analysis conducted. The five-number summary and box and whisker plots for the Phase II data were derived using the same pseudo-frequency scheme used in Phase I. This data is presented in Appendix 1 along with the Phase I data.

4.4.3 Temperature and Voltage Effects

Looking at the time-weighted average data, each terminal block tended to follow the same general performance trend as in Phase I. The lowest IRs were experienced during the second 175°C plateau and tended to increase as temperature decreased. Unlike Phase I, the IR values at the 149°C plateau differed from this performance trend; the IR at 149°C was typically lower than the 161°C plateau. During Phase II, the 149°C plateau occurred immediately after the unanticipated cooldown and hence was achieved by reintroducing the steam. Though this process was done slowly over a period of ten minutes, the environmental conditions most favorable for film formation were present. This difference in test procedure may have increased the film formation and hence could account for the lower IRs experienced during the 149°C plateau.

Figures 41 through 52 show the Phase II data plotted as a function of temperature. We see basically the same performance trend for the A, B, and G paths, with the IRs at the higher temperatures (149°C, 161°C, and 175°C) varying over the 10^4 to 10^5 ohm range, the 105°C and the 121°C temperatures varying over the mid 10^4 to 10^6 ohm range and the 95°C data spread widely from 10^5 to 10^9 ohm range. This performance is roughly equivalent to the Phase I behavior illustrated in Figures 21 through 24. The behavior of each individual terminal block in Phase II was similar to the behavior illustrated in Figures 25 through 27 for Phase I.

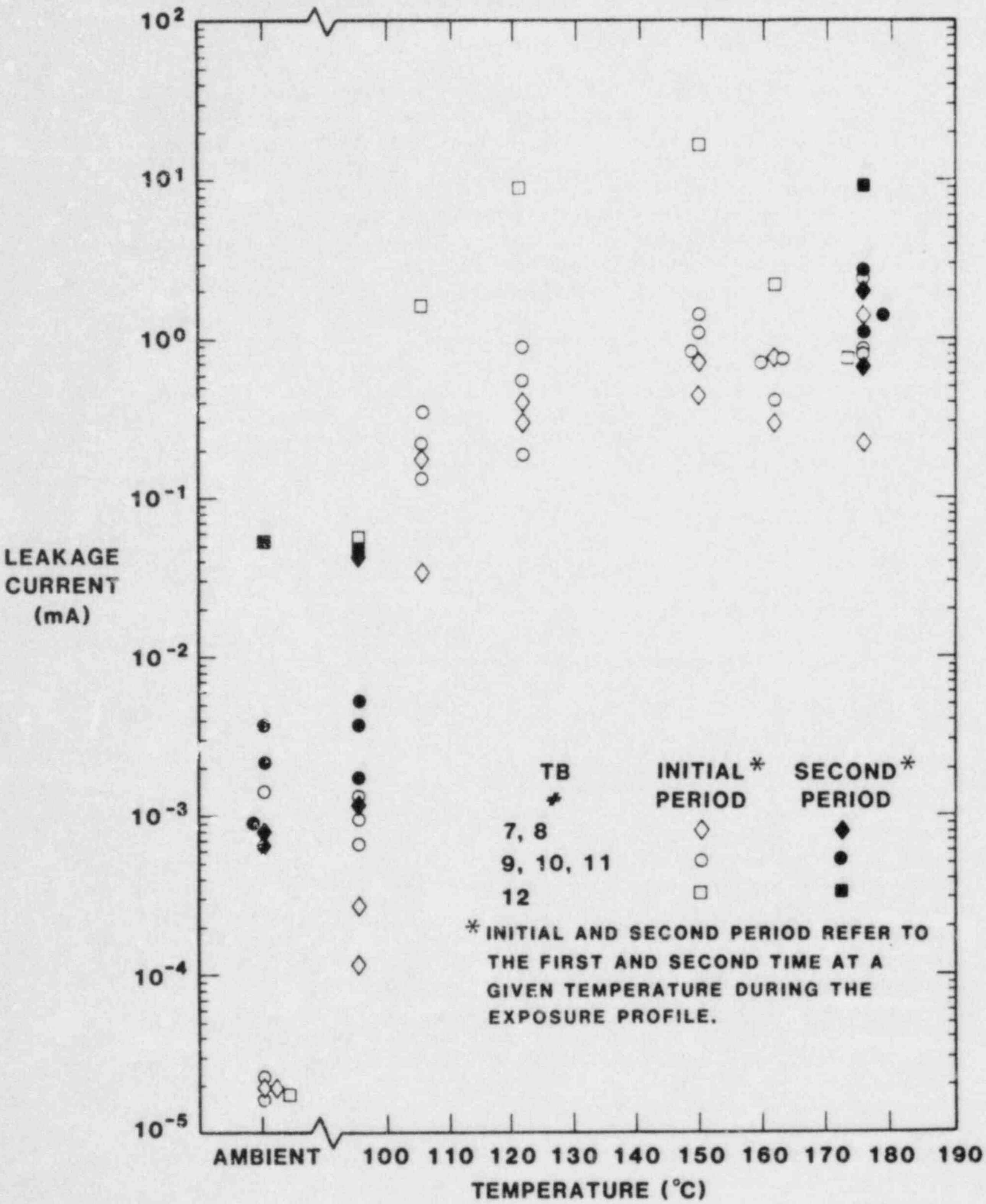

Figure 41

Leakage Current A as a Function of Temperature for 45 Vdc Terminal Blocks

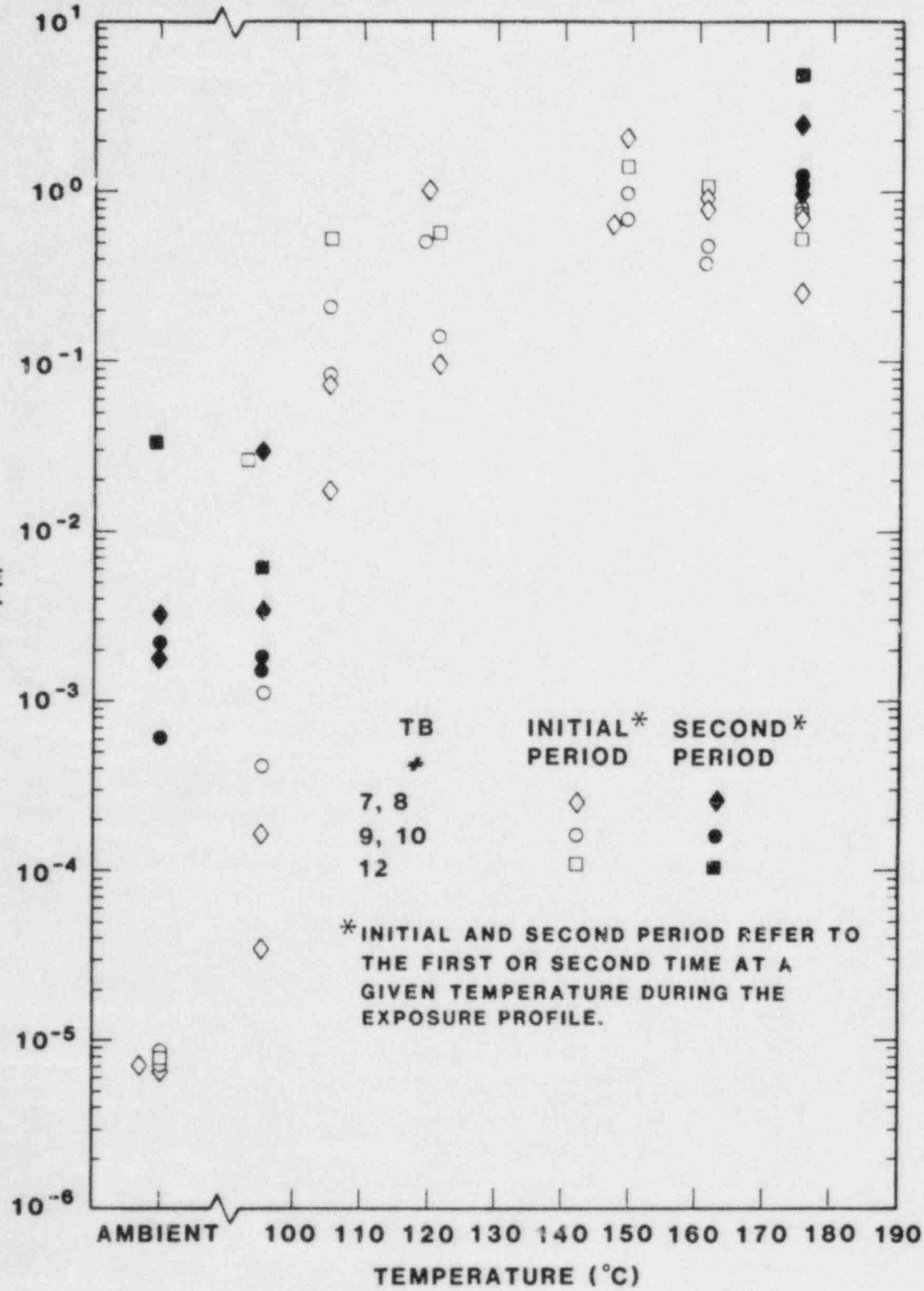

Figure 42

Leakage Current B as a Function of Temperature
for 45 Vdc Terminal Blocks

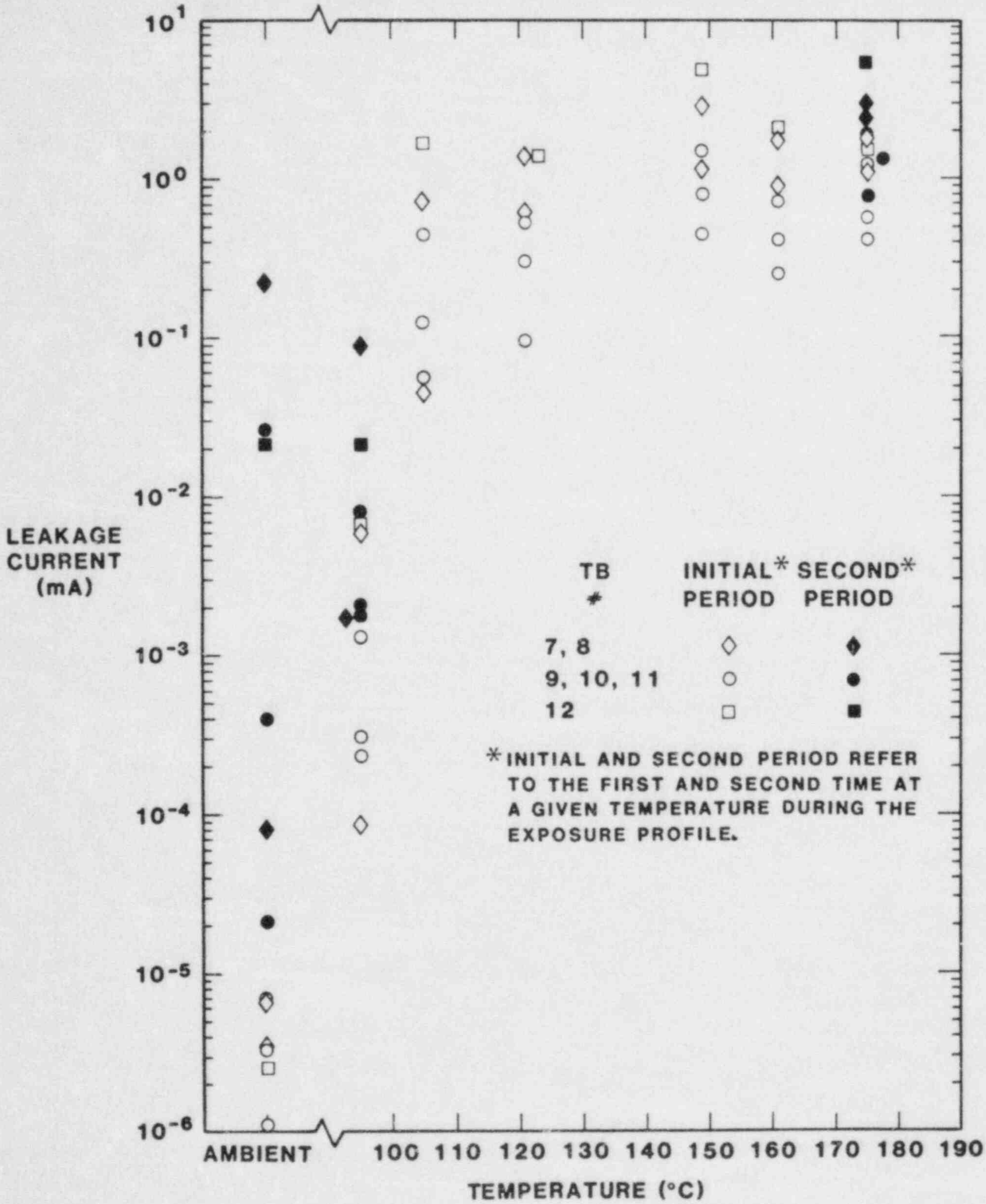

Figure 43

Leakage Current G as a Function of Temperature for 45 Vdc Terminal Blocks

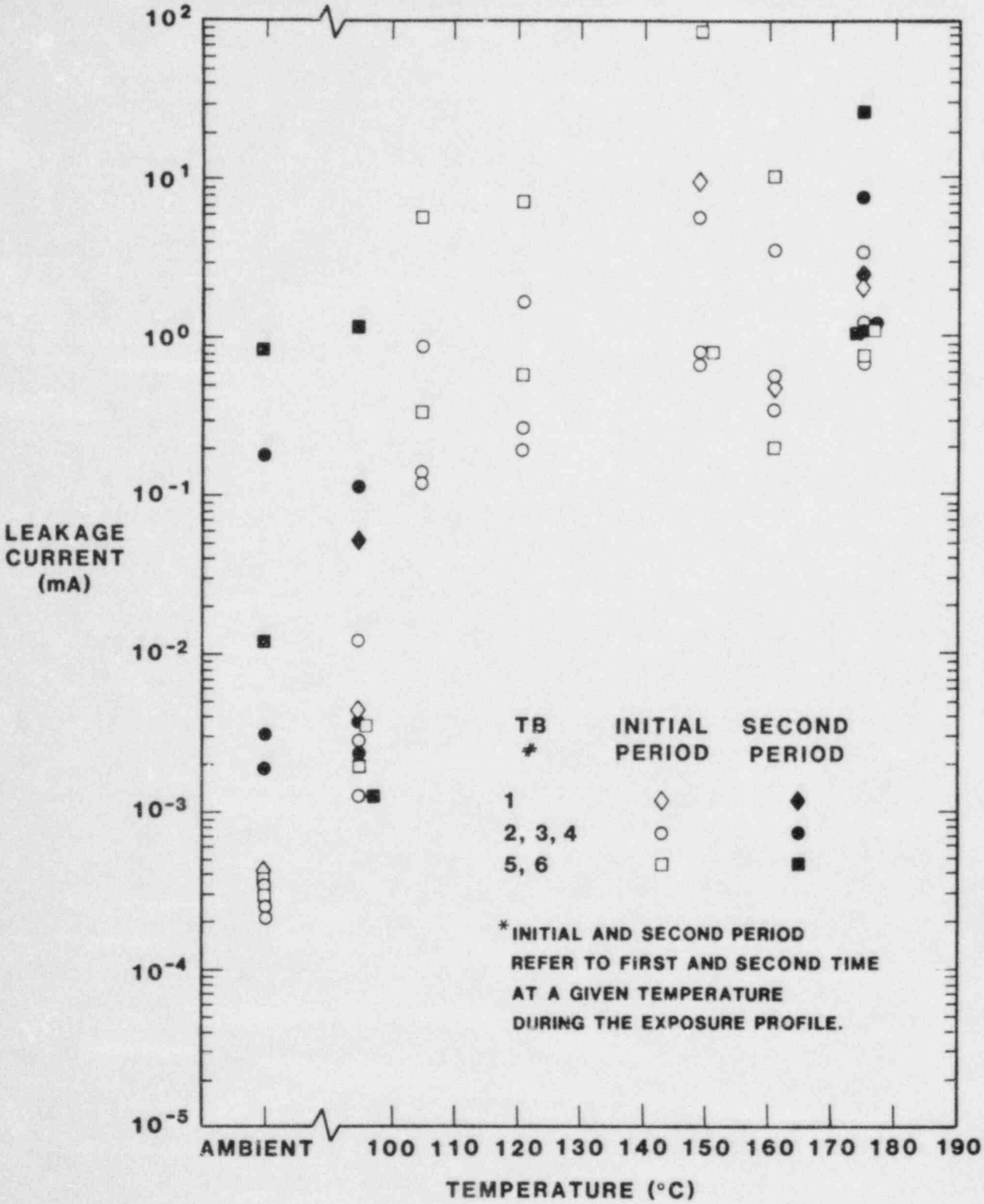

Figure 44

Leakage Current A as a Function of Temperature for 125 Vdc Terminal Blocks

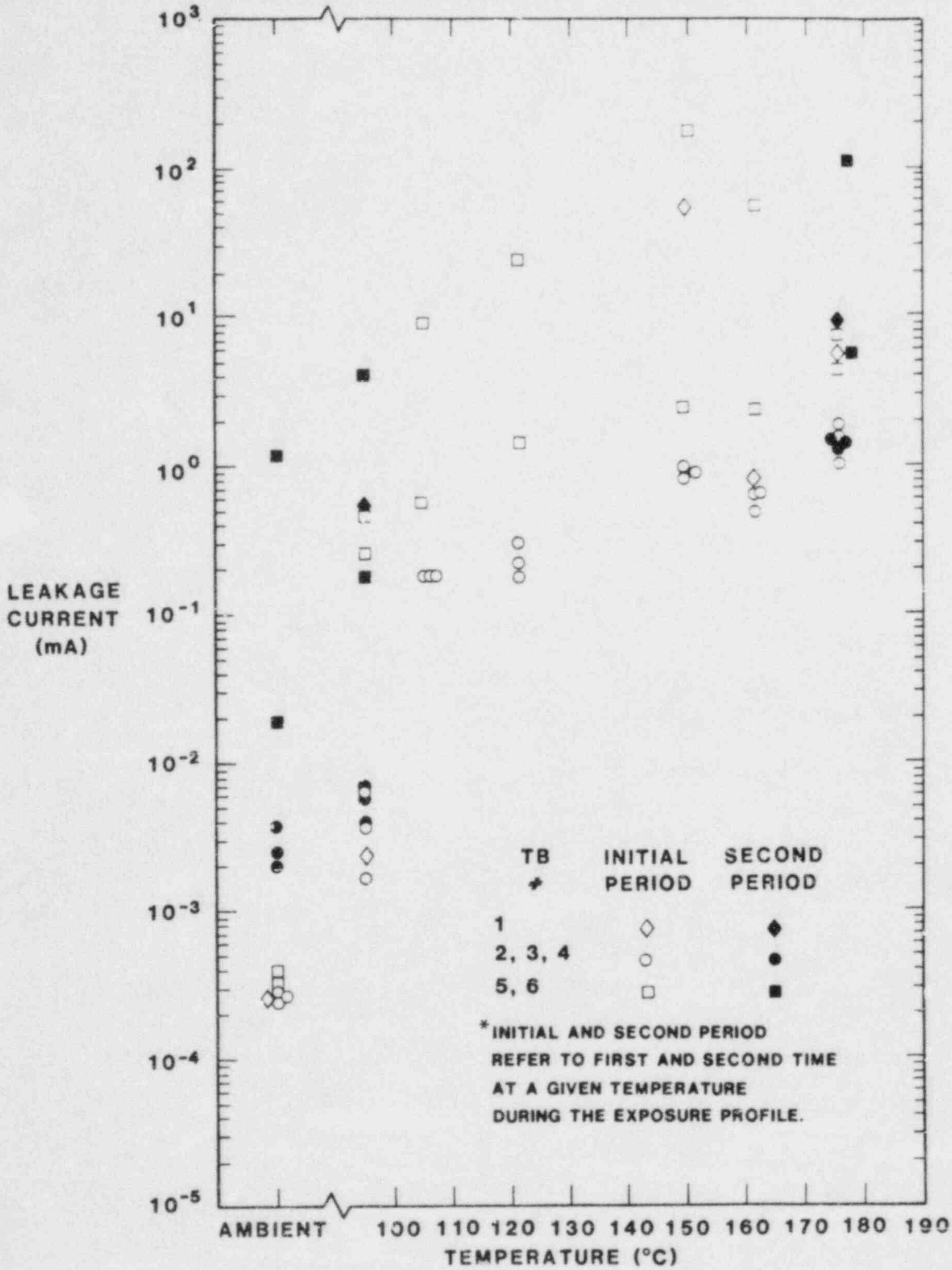

Figure 45

Leakage Current B as a Function of Temperature
for 125 Vdc Terminal Blocks

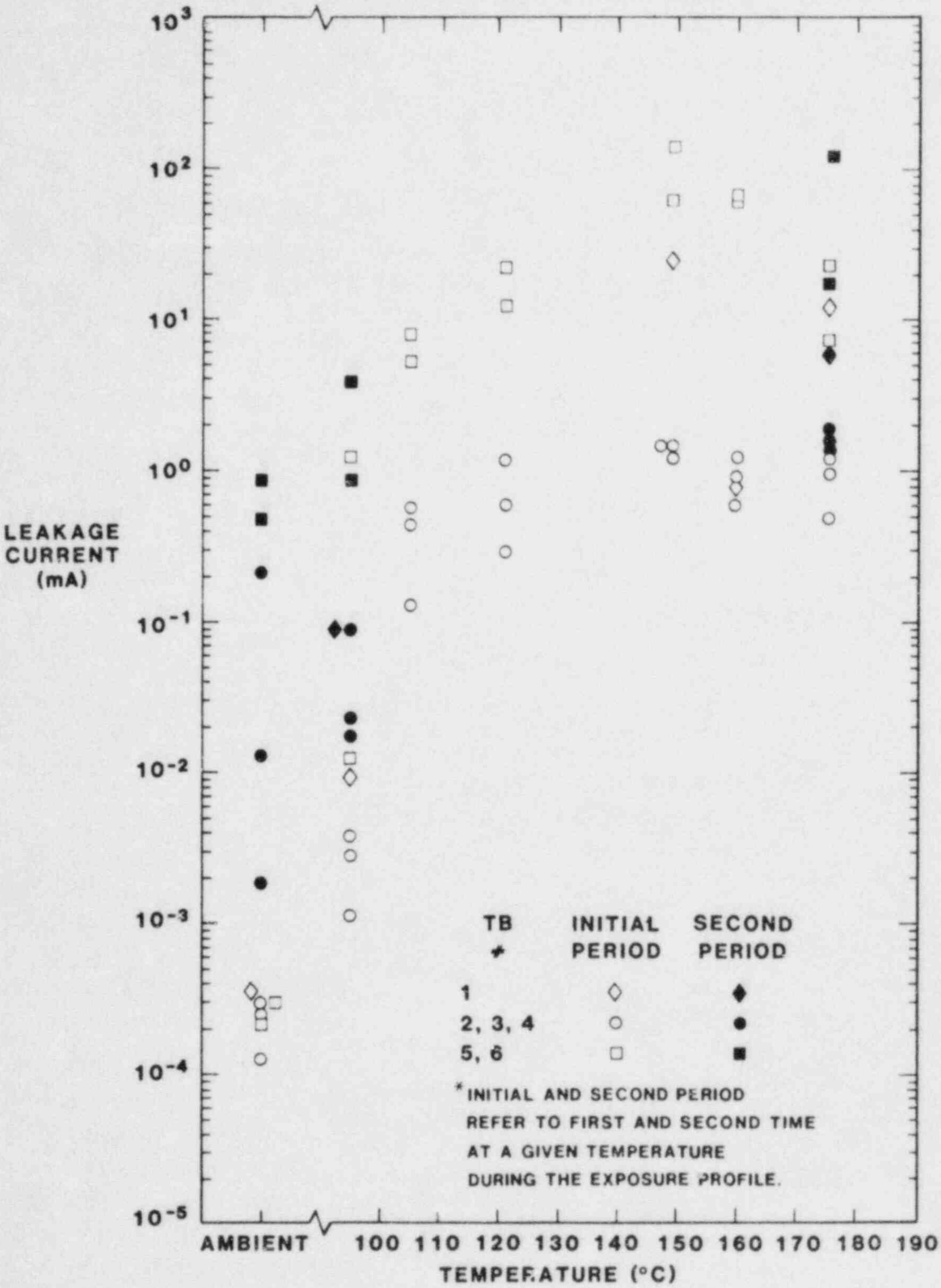

Figure 46

Leakage Current G as a Function of Temperature for 125 Vdc Terminal Blocks

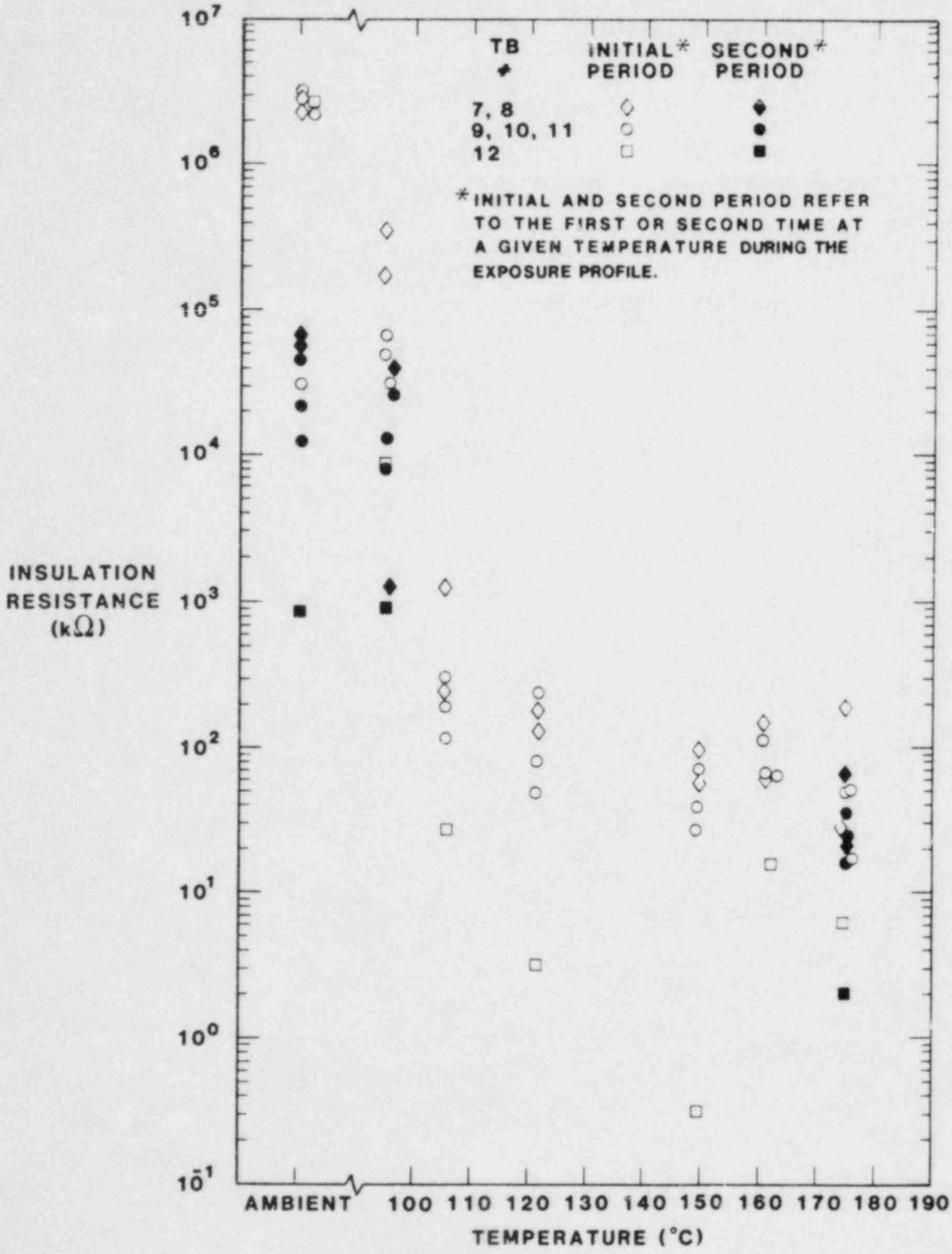

Figure 47

Insulation Resistance A as a Function of Temperature for 45 Vac Terminal Blocks

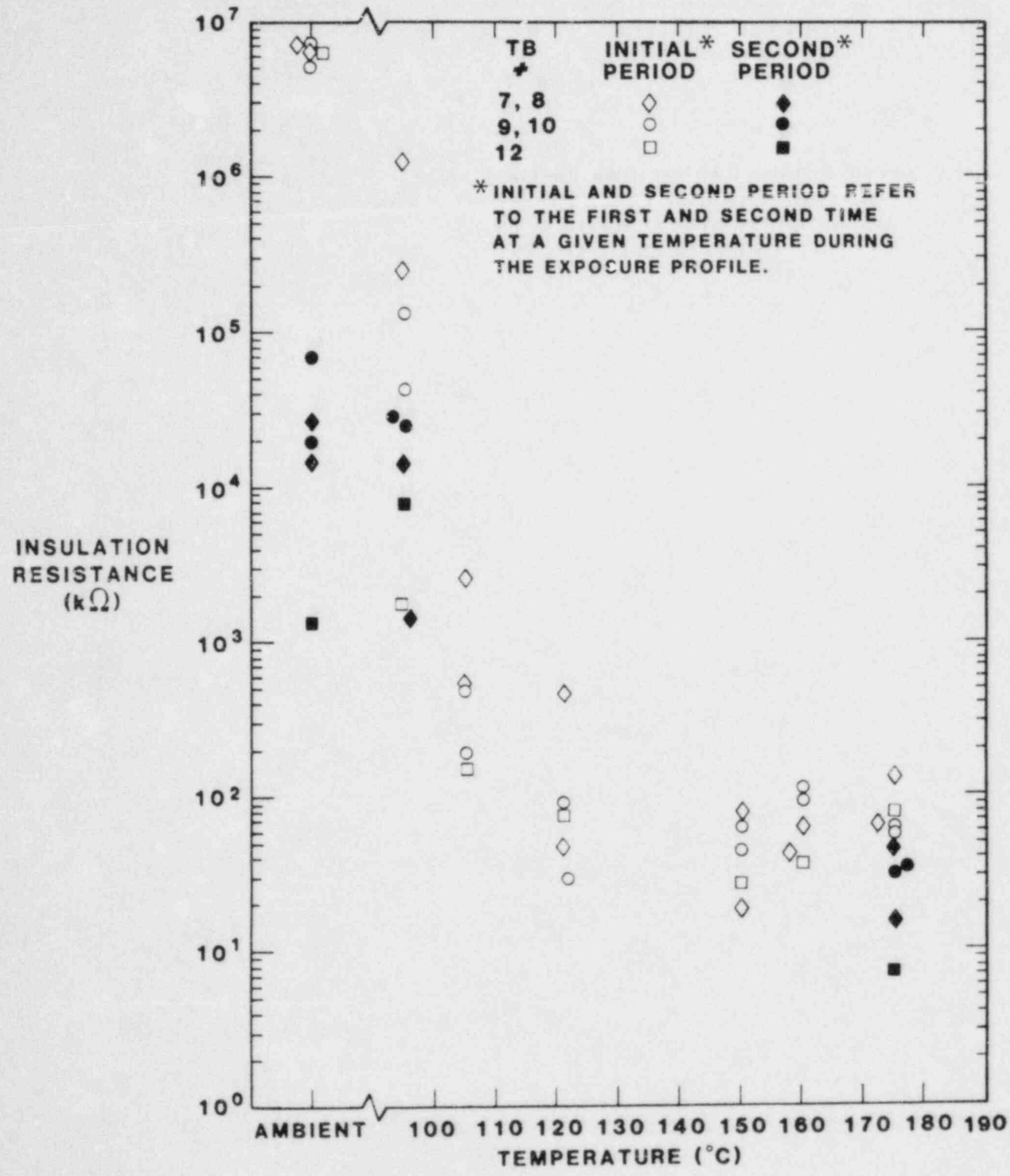

Figure 48

Insulation Resistance B as a Function of Temperature
for 45 Vdc Terminal Blocks

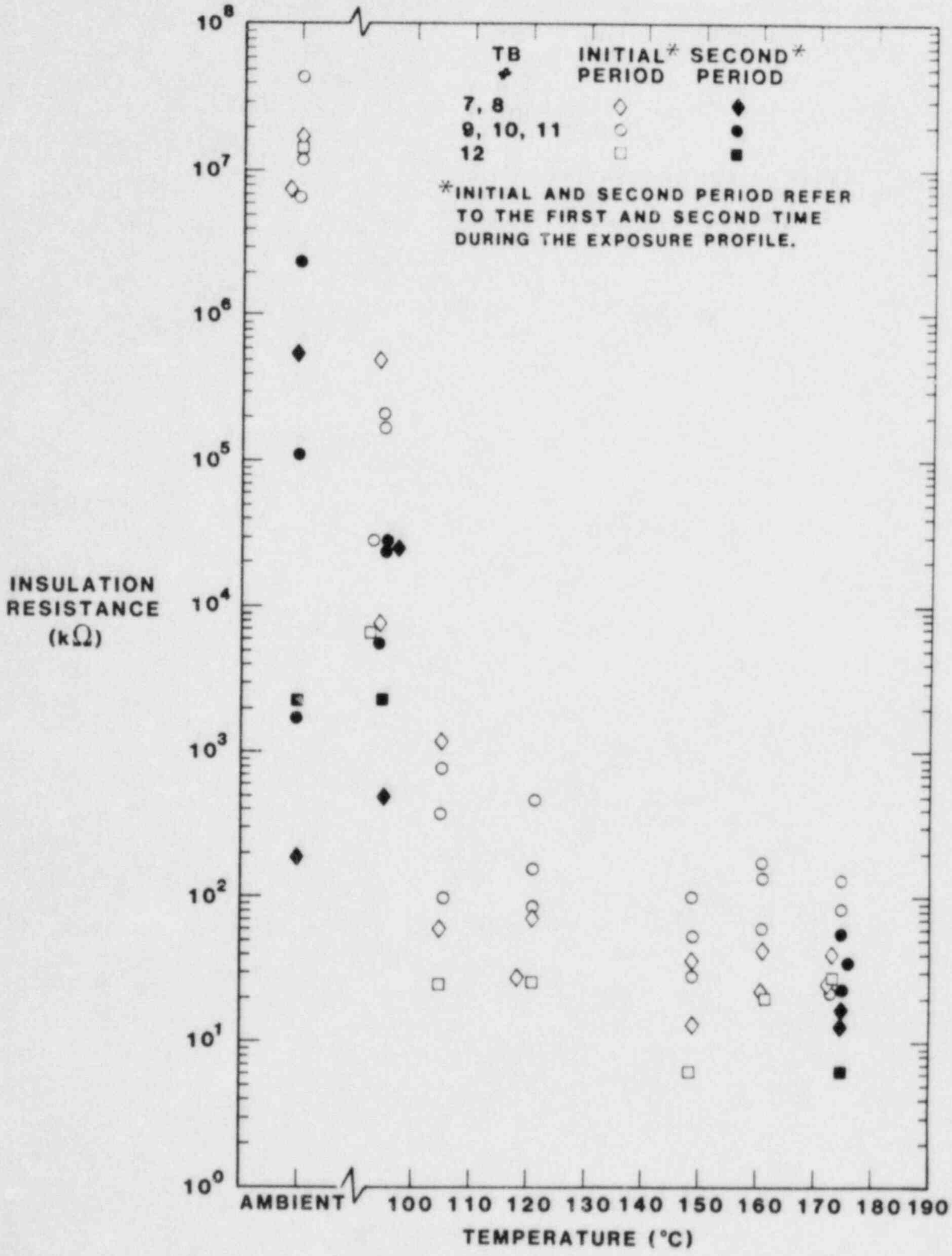

Figure 49

Insulation Resistance G as a Function of Temperature
for 45 Vdc Terminal Blocks

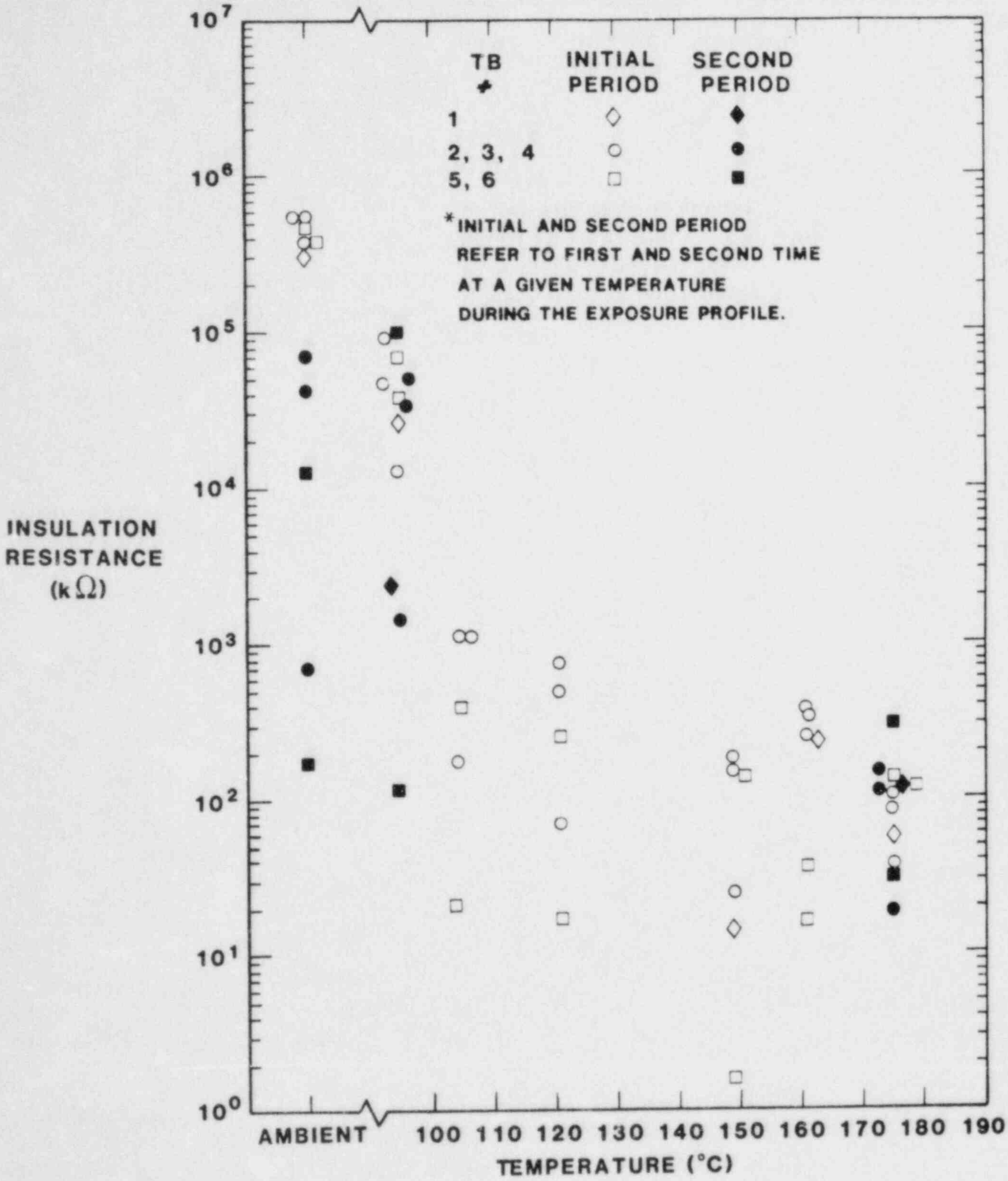

Figure 50

Insulation Resistance A as a Function of Temperature for 125 Vdc Terminal Blocks

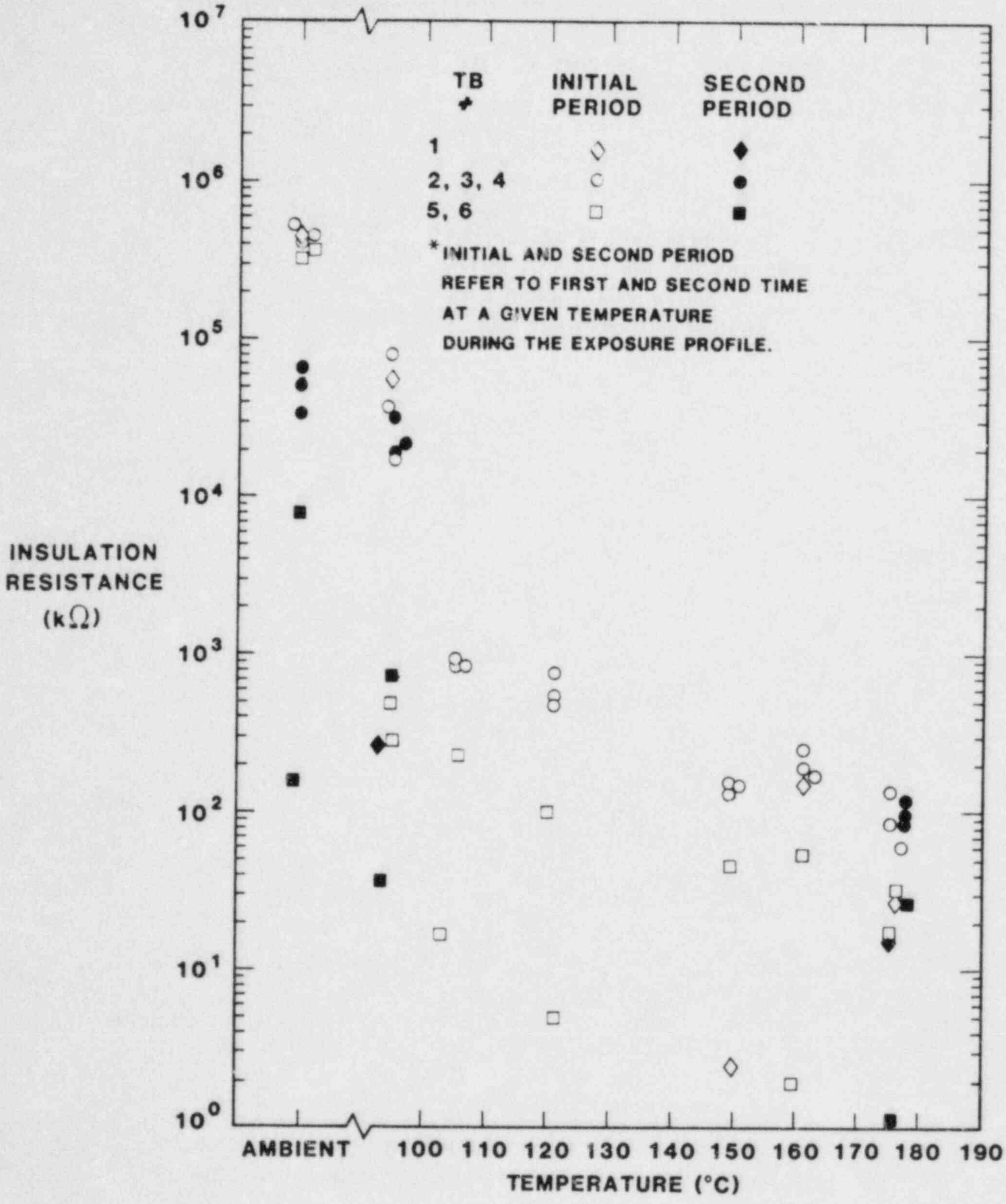

Figure 51

Insulation Resistance B as a Function of Temperature for 125 Vdc Terminal Blocks

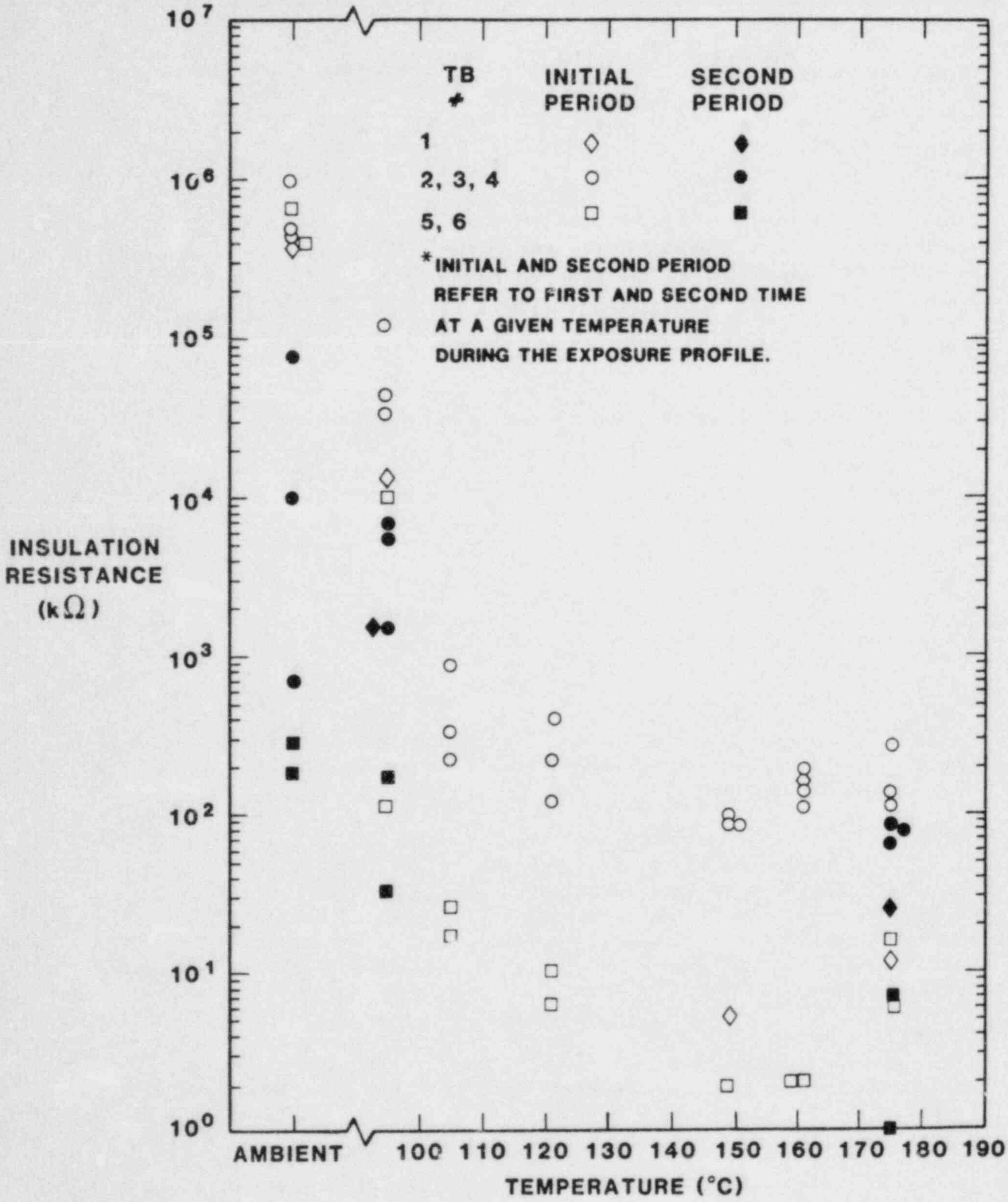

Figure 52

Insulation Resistance G as a Function of Temperature
for 125 Vdc Terminal Blocks

Figures 53 through 58 present the data as function of applied voltage for three temperatures: ambient, 175°C (first plateau), and 105°C. Unlike the Phase I data, the Phase II data does not show the increase in IR with applied voltage; the IR with 45 Vdc applied varied over the same range as the IR with 125 Vdc applied. On the surface, this behavior does not support the hypothesis made in Section 4.3.4 relating increased IR to increased voltage. However, the results of the film conduction model presented in Reference 2 show that under some conditions a voltage dependence of IR may be observed, and under other conditions it may not be observed. The various assumptions on conduction path dimensions, heat transfer characteristics, and amount of surface contaminants can affect the results of the model sufficiently to predict both the Phase I and Phase II results.

Figures 56 through 58 clearly illustrate the grouping of ambient temperature IR measurements taken before the test started (i.e., the "pre-ambient" IR measurements). Note that for a given voltage (45 or 125 Vdc) and path (A, B, or G) all terminal blocks have almost identical IR measurements. However, the magnitudes of the IRs vary between the different voltage and path combinations. The magnitude of the 125 Vdc IRs is consistent for all three paths; the 45 Vdc IRs vary over approximately 1 order of magnitude between the A and G paths, and approximately 1/2 order of magnitude between the A and B and the B and G paths. All pre-test IRs are within factors of 5 to 20 of each other. The reasonable similarity in performance between the terminal blocks in the pre-test condition indicates that either there is little or no electrical performance difference between types of terminal blocks under normal operating conditions, or that the IR values were so large that our measurement technique could not detect differences. It also indicates that our experimental apparatus was electrically consistent from terminal block to terminal block.

At 45 Vdc the Phase II IRs for the same type of blocks (Phase I terminal blocks 7 and 8 compared with Phase II terminal blocks 9, 10, and 11) were a factor of 3 to 10 greater than the IRs measured in Phase I. At 125 Vdc the Phase II IRs for the same type of blocks (Phase I terminal block 1 compared with Phase II terminal blocks 2, 3, and 4) varied from 0.5 to 13 times the Phase I IRs. If the conduction paths were uniformly distributed over the terminal block surface, the difference in wiring between Phase I (serpentine) and Phase II (straight through), would cause the Phase I IRs to be less than the Phase II IRs. This result is a simple consequence of multiple parallel conducting paths. For our experimental configuration there was approximately five times the potential conducting surface available on the Phase I terminal blocks as compared to the Phase II terminal blocks. Consequently, the insulation resistance for the Phase I terminal blocks could reasonably be expected to be one fifth of the Phase II IRs. Except for the A path of Phase II terminal block 4, the 45 Vdc data and the 125 Vdc data support the hypothesis of uniformly distributed conduction. This result is consistent with the film conduction model proposed in Reference 2.

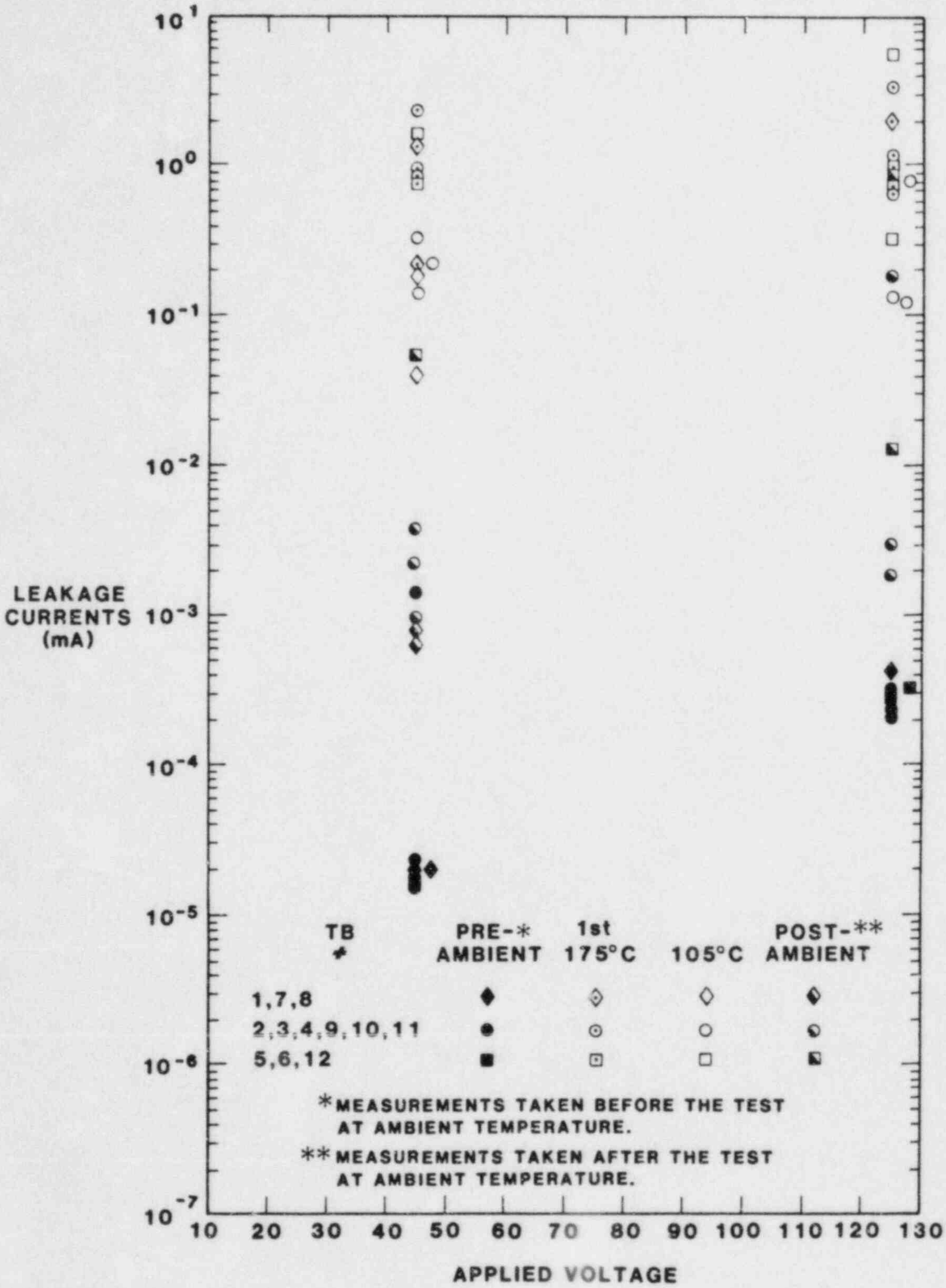

Figure 53

Leakage Current A for Pre-ambient, 175°C, 105°C, and Post-ambient Temperature Periods as a Function of Applied Voltage

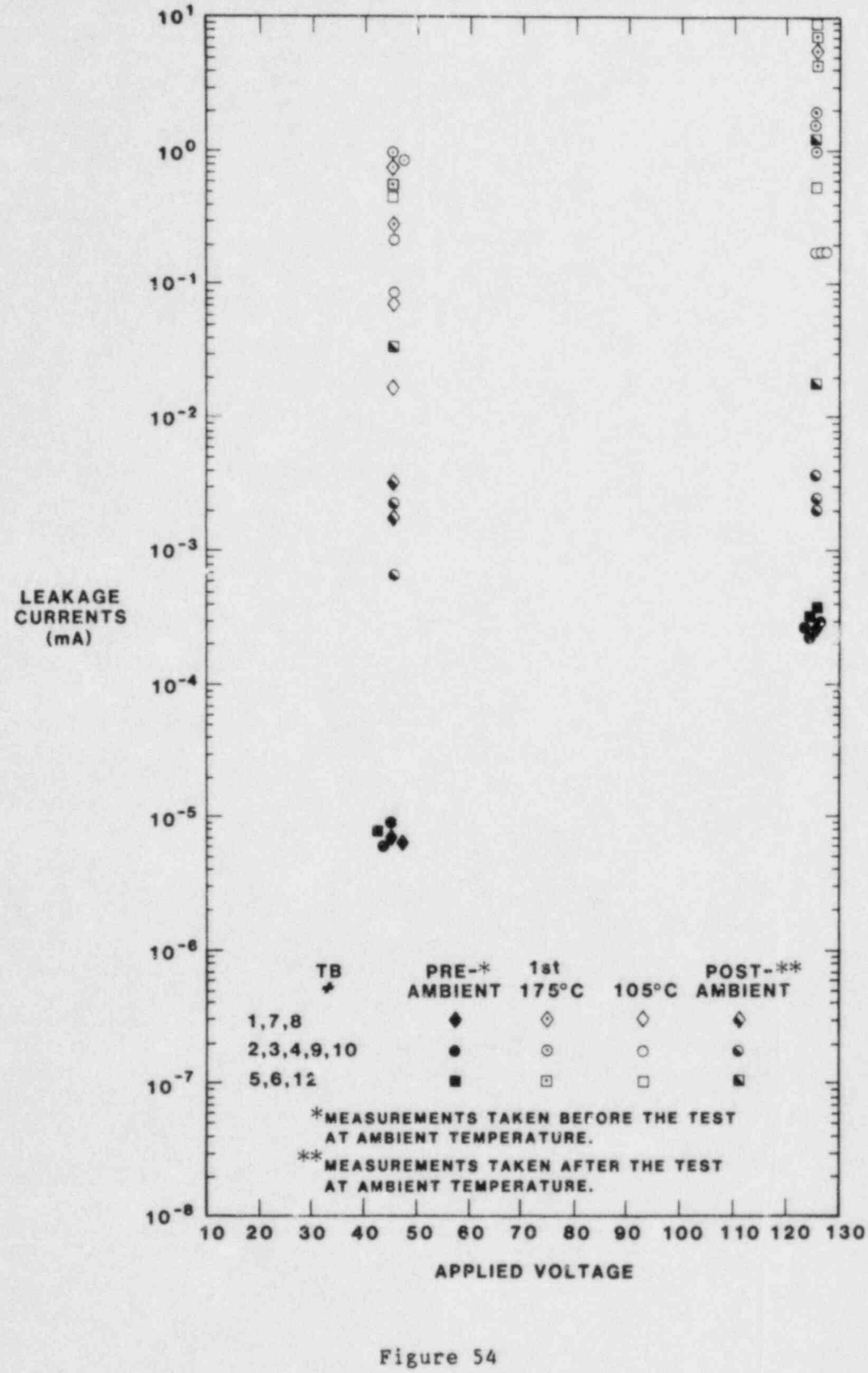

Figure 54

Leakage Current B for Pre-ambient, 175°C, 105°C, and Post-ambient Temperature Periods as a Function of Applied Voltage

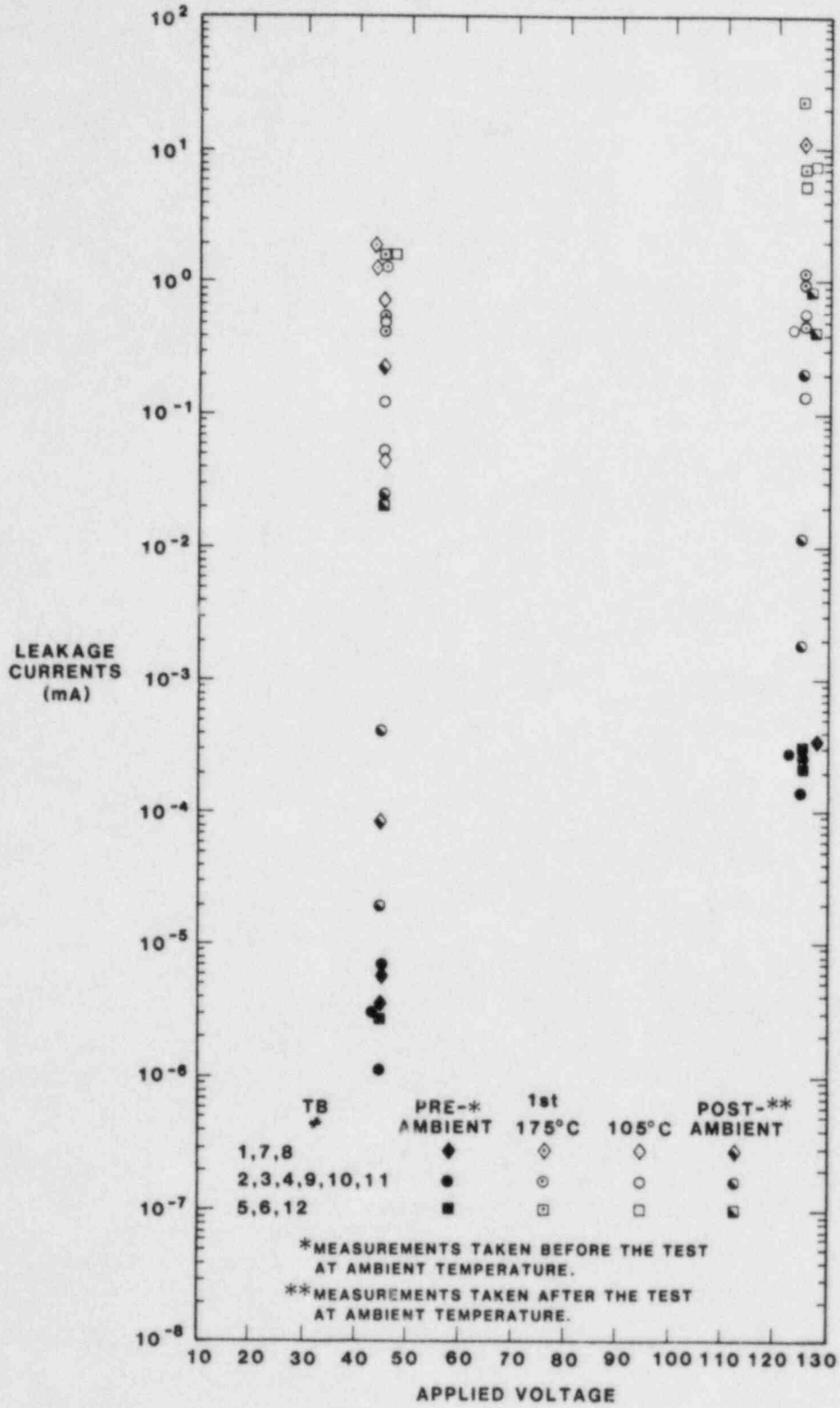

Figure 55

Leakage Current G for Pre-ambient, 175°C, 105°C, and Post-ambient Temperature Periods as a Function of Applied Voltage

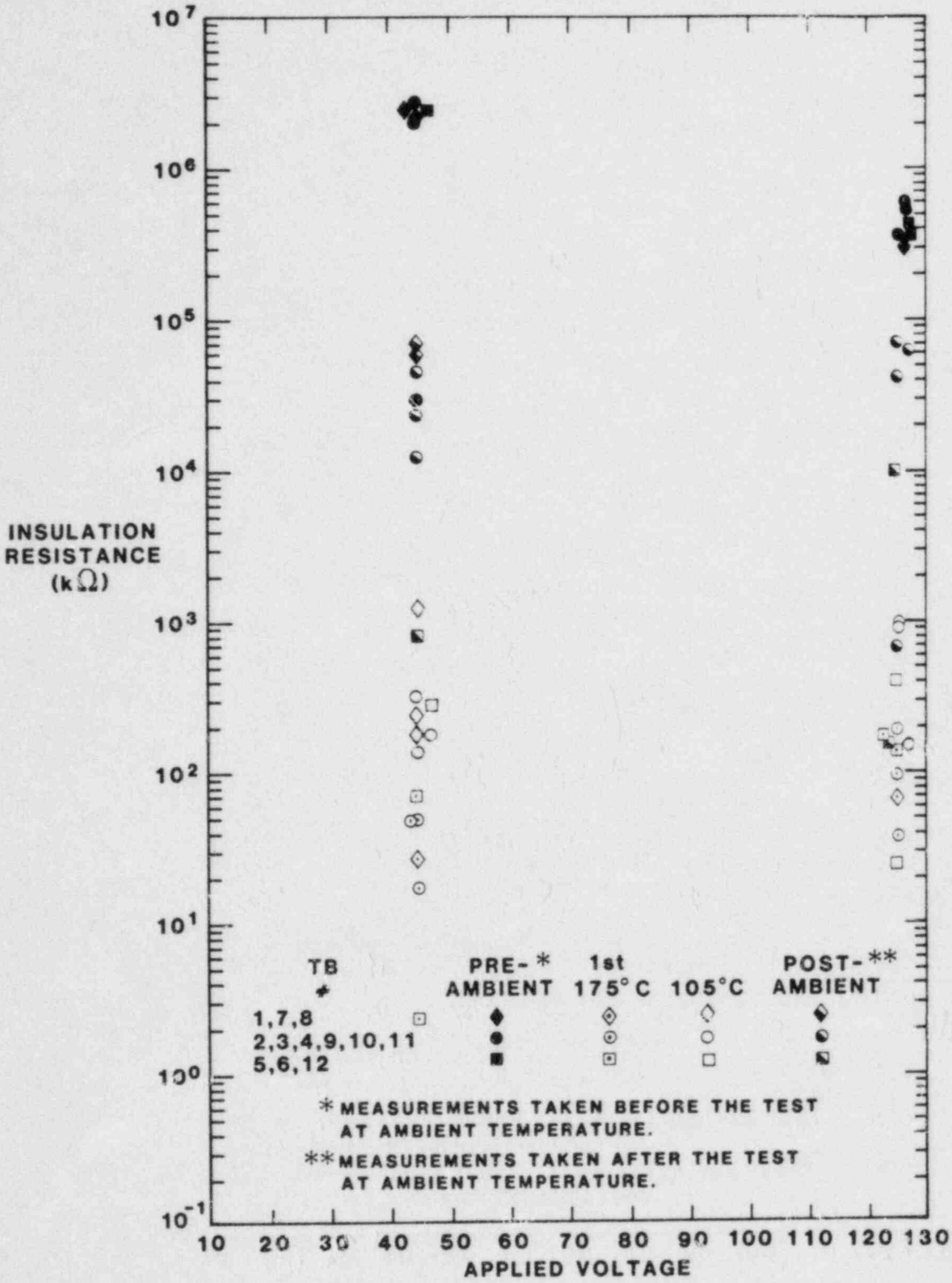

Figure 56

Insulation Resistance A for Pre-ambient, 175°C, 105°C, and Post-ambient Temperature Periods as a Function of Applied Voltage

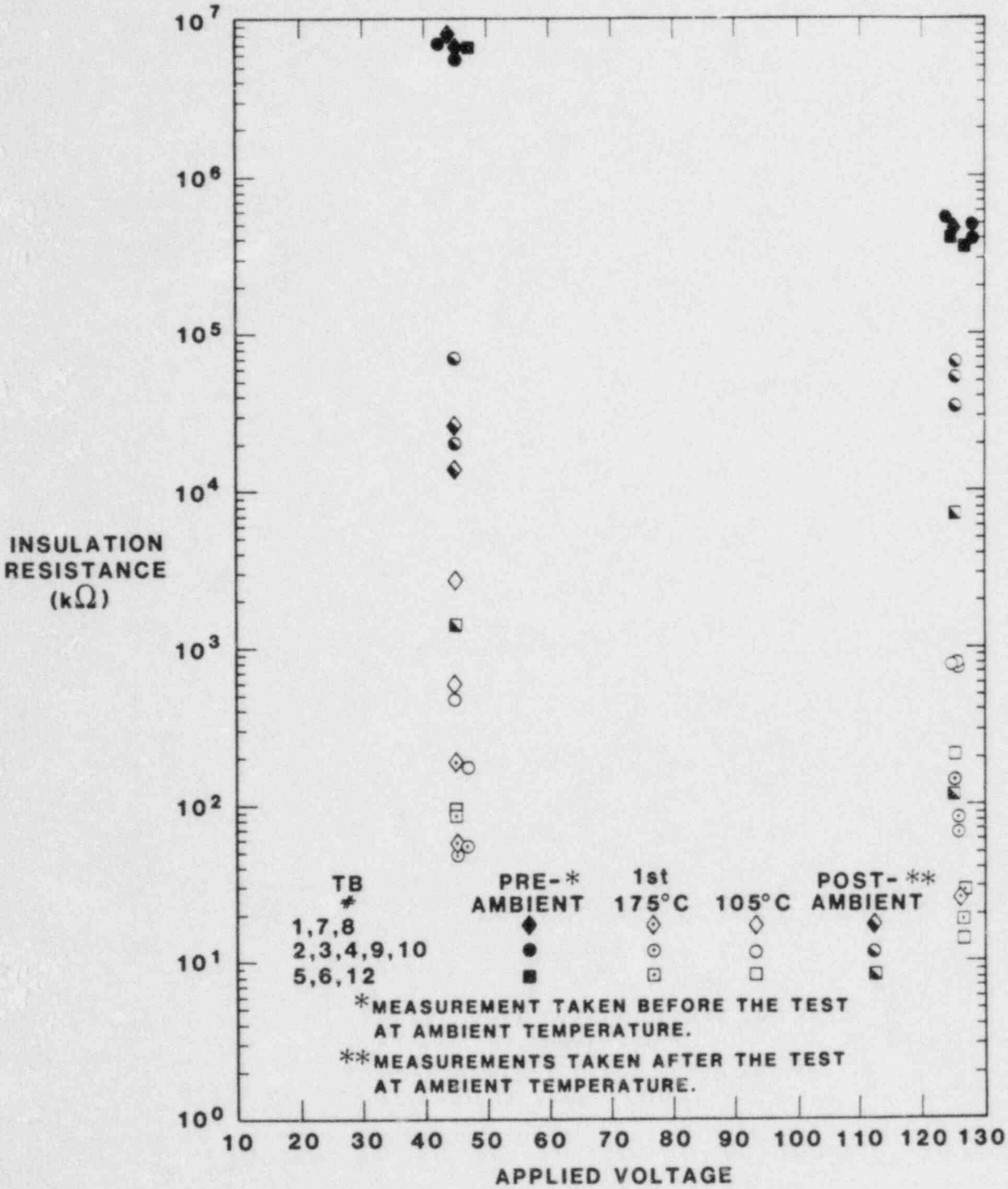

Figure 57

Insulation Resistance B for Pre-ambient, 175°C, 105°C, and Post-ambient Temperature Periods as a Function of Applied Voltage

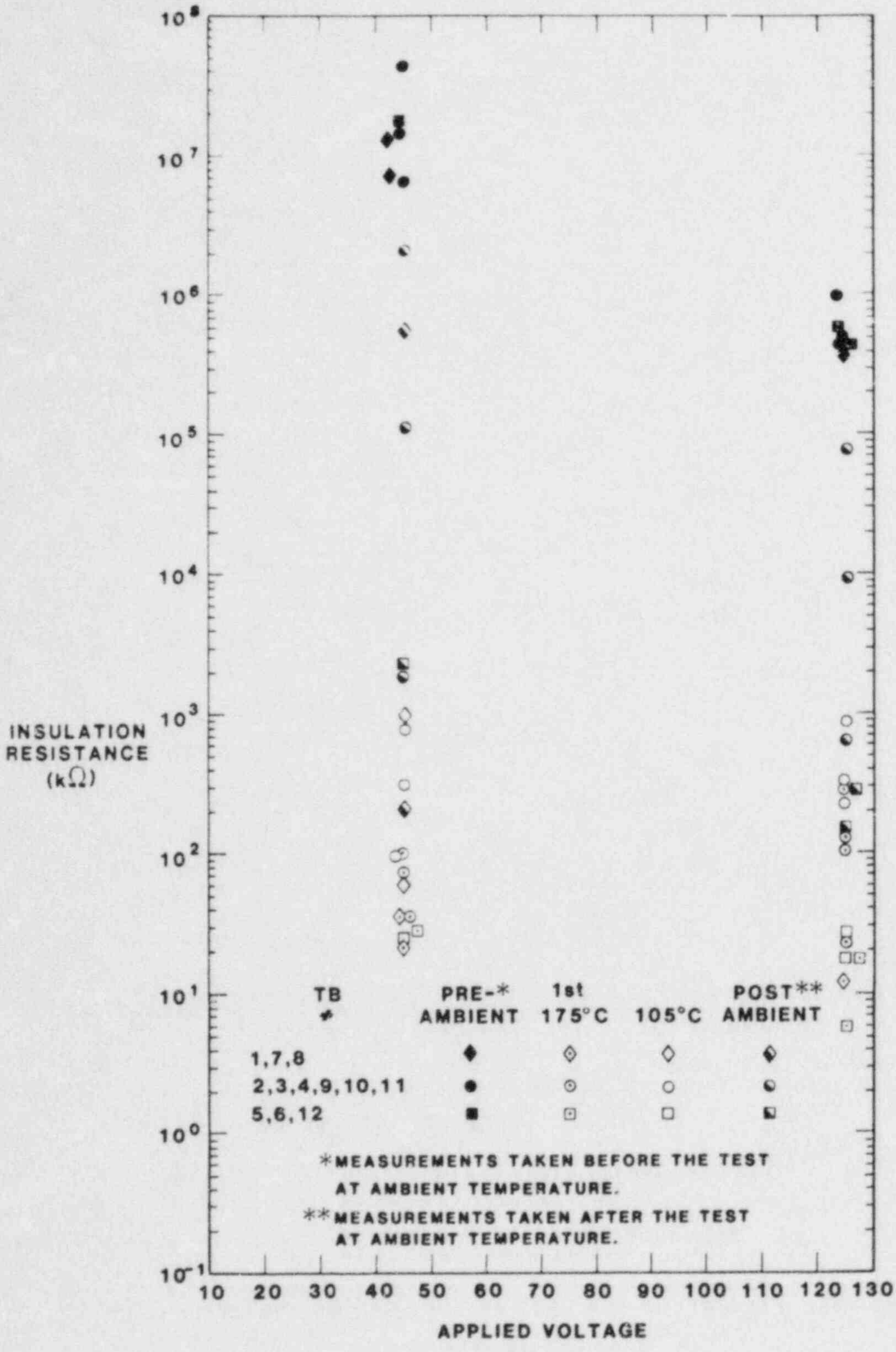

Figure 58

Insulation Resistance G for Pre-ambient, 175°C, 105°C, and Post-ambient Temperature Periods as a Function of Applied Voltage

4.4.4 General Performance Characteristics

4.4.4.1 Comparison of A, B, and G Paths

Figures 59 through 66 compare the A, B, and G leakage paths for each individual terminal block. In general, the performance of each path is comparable, though some individual differences can be noted. For example, the A path on terminal block 1 shows slightly better IR performance than either the B or G paths. A similar behavior is observable for terminal block 5. Alternately, the A path on terminal block 4 shows definitely worse performance than either the B or G paths. This behavior may imply a slight dominance of one path given the right conditions.

The post-ambient measurement of the G path on terminal block 7 is approximately 3 orders of magnitude less than the same measurement on terminal block 8. This discrepancy between the blocks begins to show up at the 105°C temperature plateau where the difference in the IR is about a factor of 17. Since both of these terminal blocks are the same model, we would normally expect them to show roughly the same IR values, as experienced earlier in the test. We have no supportable hypothesis to explain this behavior especially since the A and B path IRs of these terminal blocks are comparable. The behavior hints at the possible formation of a permanent leakage path to ground on terminal block 7; however, the shorting of the terminal block 2 and 7 G paths may have been a contributing factor to the observed behavior. (See Appendix 2 for a discussion of this anomaly.)

4.4.4.2 Open Failure of Phase II Terminal Block 1

Between 15.28 and 15.45 hours after the beginning of the test and approximately 3.17 hours after the end of the unanticipated cooldown, the power input cable connection to terminal block 1 failed open. The temperature in the chamber was 149°C at the time of the failure. The post-test examination showed that the cable separated within one or two millimeters of its connection to the terminal block.* The wire strands had necked down somewhat and the fractured ends were slightly pointed. These observations indicate that a primary factor contributing to the failure of the wire was tensile stress. Post-test examination of the surface of the terminal block showed extensive black deposits which appeared to be carbonaceous residue, though the composition was not confirmed by chemical analysis. The input wire's insulation had separated, leaving charred remains adjacent to the terminal block pole. The three output wires (the A, B, and P_{out} paths shown on Figure 12) also showed significant insulation damage and charring close to the terminal block.

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*Terminal block 1 uses compression type box lug connectors which clamp directly onto the wire. A ring lug connector on the wire end is not used.

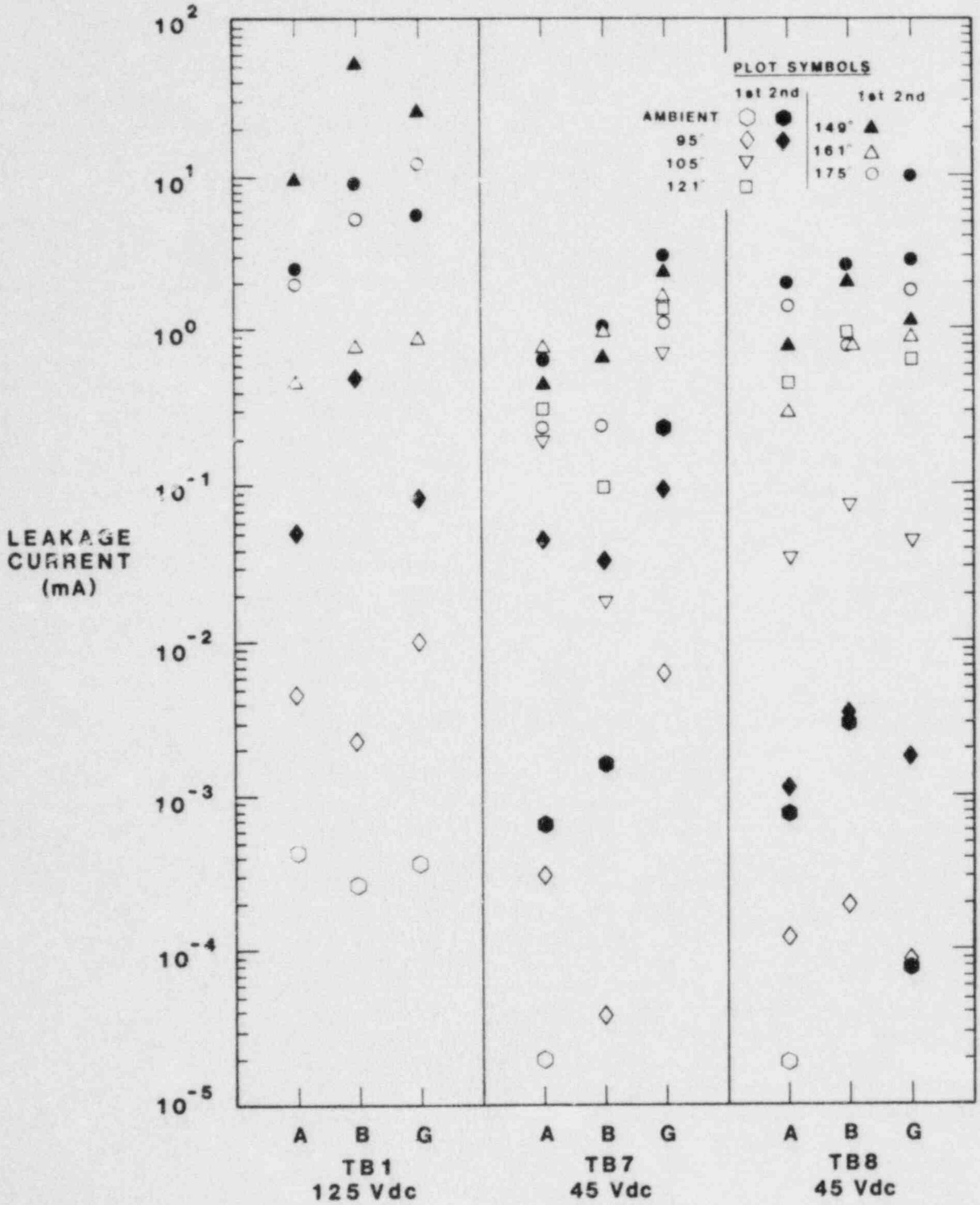

Figure 59

Leakage Currents A, B, and G for Phase II
Terminal Blocks 1, 7, and 8

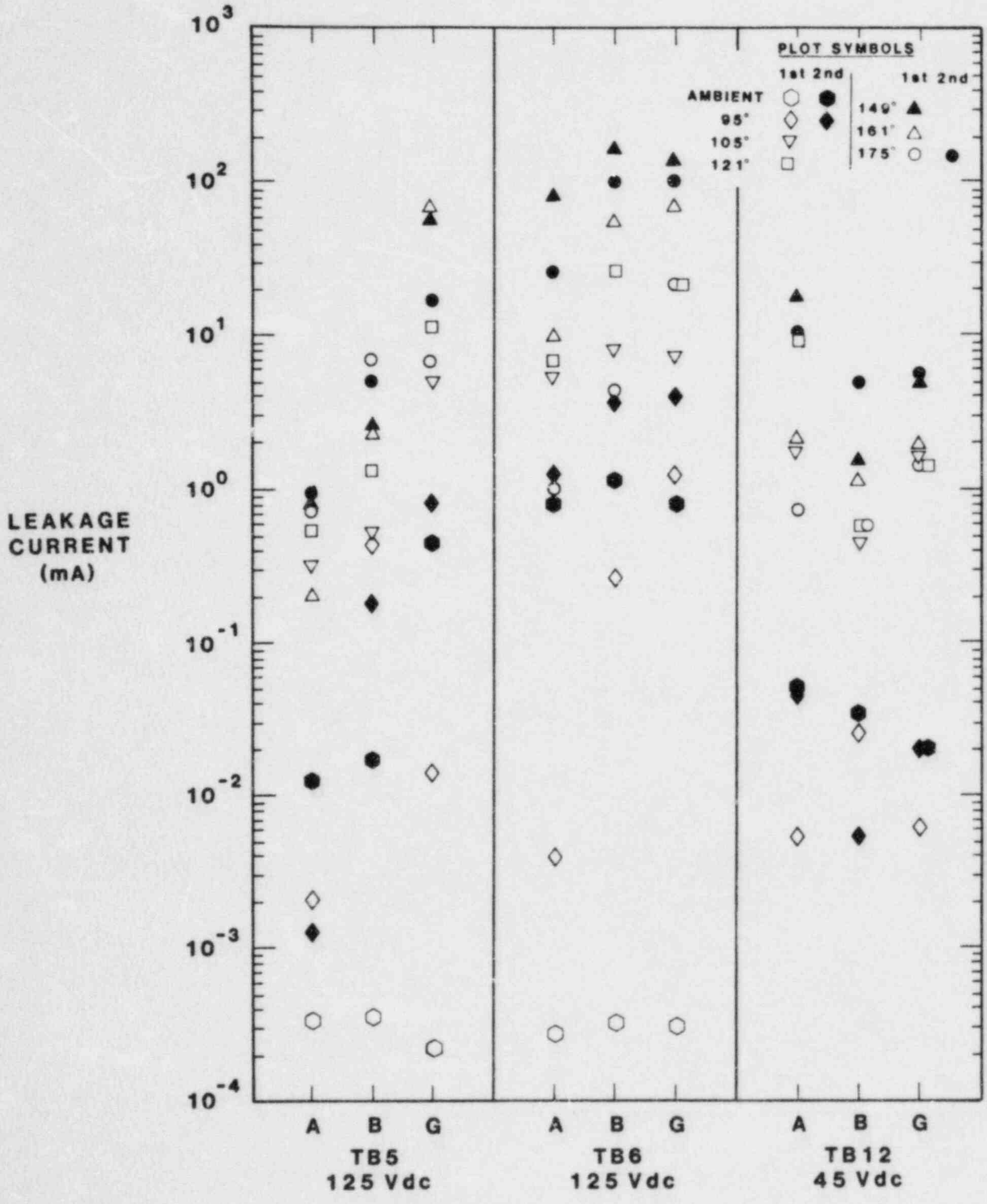

Figure 60

Leakage Currents A, B, and G for Phase II Terminal Blocks 5, 6, and 12

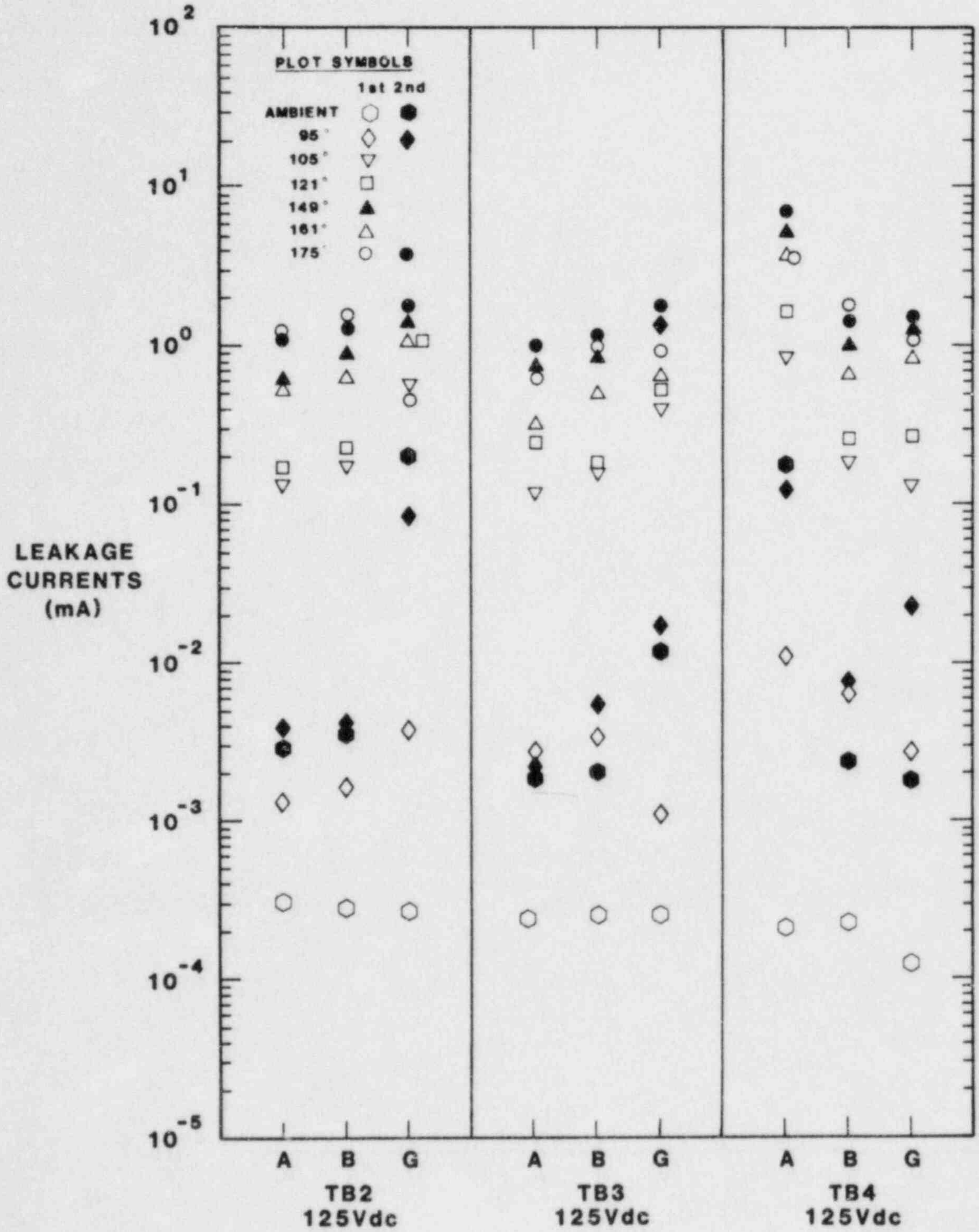

Figure 61

Leakage Currents A, B, and G for Phase II
Terminal Blocks 2, 3, and 4

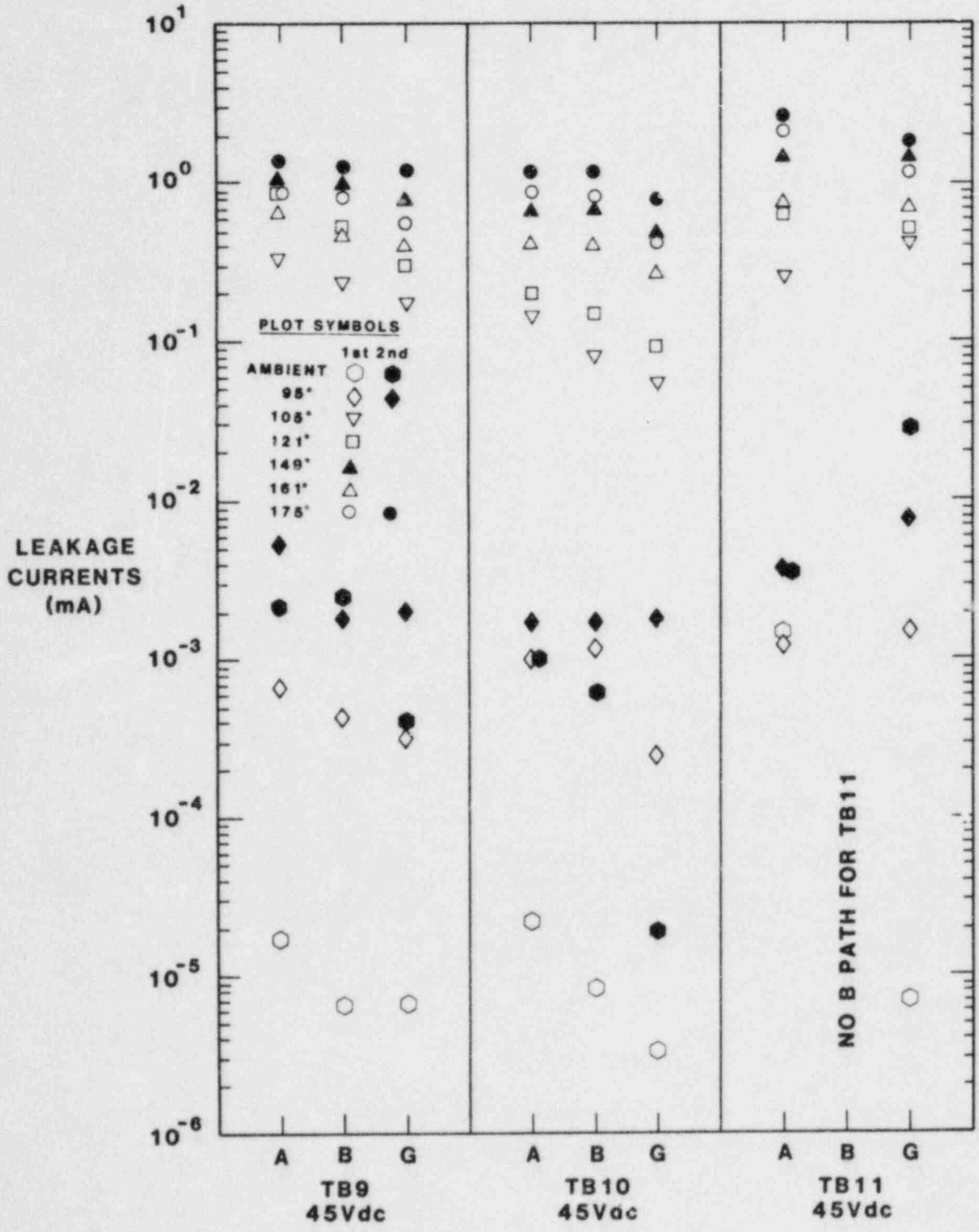

Figure 62

Leakage Currents A, B, and G for Phase II
Terminal Blocks 9, 10, and 11

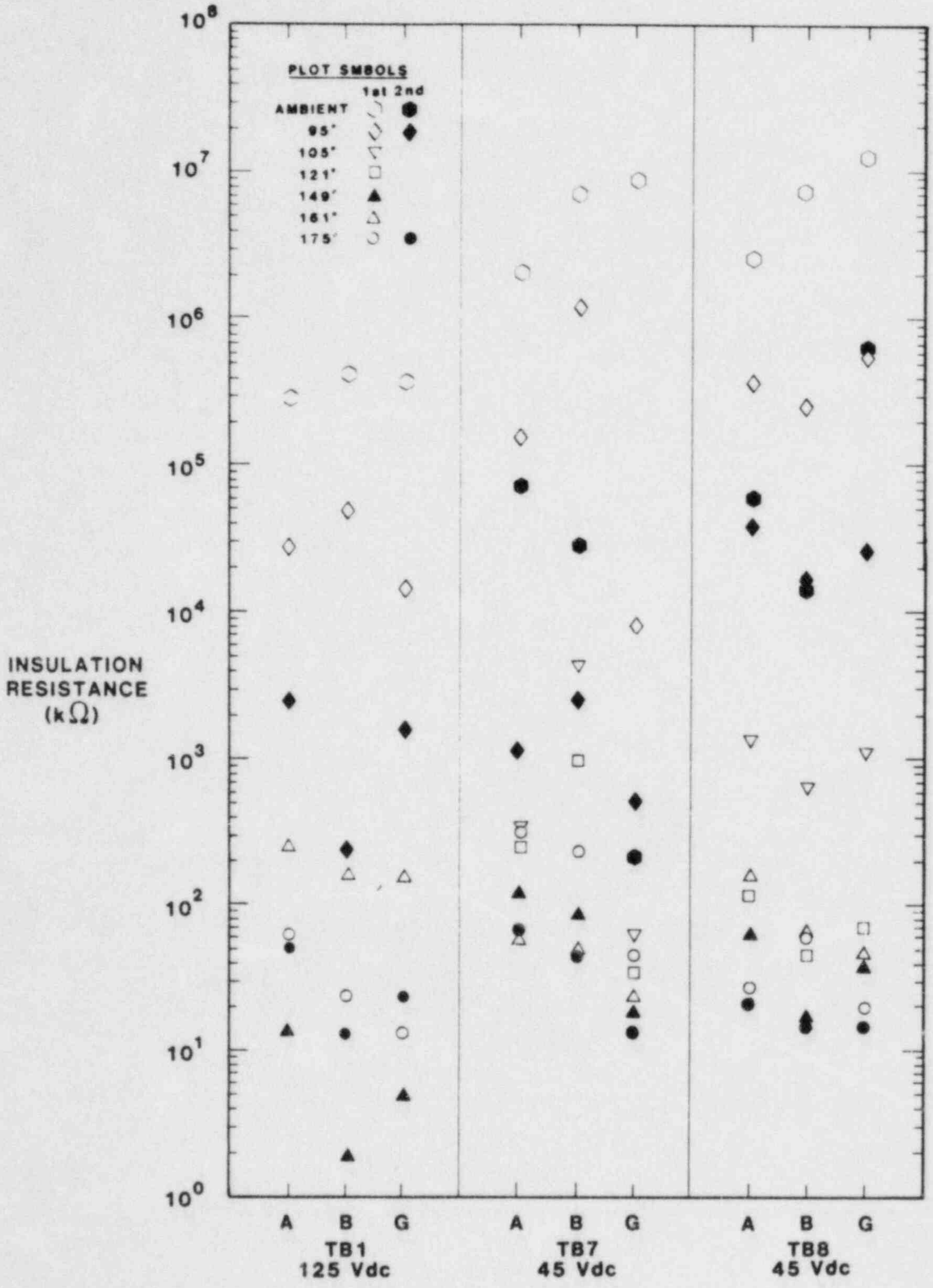

Figure 63

'nsulation Resistance A, B, and G for Phase II
Terminal Blocks 1, 7, and 8

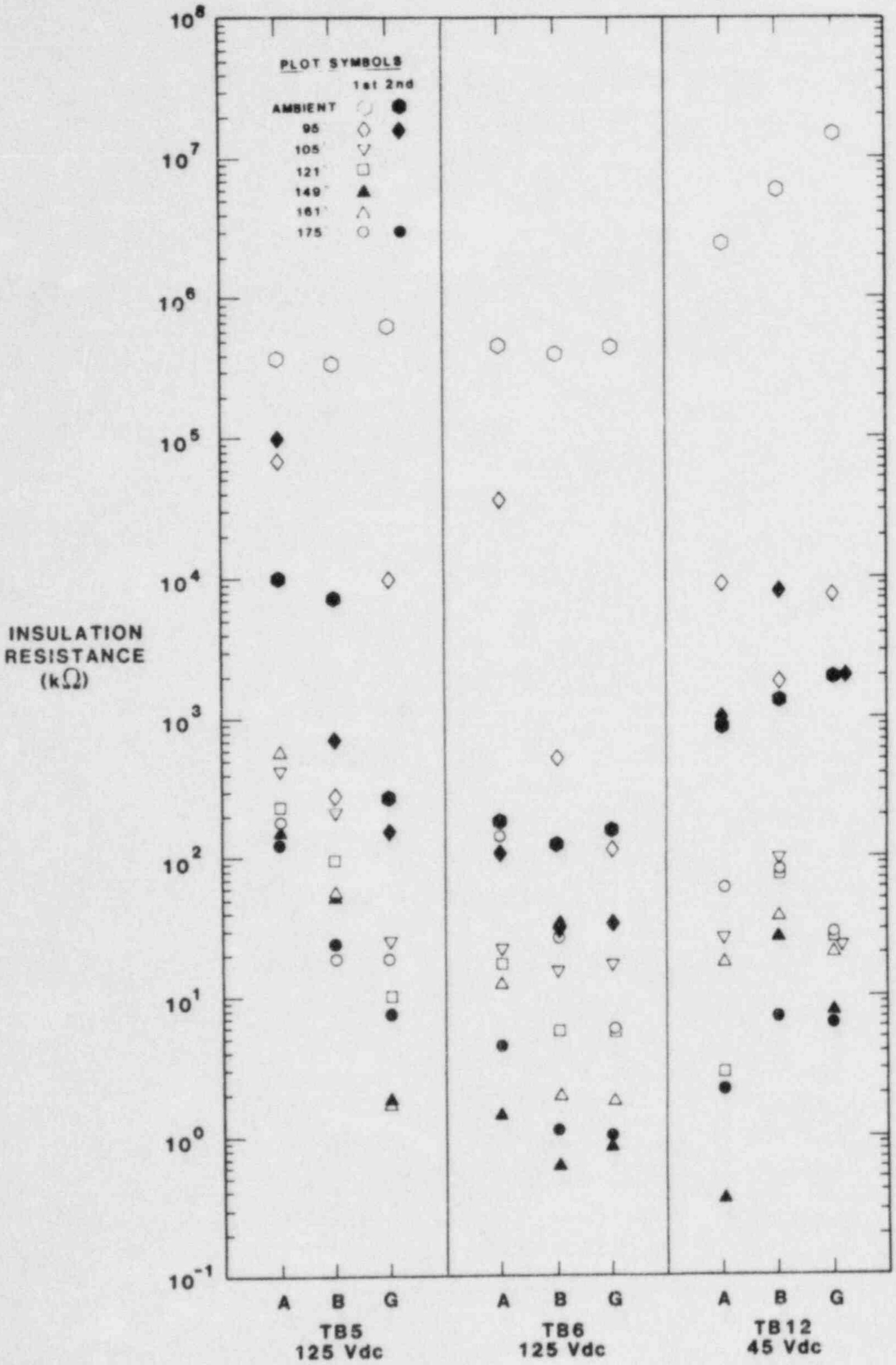

Figure 64

Insulation Resistance A, B, and G for Phase II Terminal Blocks 5, 6, and 12

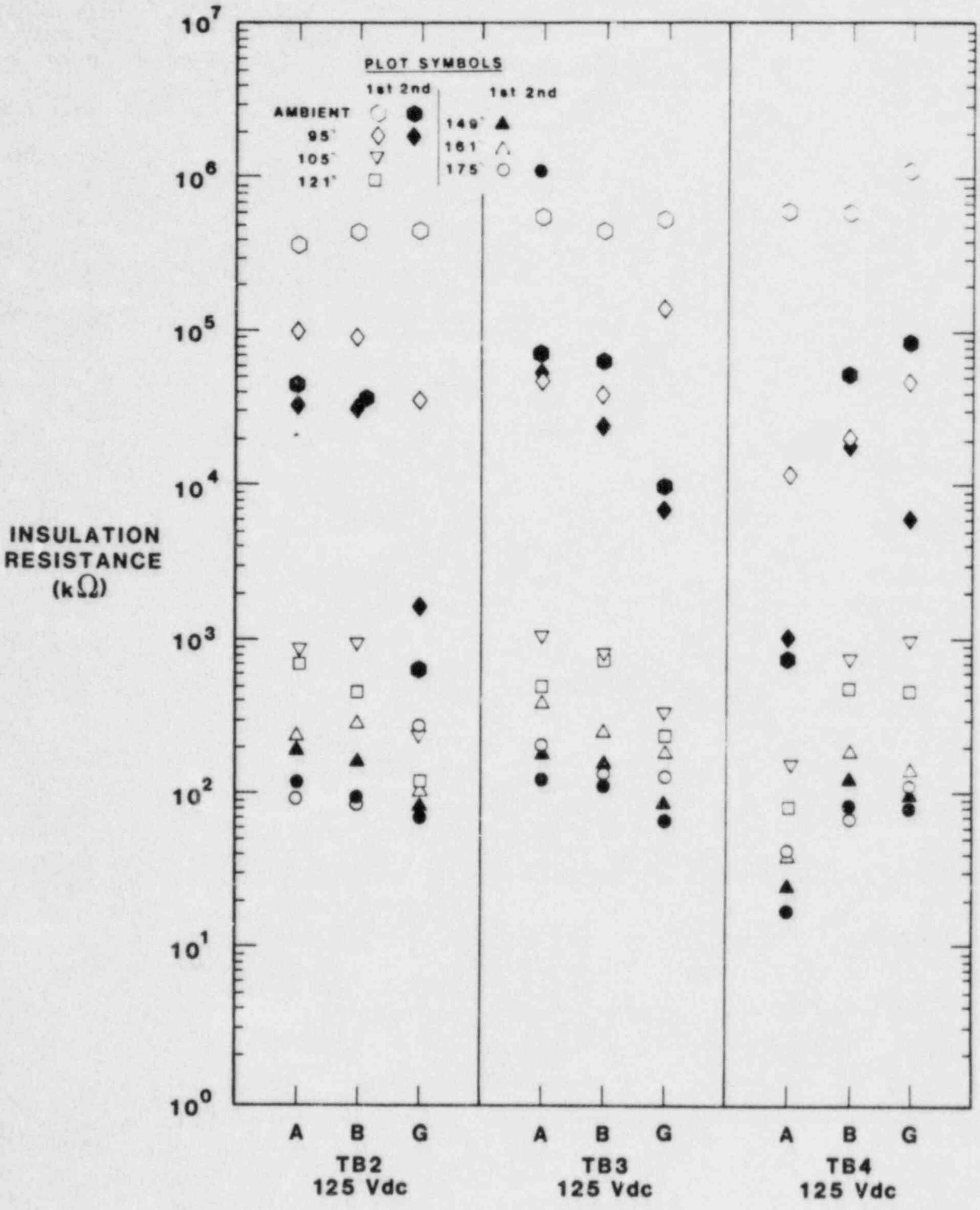

Figure 65

Insulation Resistance A, B, and G for Phase II Terminal Blocks 2, 3, and 4

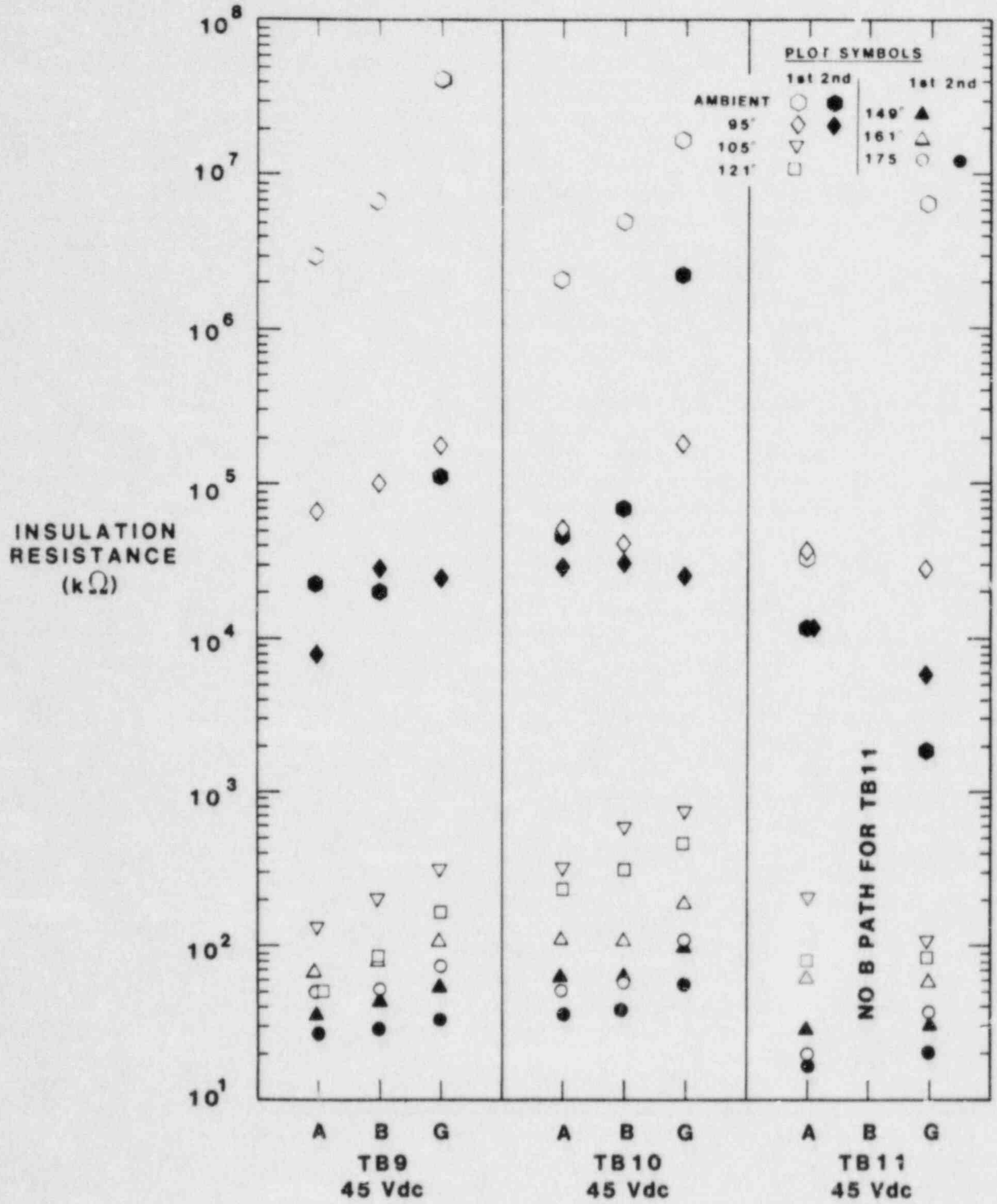

Figure 66

Insulation Resistance A, B, and G for Phase II
Terminal Blocks 9, 10, and 11

Throughout the approximately 180-minute period preceding the failure of the wire, the leakage currents increased in all paths. Table 16 summarizes the measured leakage currents and the calculated insulation resistances during this period. The B path increased the most and the A path increased the least; the last data point in Table 16 indicates a total leakage current for all paths of 283 mA. The upward trend of the leakage currents indicates that subsequent to the last data point, the leakage currents continued to increase. Because of the discrete time monitoring by the datalogger, the values of leakage current just before separation were not recorded. The load bank design limited the current in each return branch of the circuit to one ampere. Thus, the input cable could have carried a maximum of four amperes, which is insufficient to cause 12 AWG conductor to separate without the interaction of other factors.

During the first 175°C plateau, some of the cables extruded through the test chamber compression penetrations. Though not directly causing physical damage to the cables, the extrusion tensioned some of them. Appendix 2 contains a discussion of this anomaly. The input cable for terminal block 1 extruded approximately 6 cm causing it to bend against the adjacent inter-terminal barrier of the terminal block. An undetermined amount of tensile stress was introduced to the stranded conductor of the cable; we estimate that the force may have been as high as two or three kilograms-force. The tensile stress and the bending of the cable probably pinched the insulation between the conductor and the terminal block inter-terminal barrier. The terminal block operated in this configuration for approximately 12 hours with leakage currents similar to those of the other blocks. This 12 hours included the two 175°C plateaus, the 161°C plateau, and the unanticipated cooldown of the environmental exposure. We hypothesize that the length of time at the high temperatures combined with the pinching of the cable insulation to produce creep shortout of the cable [17], resulting in direct conductor contact with the edge of the terminal block barrier.

The introduction of steam after the unanticipated cooldown caused all the terminal blocks to experience relatively high leakage currents. On terminal block 1 we believe that a primary leakage path was through the insulation at the creep shortout point. Consequently, the insulation experienced increased degradation and carbonization. Because of the terminal block's orientation, the cable was bent over the barrier separating the powered pole and the B leakage path pole. This configuration may have created a preferential leakage current path which would account for the higher leakage currents observed in the B path. The tensile stress in the conductor probably led to slow plastic deformation of the conductor strands. As the stretching occurred, the strands necked down increasing the localized resistance and conductor heating. As a consequence, the deterioration of the cable insulation and the elongation process was further aggravated. The enhanced deterioration of the cable insulation and the deposition of residue on the terminal block's surface further increased the leakage currents. Eventually the ultimate tensile elongation of the conductor strands was reached and they separated, thus ending the process.

Table 16

Leakage Currents and Insulation Resistance for Terminal Block 1
During the Period Immediately Preceding the Failed Open Condition

Time Hr:Min:Sec	Elapsed Time From Start of Experiment (Hrs)	Leakage Currents (mA) A	B	G	Insulation Resistance (kohms) A	B	G
01:27:04	12.4503	0.915	1.78	1.21	138.0	71.1	104.0
01:37:04	12.6169	0.621	2.35	1.26	204.0	53.7	100.C
01:47:04	12.7836	0.609	15.30	3.29	207.0	8.12	38.4
01:57:04	12.9503	0.592	18.3	4.03	214.0	6.79	31.3
02:07:04	13.1169	0.379	6.01	1.73	334.0	20.9	73.0
02:17:04	13.2836	C.581	15.8	4.08	218.0	7.89	30.9
02:27:04	13.4503	).560	20.75	5.44	192.0	5.98	23.1
02:37:04	13.6169	0.480	12.6	4.23	263.0	9.90	29.8
02:47:04	13.7836	0.337	7.27	2.16	375.0	17.3	58.5
02:57:04	13.9503	1.08	36.8	13.3	117.0	3.31	9.35
03:07:04	14.1169	6.19	48.4	14.0	20.3	2.49	8.93
03:17:04	14.2836	20.2	115.0	58.5	6.14	0.971	2.23
03:27:04	14.4503	16.0	74.0	32.0	7.78	1.58	3.82
03:37:04	14.6169	28.7	114.0	54.4	4.27	0.978	2.19
03:47:04	14.7836	0.733	94.9	37.2	172.0	1.20	3.27
03:57:04	14.9503	31.8	171.0	84.2	3.85	0.611	1.37
04:07:04	15.1169	34.1	147,0	73.8	3.57	0.733	1.58
04:17:04	15.2836	35.2	158.0	89.7	3.44	0.674	1.58
04:27:04	15.4503	FAILED OPEN					

Though we do not believe that the leakage currents were the cause of the cable failure, they were a contributing factor. They were primarily responsible for the severe deterioration of the cable insulation and for hastening the separation of the wire strands. This event illustrates how complex coupling of phenomena can lead to degraded electrical performance and permanent failure of the circuit.

4.4.4.3 Performance of Terminal Blocks 5, 6, and 12

Qualitatively, terminal blocks 5, 6 and 12 performed noticeably worse throughout the test than the other terminal blocks. The data bear out this observation; the IR values for these blocks are one to two orders of magnitude less than for the other blocks. As Figures 19 and 20 show the same relative performance for this model of terminal block was also experienced in the Phase I test (Phase I terminal blocks 2, 3, and 9). A part of this difference may be related to the design of the block. These terminal blocks are of sectional construction. Their method of assembly into a terminal block unit is not significantly different than the other sectional blocks tested. However, their design incorporates a cavity in the insulation directly below the metallic conductors which is capable of collecting fluid and contaminants. The surface standoff distance to ground for this cavity is approximately 0.95 cm and is located between sections of the terminal block. The interface between the sections is not sufficiently tight to preclude moisture penetration and hence the narrow gap that exists between the section surfaces may hold fluid via capillary action. Therefore, as a consequence of the design, it is possible for the standoff surface between the cavity and ground to become a conduction path that is not as susceptible to the factors affecting film dissipation as an exposed surfaces might be.

The data in Tables 10-15 show that leakage paths A and B of terminal block 6 experienced significantly lower IRs than comparable paths on other blocks. The inter-terminal barrier between the power input and the B leakage pole of terminal block 6 was substantially eroded. The erosion in the plane of the poles completely cut the barrier, indicating that a primary leakage current path was around the end of the barrier rather than over the barrier. Also, though the G leakage path did not show excessively low IR, some of the intersectional surface leading to the ground plate was eroded away.

4.4.4.4 Specially Cleaned Terminal Block

As described in section 3.3, terminal block 10 was specially cleaned prior to the test; however, no significant difference between the IRs (see Figures 34-39) was measured during the steam exposure for it or the other terminal blocks of the same type powered at the same voltage. Although the cleaning procedure may not have been perfect, it was superior to any reasonable field cleaning process. Consequently, we do not believe that cleaning new or "as-received" terminal blocks is of much positive benefit to performance, possibly because of the difficulty of thoroughly cleaning the convoluted surfaces of the terminal block.

4.4.5 Post-Test Chemical Analysis [18]

Subsequent to the steam exposure and prior to the submergence test, terminal blocks 3, 5, 8, and 10 (i.e., the middle blocks in each enclosure) were removed for chemical analysis. Residues from three of these terminal blocks (3, 5, and 8) were analyzed using Emission Spectroscopy* and Laser Raman Microprobe* techniques. Table 17

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*Emission Spectroscopy consumes a sample in a DC arc, exciting the sample so that the elements present emit their characteristic wavelengths of light. This analysis provides information on whether certain elements (primarily metals) are present in major (greater than 10%), minor (1-10%), or trace (less than 1%) concentrations. The Laser Raman Microprobe technique focuses a low intensity laser beam on the sample which nondestructively interacts with the molecular structure of the sample to produce wavelengths which are characteristic of the molecular vibrations. The Raman data therefore provides the molecular composition of the sample. Together the two techniques provide complimentary elemental and molecular structure information.

summarizes the results of this analysis. CdS was identified in samples from all three terminal blocks. Even though Emission Spectroscopy has very poor sensitivity for cadmium, one sample from terminal block 3 showed weak lines indicating its presences. The Raman spectra of all blocks, however, showed intense bands indicative of CdS and there can be little doubt that its identification is correct since the CdS spectrum is very distinctive; ZnS was also identified on terminal block 3. Zinc and cadmium are typical coatings on screws, bolts, and nuts. The only cadmium source identified was the nuts used to attach the mounting plates holding the ceramic standoffs to the enclosure studs. The exact source of the zinc was not identified, but probably came from the screws used to attach the terminal blocks to the ceramic standoffs or the standoffs to the mounting plate. Two potential sources of sulfur are the sodium thiosulfate in the chemical spray and the sulfur in the chemical formulation of the cable jacket. CdS is a potential constituent in galvanic reactions. In post-test measurements of terminal block IRs at ambient temperatures, many of the blocks acted as relatively strong (1/2 V at approximately 1 mA) batteries. (See Appendix 3).

Organic residues were observed in the Raman spectra of the residues from terminal blocks 3 and 8. These spectral bands were indicative of atomic carbon in a graphite-like structure which is usually electrically conductive. One possible source of these carbonaceous residues is the decomposition of organic material which can lead to the formation of graphitic carbon, often with fluorescent intermediate decomposition products also present. The carbonaceous residue on terminal block 3 may be from this source. The residue on a metallic conductor of terminal block 8 showed a Raman spectrum indicative of an alkyl hydrocarbon with attached nitro-, amide-, and possibly amine or hydroxyl groups. The source of this material may be the wire insulation which was in close proximity to the terminal conductor and showed visual signs of degradation.

In summary, the graphitic carbon and the CdS are of major interest because they are respectively electrically conductive and potential participants in galvanic reactions.

4.4.6 Condensate Sample Analysis

As in Phase I, condensate samples were collected at sporadic intervals throughout the Phase II test. Except for three samples (8, 9, and 10), their conductivity was measured shortly after taking the sample, and again during a cursory chemical analysis of the condensate samples performed approximately one month after the test. The results of these measurements and the cursory chemical analysis are reported in Table 18. Due to temperature effects, the laboratory conductivity measurements either agreed with (samples 8, 9, and 10) or were slightly less than the conductivity measurements made at sample time. This result is exactly as expected. The samples taken during the periods of spray and no-spray can be easily identified by the pH and Boron measurements. During periods of spray the chamber condensate reflects the spray chemical composition and pH, and after spray periods the chamber flushes clean fairly rapidly. At long times after the spray, all traces of spray in the condensate are effectively gone.

Table 17
Chemical Analysis Summary of Terminal Block Residues

Terminal Block	Sample Location	Residue Color	Emmission Spectroscopy* (Elemental Analysis) Major(>10%)	Minor(1-10%)	Trace(<1%)	Laser Raman Microprobe (Molecular Analysis)
3	Wire hinge connecting cover to TB	Yellow	Ca (Cd, probably Major or Minor)	Fe, Si	Cu	CdS
	End of TB at point where it is connected to ground plate	White	Si, Ca	Zn	Cu, Mg, Al	$CaCO_3$
	Powered terminal at junction of lug and terminal block screw	White	Zn	Ni	Cu	ZnS
	Leakage Path A terminal on TB screw	Brown	Ca	Fe, Si	Cu, Mg, Al	Carbonaceous residues (graphite-like and fluorescent)
5	Bottom face of TB insulation as it slopes into the ground plate	Rust	Fe, Ca, Na			No Raman bands observed
	Maintaining groove in insulation where TB section couples to metallic mounting coil	White	Not performed+			$CaCO_3$
	Leakage Path A terminal at end opposite of where wire connects	Mustard	Not performed+			CdS
8	Terminal close to wire connect point	Yellow/ White	Fe, Si	Ca, Zn Ni, Al	Cu, Mn Mg, Ti	Fluorescent alkyl hydrocarbon(s) with nitro, amide, and possibly amine or hydroxyl groups

+Elemental analysis not required because previously analyzed samples had identical Raman spectrums

Table 17 (ccnt)
Chemical Analysis Summary of Terminal Block Residues

Terminal Block	Sample Location	Residue Color	Emmission Spectroscopy* (Elemental Analysis) Major(>10%)	Minor(1-10%)	Trace(<1%)	Laser Raman Microprobe (Molecular Analysis)
	Insulation just below wire connect point	Black	Not performed+			Graphite-like carbonaceous residues
	Insulation just below terminal conductor on interior surface of a section, i.e., a surface that would be abutted against the neighboring section in the terminal block assembly	Brown	Not performed+			CdS, with possible graphite-like carbonaceous residues

+Elemental analysis not required because previously analyzed samples had identical Raman spectrums

Table 18
Phase II Condensate Analyses [19]

Sample ID			Conductivity at Sample Time μmho/cm	deionized μmho/cm	Lab Measurement μmho/cm (@ 1 KHz)	pH	Boron μgm/ml	Sodium μgm/ml	Remarks
1	11-18	12:50**	--	--	22645	10.6	3100 ± 400	7300 ± 800	Chemical Tank Control
2	11-18	13:16	380	0.2	337.1	8.2	11 ± 2	<1	Before Spray
3	11-18	13:50	30000	0.2	16880	10.3	2500 ± 300	6700 ± 700	During Spray
4	11-18	15:05	28000	0.1	17290	10.4	2300 ± 300	6100 ± 700	During Spray
5	11-18	17:30	120	0.2	150.1	8.9	<2	3.3 ± 0.5	After Peak 1 Spray
6	11-18	22:20	25000	0.6	17600	10.4	2400 ± 400	6500 ± 700	During Spray
7	11-19	01:45**	--	--	2[illegible]260	10.6	3400 ± 400	7300 ± 800	Chemical Tank Control
8	11-19	11:28	4700*	0.2*	4876	9.7	310 ± 40	900 ± 100	Immediately After Spray Off
9	11-22	12:15	28*	0.2*	24	8.0	<1	<2	No Spray
10	11-23	10:00	20*	0.2*	17.5	7.6	<1	<1	No Spray
11	11-24	11:11+	--	--	2627	8.4	210 ± 30	660 ± 70	After Peak 1 Spray
Submergence Test									
12	11-30	11:44	16	0.3	14.3	7.6	<1	<1	Before Spray
13	11-30	14:48@	26000	0.2	18110	10.3	2400 ± 300	6600 ± 700	During Condensate Removal
14	11-30	14:55#	29000	0.3	18110	10.3	2500 ± 400	5200 ± 900	(During Condensate Removal)
15	11-30	15:14**	31000	0.2	23410	10.4	3600 ± 500	8400 ± 900	Chemical Tank Control
16	12-1$				0.7&	6.34	<1	<1	Control Sample

* Measurement made at ambient
** Chemical tank
\+ Cable drippings (i.e., water forced out of the chemical along the cable conductors)
@ Bottom of chamber condensate
\# Top of chamber condensate
$ Deionized water sample
& 85 Hz

4.5 Chemical Spray and Submergence Test

4.5.1 Chemical Spray Analysis

The environmental test profile for Phase II, given in Figure 2, shows the four chemical spray periods. They were (1) a 2-hour period during the first 3-hour 175°C plateau, (2) a 5-hour, 26-minute period from the beginning of the second 175°C plateau until the unanticipated cooldown, (3) a 10-hour, 3-minute period from the end of the unanticipated cooldown until the 6-hour, 6-minute point of the 121°C plateau, and (4) a 1-hour, 29-minute period from the 7-hour, 14-minute to the 8-hour, 43-minute points of the 121°C plateau. Three temperature periods, the first 175°C plateau, the 95°C cooldown period between the two 175°C plateaus, and the 121°C plateau had subperiods of spray and no spray.* Since the effect of temperature is eliminated within these periods, it is possible to assess the effect of chemical spray on terminal block performance by comparing IR values between the spray/no-spray subperiods. Tables 19, 20, and 21 summarize the time-weighted average values of IR in the spray/no-spray subperiods for each of these three isothermal periods. In reviewing these tables, no distinct trend is apparent when comparing spray and no-spray values for the isothermal periods. Figures 67, 68, and 69 better illustrate this fact. These figures present the data in a format which characterizes the changes from spray to no-spray and vice versa. The data is presented as a histogram where the length of the bar is proportional to the ratio of the average values of IR in the subperiods before and after the transition between spray and no-spray or no-spray and spray. The actual ratio is quoted at the end of each bar. The direction of the bar indicates whether the transition was an increase or decrease in IR value. A dot indicates that no change occurred across a transition and that the ratio was identically 1 (within experimental accuracy).

We hypothesized that if chemical spray solution penetrated to the terminal block surfaces, the introduction of Na^+ and OH^- ions to the film would enhance the observed leakage currents.** Thus, we would expect a decrease in IR for no-spray to spray transitions. Alternately, no corresponding increase in IR would be expected for the spray to no-spray transitions since no immediate removal mechanism for the ions existed. Figures 67, 68, and 69 show that no consistent changes in IR occurred for either type of transition. Table 22 summarizes the change statistics, and shows that for both types of transitions, 40 to 50 percent of the blocks showed a decrease in IR. Also, the magnitudes of the transitions are generally small: 70 percent of the ratios are between 1 and 2, while only 8 percent exceed 5. Thus, the expected behavior for spray affecting terminal block performance was not observed.

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*The three other temperature periods that also had spray were the second 175°C plateau, the 161°C plateau, and the 149°C plateau. Spray was on for the entire duration of each of these periods.

**Note that the boric acid has a very low dissociation constant, and therefore, contributes only negligibly to the spray conductivity.

Table 19
Insulation Resistance A for Isothermal Periods of Spray and No-Spray
(kohm)

TB Number	175°C No Spray	175°C Spray	95°C No Spray	95°C Spray	121°C No Spray	121°C Spray
1	1.4E+02 3.3E+01	7.7E+01	3.5E+04	7.3E+03	Failed Open	Failed Open
2	6.4E+01 (1)* 1.3E+02 (3)	1.0E+02 (2)	9.6E+04 (4)	1.2E+05 (5)	2.4E+02 (7) 4.2E+02 (8)	5.3E+02 (6) 4.6E+02 (9) 4.6E+02 (10)
3	1.3E+02 2.3E+02	2.0E+02	4.4E+02	8.4E+04	2.8E+02 3.1E+02	5.4E+02 2.4E+02 3.5E+02
4	4.3E+01 3.4E+01	3.8E+01	1.1E+04	1.2E+04	------- 3.4E+01	4.3E+01 4.6E+01 4.7E+01
5	5.0E+01 6.4E+02	2.6E+02	6.2E+04	-------	4.3E+01 -------	7.5E+01 6.1E+01 -------
6	8.4E+01 1.7E+02	1.3E+02	3.4E+04	-------	3.0E+00 -------	7.0E+00 9.0E+00 -------
7	8.3E+01 (1)* 2.9E+02 (3)	2.3E+02 (2)	7.4E+05 (4)	1.3E+04 (5)	1.1E+02 (7)	5.4E+01 (6) 1.2E+02 (8)
8	7.8E+01 1.3E+01	3.3E+01	1.1E+06	3.2E+04	2.2E+01	1.7E+01 2.2E+01
9	5.0E+01 6.1E+01	4.3E+01	6.8E+04	7.0E+04	1.8E+01	3.7E+01 3.2E+01
10	4.5E+01 7.4E+01	4.2E+01	4.5E+04	8.5E+04	2.1E+02	2.3E+02 3.8E+02
11	2.2E+01 2.9E+01	1.5E+01	3.0E+04	1.1E+05	4.3E+01	4.1E+01 4.3E+01
12	3.0E+01 7.5E+01	6.9E+01	1.6E+04	1.1E+03	1.0E-01	3.0E-01 2.0E-01

*Numbers in parenthesis for terminal blocks 2 and 7 indicate the relative progression in time of the data. These numbers are used to determine the transition sequences displayed in Figures 67, 68, and 69. The sequence indicated in the terminal block 2 row applies to terminal blocks 1, 2, 3, 4, 5, and 6. The sequence in the terminal block 7 row applies to terminal blocks 7, 8, 9, 10, 11, and 12.

Table 20
Insulation Resistance B for Isothermal Periods of Spray and No-Spray
(kohm)

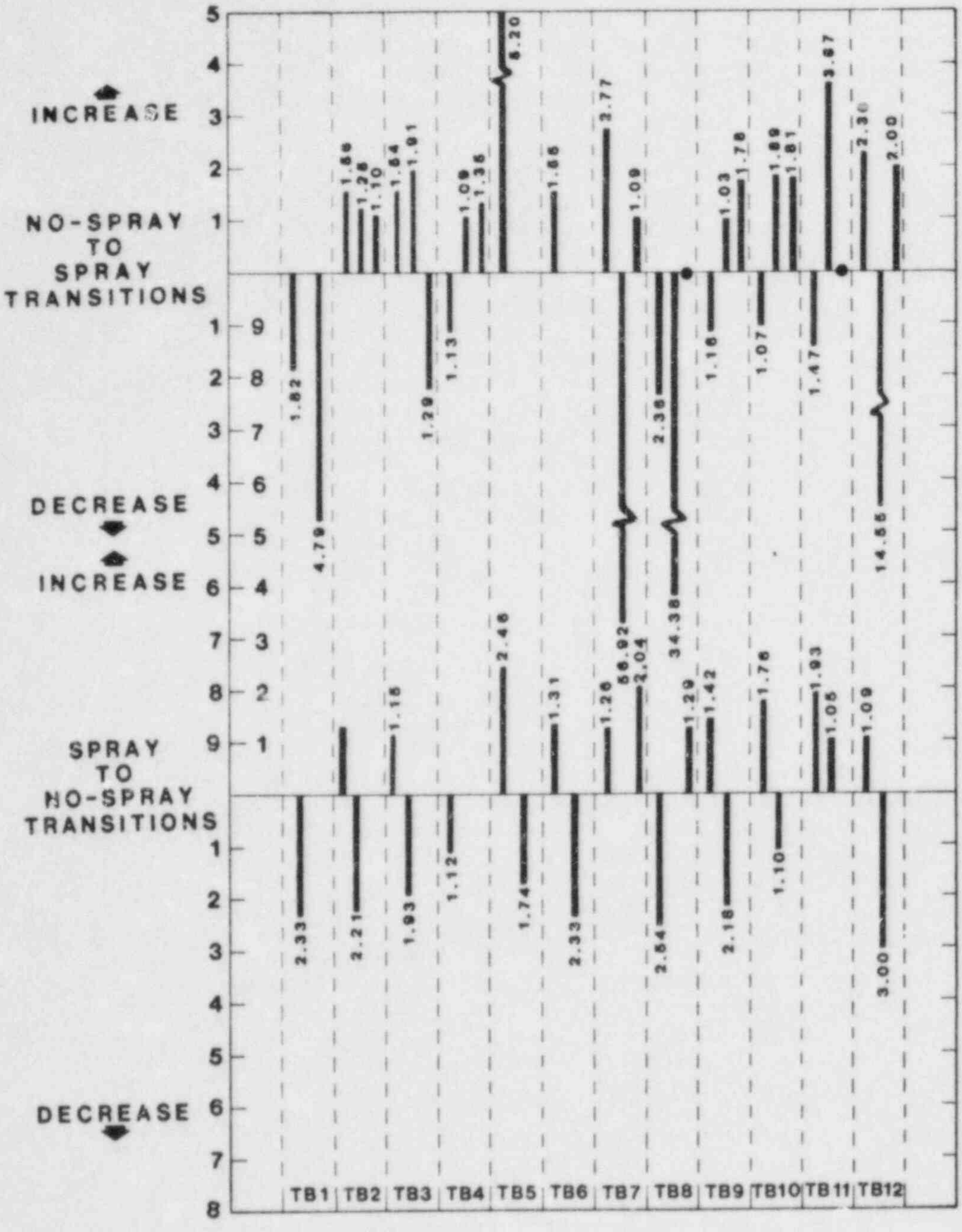
TB Number	175°C No Spray	175°C Spray	95°C No Spray	95°C Spray	121°C No Spray	121°C Spray
1	1.9E+02 1.8E+01	2.2E+01	5.7E+04	2.0E+04	Failed Open	Failed Open
2	6.0E+01 (1)* 1.1E+02 (3)	8.1E+01 (2)	7.8E+04 (4)	1.0E+05 (5)	2.2E+02 (7) 3.3E+02 (8)	4.6E+02 (6) 4.2E+02 (9) 3.7E+02 (10)
3	8.6E+01 1.7E+02	1.3E+02	3.5E+04	6.9E+04	3.3E+02 3.5E+02	5.5E+02 4.6E+02 4.3E+02
4	5.6E+01 8.3E+01	6.4E+01	1.8E+04	3.4E+04	------- 1.1E+02	3.0E+02 2.3E+02 2.8E+02
5	4.2E+01 7.0E+00	2.9E+01	3.0E+02	-------	1.7E+01 -------	1.7E+01 4.0E+00 -------
6	5.0E+01 3.4E+01	2.5E+01	4.7E+02	-------	2.0E+00 -------	7.0E-01 2.0E+00 -------
7	7.7E+01 (1)* 3.2E+02 (3)	1.9E+02 (2)	5.7E+06 (4)	1.0E+05 (5)	9.4E+02 (7)	1.2E+02 (6) 9.1E+02 (8)
8	8.9E+01 2.9E+01	7.9E+01	1.5E+06	1.9E+04	1.6E+01	6.0E+00 1.3E+01
9	4.7E+01 7.0E+01	4.5E+01	1.0E+05	1.4E+05	4.4E+01	9.5E+01 1.0E+02
10	5.4E+01 9.0E+01	4.8E+01	4.1E+04	8.7E+04	2.4E+02	2.8E+02 3.8E+02
11	NO B PATH FOR TERMINAL BLOCK 11					
12	4.5E+01 1.2E+02	7.7E+01	2.2E+03	5.0E+02	9.4E+01	1.2E+01 9.3E+01

*Numbers in parenthesis for terminal blocks 2 and 7 indicate the relative progression in time of the data. These numbers are used to determine the transition sequences displayed in Figures 67, 68, and 69. The sequence indicated in the terminal block 2 row applies to terminal blocks 1, 2, 3, 4, 5, and 6. The sequence in the terminal block 7 row applies to terminal blocks 7, 8, 9, 10, 11, and 12.

Table 21
Insulation Resistance G for Isothermal Periods of Spray and No-Spray
(kohm)

TB Number	175°C No Spray	175°C Spray	95°C No Spray	95°C Spray	121°C No Spray	121°C Spray
1	3.4E+02 1.2E+01	9.0E+00	1.3E+04	1.5E+04	Failed Open	Failed Open
2	1.7E+02 (1)* 2.0E+02 (3)	3.8E+02 (2)	3.3E+04 (4)	4.4E+04 (5)	6.8E+02 (7) 5.7E+01 (8)	4.9E+01 (6) 6.2E+01 (9) 5.9E+01 (10)
3	7.4E+01 1.8E+02	1.4E+02	1.2E+05	1.7E+05	1.1E+02 3.1E+02	2.0E+02 1.9E+02 1.7E+02
4	1.1E+02 1.1E+02	1.1E+02	4.4E+04	7.5E+04	------- 1.3E+02	2.9E+02 2.3E+02 2.1E+02
5	3.4E+01 2.1E+01	1.5E+01	1.0E+04	-------	4.0E+00 -------	1.0E+00 1.0E+00 -------
6	3.5E+01 1.3E+01	4.0E+00	1.1E+02	-------	2.0E+00 -------	6.0E-01 2.0E+00 -------
7	[illegible].8E+01 (1)* 2.7E+01 (3)	3.7E+01 (2)	8.2E+03 (4)	2.6E+03 (5)	2.5E+01 (7)	1.3E+01 (6) 1.4E+01 (8)
8	1.6E+02 9.0E+00	2.4E+01	5.0E+06	3.7E+04	1.9E+01	9.0E+00 1.8E+01
9	8.3E+01 8.0E+01	7.2E+01	1.4E+05	1.5E+05	1.3E+02	1.7E+02 1.8E+02
10	8.0E+01 1.7E+02	9.4E+01	1.8E+05	2.3E+05	1.6E+02	2.9E+02 8.5E+02
11	3.8E+01 4.4E+01	3.2E+01	2.7E+04	4.6E+04	6.5E+01	6.7E+01 1.3E+02
12	2.6E+01 3.1E+01	2.7E+01	6.7E+03	6.6E+03	2.6E+01	3.1E+01 2.6E+01

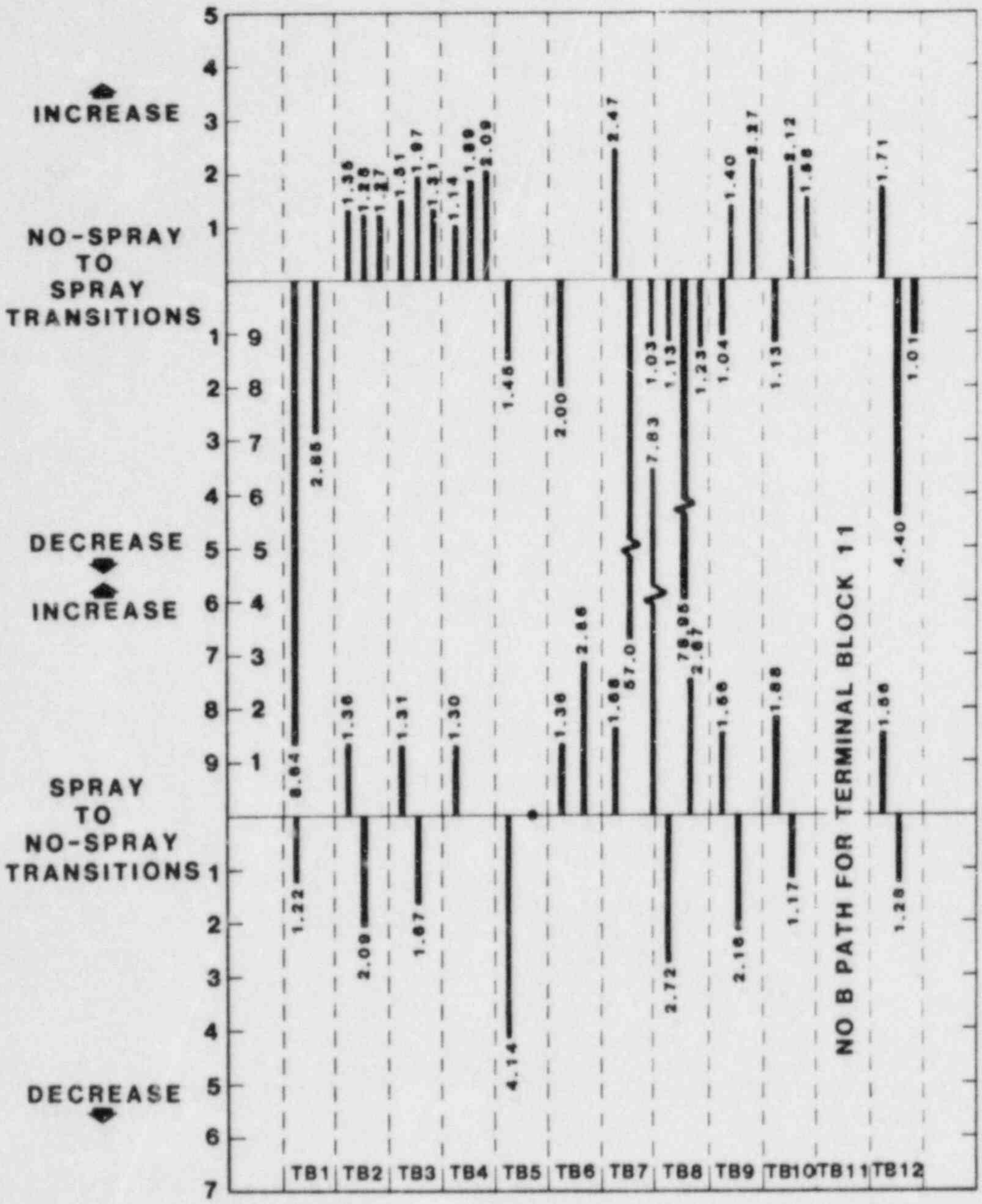
*Numbers in parenthesis for terminal blocks 2 and 7 indicate the relative progression in time of the data. These numbers are used to determine the transition sequences displayed in Figures 67, 68, and 69. The sequence indicated in the terminal block 2 row applies to terminal blocks 1, 2, 3, 4, 5, and 6. The sequence in the terminal block 7 row applies to terminal blocks 7, 8, 9, 10, 11, and 12.



NOTE: NUMBERS ARE THE RATIO OF THE BEFORE AND AFTER TRANSITION VALUES OF THE DATA. BAR LENGTHS ARE PROPORTIONAL TO THE RATIOS. DIRECTION OF BAR INDICATES DIRECTION OF TRANSITION. DOTS INDICATE NO CHANGE ACROSS THE TRANSITION.

Figure 67

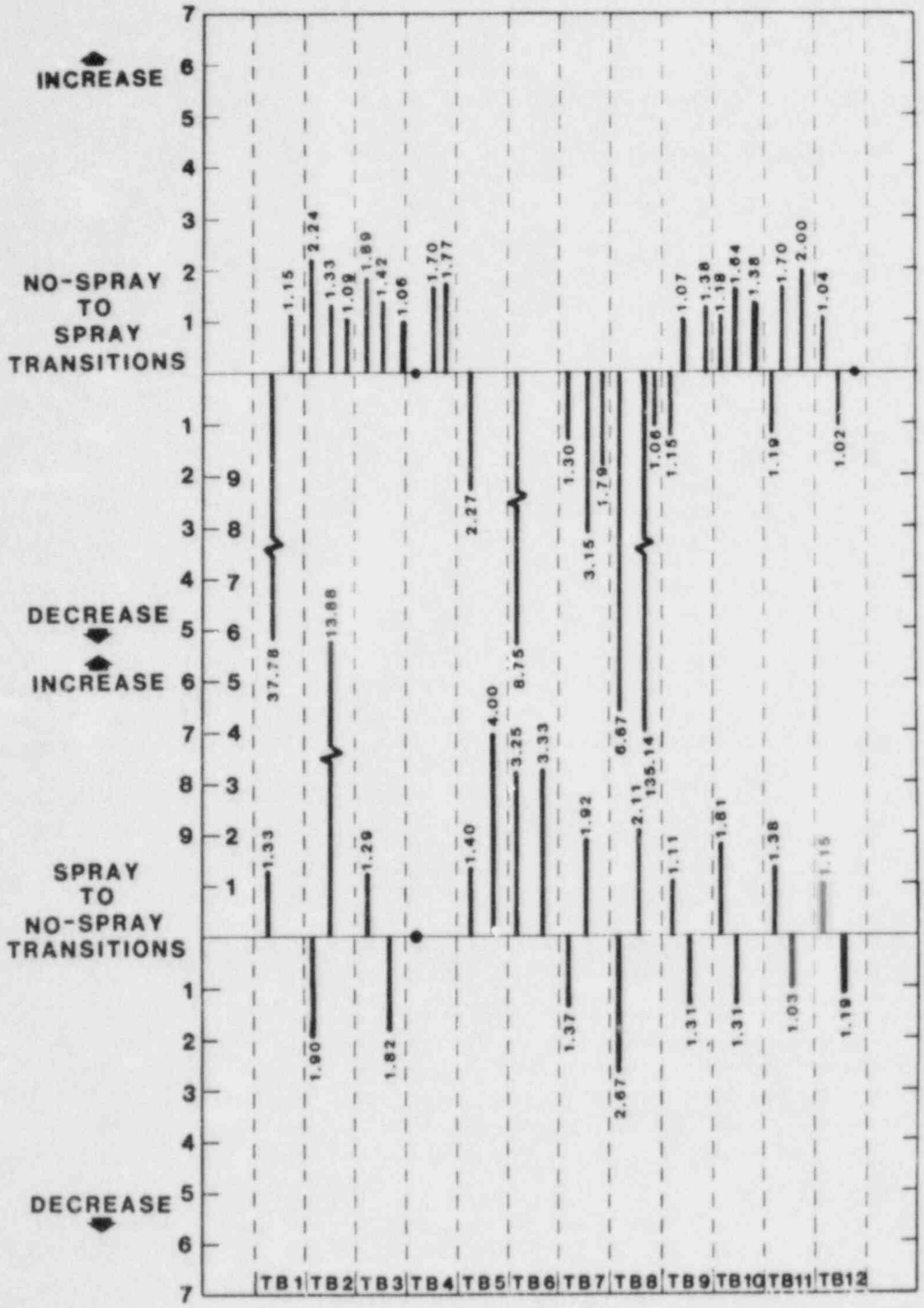
Insulation Resistance A Transitions from Spray to No-Spray and No-Spray to Spray for Isothermal Periods



NOTE: NUMBERS ARE THE RATIO OF THE BEFORE AND AFTER TRANSITION VALUES OF THE DATA. BAR LENGTHS ARE PROPORTIONAL TO THE RATIOS. DIRECTION OF BAR INDICATES DIRECTION OF TRANSITION. DOTS INDICATE NO CHANGE ACROSS THE TRANSITION.

Figure 68

Insulation Resistance B Transitions from Spray to No-Spray and No-Spray to Spray for Isothermal Periods



NOTE: NUMBERS ARE THE RATIO OF THE BEFORE AND AFTER TRANSITION VALUES OF THE DATA. BAR LENGTHS ARE PROPORTIONAL TO THE RATIOS. DIRECTION OF BAR INDICATES DIRECTION OF TRANSITION. DOTS INDICATE NO CHANGE ACROSS THE TRANSITION.

Figure 69

Insulation Resistance G Transitions from Spray to No-Spray and No-Spray to Spray for Isothermal Periods

Table 22
Spray/No-Spray Transition Change Statistics

	Spray to No-Spray						No-Spray to Spray					
	A		B		G		A		B		G	
	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%
Increase	12	55	11	55	13	59	18	58	15	54	17	55
No Change	0	0	1	5	1	5	2	6	0	0	2	6
Decrease	10	45	8	40	8	36	11	35	13	46	12	39
Total	22	100	20	100	22	100	31	100	28	100	31	100

This finding was a bit surprising because we expected the spray to enter the enclosures via the cable conduit, run down the cable/conduit interstitial space, and drip onto the terminal blocks. Since this mode of entry did not seem operative, we decided to further investigate the performance of terminal blocks positively known to be contaminated with spray solution.

4.5.2 Submergence Test Analysis

To measure the performance of blocks positively known to be contaminated with chemical spray solution, a submergence test was conducted at the end of the Phase II environmental exposure. Section 3.1 describes the physical conduct of this special experiment. Terminal blocks 4, 6, and 11 were completely submerged during the submergence test. During the submergence period these blocks showed similar IRs on all leakage paths in the range of 10-100 ohms. Subsequent to their submergence, all the blocks recovered immediately to IR values in the range of 10 kohms; thereafter, slight further recovery was observed in the remaining three hours of steam exposure. During the cooldown to ambient, the IRs further recovered to about 100 to 10,000 kohms.

Terminal blocks 2, 9, and 12 which correspond respectively in block type and applied voltage level to blocks 4, 6, and 11 were not submerged during the submergence test. During the time when blocks 4, 6, and 11 were submerged, blocks 2, 9, and 12 experienced IRs in the range of 20 to 100 kohms with slight recovery in the remaining three hours of steam exposure. During the cooldown to ambient temperature, these blocks recovered to about 1000 to 100,000 kohms.

The fluid which submerged the blocks was approximately two-thirds chemical spray solution and one-third steam condensate. Table 18 includes analyses of this submergence fluid. Its conductivity was comparable to the conductivity of the condensate samples taken during the spray periods in the initial Phase II exposure. The almost immediate recovery of the IRs on terminal blocks 4, 6, and 11 to values comparable to the low end of the nonsubmerged terminal blocks IRs indicates that the film remaining on the surfaces of these terminal blocks was only slightly more conductive than the film introduced to the nonsubmerged blocks by the steam environment only. During the cooldown the submerged blocks followed the same recovery pattern, but to values that varied between a factor of two and two orders of magnitude less than the recovery experienced by the nonsubmerged terminal blocks.

The results of the submergence test coupled with the observation that the Phase I test results are compatible with the Phase II results show that even if spray had penetrated the enclosures little difference in leakage currents may have been observed. Apparently the additional conducting ions from the spray may not significantly alter the conductivity of the film. These results also preclude a definite conclusion about the effectiveness of the NEMA-4 enclosure in preventing chemical spray from penetrating to the terminal blocks. However, we believe the NEMA-4 enclosures as they were installed in our test are reasonably effective in preventing such penetration.

5.0 CONCLUSIONS

1. Surface moisture films are the most probable explanation for the observed degradation of terminal block performance. Because films are a transient phenomena, the performance of the terminal blocks change with changing environmental conditions. Test conditions which do not adequately simulate the dominant accident conditions may bias the results of the test. For example superheated test conditions may not accurately reflect the terminal block's performance in a saturated environment.

2. Exposure to the LOCA environment caused some permanent degradation to the terminal block surface IRs, decreasing post-test and cooldown period IRs by one to two orders of magnitude.

3. Rapid, increasing voltage gradients cause sharp decreases in IR which recover over a period of minutes to hours. At steady state, a correlation between IR and applied voltage was not definitely identified during either of our LOCA tests, though the Phase I results indicate that a correlation may exist.

4. IRs were observed to be inversely related to the temperature of the environment.

5. The chemical spray and submergence test results indicate that little change in the film conductivity may be expected as a result of chemical spray.

6. The comparison between the serpentine circuit connection and the once-through connection is consistent with expected results based on parallel conducting path arguments and supports the conclusion that distributed conduction occurs in the film.

7. The performance of the terminal block used to connect a transmitter circuit validates the analyses of the effects on circuit performance done elsewhere [2] and verifies that the results from the other experimental circuits in the test are reasonable.

8. Cleaning of new or "as-received" terminal blocks does not appear to be effective in reducing terminal block leakage currents in a steam environment.

6.0 REFERENCES

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APPENDIX 1
Five-Number Summaries of Leakage Current and Insulation Resistance Data

Sections 4.3.3 and 4.4.2 discuss the presentation of the data in a five-number summary format. This appendix compiles the data in this format in both tabular and graphic form. The tabular arrangement for the data is:

	median	
lower quartile		upper quartile
lower extreme		upper extreme

The graphic format is:

upper extreme

upper quartile

median

lower quartile

lower extreme

The graphical presentation is commonly referred to as a box and whisker plot for obvious reasons.

TABLE A1-1a

Five-Number Summaries of Leakage Current, Phase I Terminal Blocks
(mA)

	Ambient		Peak 1 172°C		95°C		Peak 2 172°C		161°C	
TB 1	8.35E-03		3.50E+00		2.29E-02		6.25E+00		4.21E+00	
	8.35E-03	8.35E-03	3.34E+00	3.85E+00	2.29E-02	2.29E-02	5.52E+00	6.57E+00	4.10E+00	4.33E+00
	8.35E-03	8.35E-03	3.12E+00	7.68E+00	2.28E-02	2.29E-02	3.38E+00	8.62E+00	3.95E+00	4.39E+00
TB 2	8.55E-03		5.17E+00		1.12E-01		1.32E+01		1.11E+01	
	8.54E-03	8.55E-03	2.97E+00	5.22E+00	1.12E-01	1.12E-01	1.25E+01	1.51E+01	9.38E+00	1.29E+01
	8.54E-03	8.55E-03	1.93E+00	7.99E+00	1.01E-01	1.12E-01	9.40E+00	1.79E+01	8.52E+00	1.51E+01
TB 3	9.15E-03		5.31E+00		1.97E-02		1.44E+01		1.80E+01	
	9.15E-03	9.15E-03	2.40E+00	5.35E+00	1.97E-02	1.97E-02	1.34E+01	1.50E+01	1.79E+01	1.82E+01
	9.15E-03	9.15E-03	1.93E+00	7.77E+00	1.96E-02	1.97E-02	9.89E+00	1.77E+01	1.75E+01	1.84E+01

TABLE A1-1b

Five-Number Summaries of Leakage Current, Phase I Terminal Blocks
(mA)

TB	150°C	122°C	105°C	105°C (4 Vdc)
TB 1	3.55E+00 3.14E+00 3.62E+00 2.61E+00 3.76E+00	1.19E+00 1.06E+00 1.33E+00 6.86E-01 3.78E+00	Sub 1: 8.56E-01 7.50E-01 2.85E+00 6.69E-01 3.54E+00 Sub 2: 8.86E-01 7.99E-01 1.12E+00 7.30E-01 2.51E+00 Overall: 8.66E-01 7.53E-01 1.54E+00 6.69E-01 3.54E+00	1.92E-01 1.86E-01 1.97E-01 1.03E-01 2.63E+00
TB 2	4.88E+00 4.09E+00 5.38E+00 3.73E+00 1.05E+01	1.81E+00 1.48E+00 2.21E+00 6.15E-01 8.35E+00	Sub 1: 3.27E+00 2.51E+00 1.11E+01 2.14E+00 1.14E+01 Sub 2: 2.69E+00 2.46E+00 3.10E+00 2.42E+00 4.29E+00 Overall: 2.94E+00 2.47E+00 4.46E+00 2.14E+00 1.14E+01	3.15E-01 3.05E-01 3.23E-01 2.00E-01 4.26E+00
TB 3	1.69E+01 1.47E+01 1.72E+01 1.22E+01 1.81E+01	2.82E+00 2.47E+00 3.27E+00 1.57E+00 5.65E+00	Sub 1: 3.69E+00 2.91E+00 1.18E+01 2.61E+00 1.21E+01 Sub 2: 3.23E+00 2.83E+00 4.11E+00 2.68E+00 7.57E+00 Overall: 3.48E+00 2.88E+00 6.31E+00 2.61E+00 2.21E+01	5.52E-01 5.27E-01 5.67E-01 2.61E-01 8.30E+00

TABLE A1-1c

Five-Number Summaries of Leakage Current, Phase I Terminal Blocks
(mA)

	Ambient		Peak 1 172°C		95°C		Peak 2 172°C		161°C	
TB 4	9.00E-03		6.02E+00		1.41E-02		7.89E+00		4.84E+00	
	9.00E-03	9.00E-03	3.51E+00	6.06E+00	1.41E-02	1.41E-02	7.34E+00	8.43E+00	4.69E+00	5.05E+00
	8.99E-03	9.00E-03	3.06E+00	9.13E+00	1.40E-02	1.41E-02	4.55E+00	1.16E+01	4.54E+00	5.12E+00
TB 5	8.73E-03		5.66E+00		1.25E-02		7.43E+00		4.44E+00	
	8.73E-03	8.73E-03	3.16E+00	5.84E+00	1.25E-02	1.25E-02	6.93E+00	8.14E+00	4.39E+00	4.61E+00
	8.72E-03	8.73E-03	2.29E+00	8.39E+00	1.24E-02	1.25E-02	4.71E+00	1.15E+01	4.17E+00	4.64E+00
TB 6	7.80E-03		3.14E+00		9.84E-03		3.10E+00		2.55E+00	
	7.80E-03	7.80E-03	2.77E+00	3.15E+00	9.84E-03	9.84E-03	2.88E+00	3.56E+00	2.53E+00	2.57E+00
	7.80E-03	7.80E-03	2.51E+00	3.98E+00	9.61E-03	9.84E-03	2.09E+00	5.08?+00	2.45E+00	2.59E+00

TABLE A1-1d

Five-Number Summaries of Leakage Current, Phase I Terminal Blocks (mA)

TB	150°C	122°C	105°C	105°C (4 Vdc)
4	3.50E+00 3.44E+00 3.55E+00 3.37E-02 3.69E+00	8.70E-01 7.63E-01 1.25E+00 4.73E-01 4.99E+00	Sub 1: 7.28E-01 6.51E-01 2.15E+00 5.99E-01 2.75E+00 Sub 2: 3.86E-01 3.75E-01 3.97E-01 3.59E-01 9.13E-01 Overall: 6.65E-01 4.67E-01 9.13E-01 3.59E-01 2.75E+00	8.68E-02 8.54E-02 8.76E-02 6.38E-02 8.91E-01
5	2.98E+00 2.95E+00 3.02E+00 2.85E+00 3.05E+00	6.18E-01 4.88E-01 7.72E-01 3.39E-01 3.34E+00	Sub 1: 5.18E-01 4.29E-01 1.95E+00 3.77E-01 2.77E+00 Sub 2: 6.66E-01 6.15E-01 8.42E-01 5.56E-01 1.54E+00 Overall: 6.15E-01 4.40E-01 1.04E+00 3.77E-01 2.77E+00	9.11E-02 6.02E-02 1.04E-01 3.81E-02 1.53E+00
6	1.80E+00 1.62E+00 1.86E+00 1.33E+00 1.93E+00	1.22E-01 8.92E-02 1.35E-01 9.34E-03 1.27E+00	Sub 1: 1.84E-01 1.56E-01 1.64E+00 1.33E-01 2.09E+00 Sub 2: 1.57E-01 1.39E-01 3.11E-01 1.18E-01 7.79E-01 Overall: 1.81E-01 1.50E-01 4.48E-01 1.18E-01 2.09E+00	6.06E-02 5.64E-02 6.38E-02 5.24E-02 4.53E-01

TABLE A1-1e

Five-Number Summaries of Leakage Current, Phase I Terminal Blocks
(mA)

	Ambient		Peak 1 172°C		95°C		Peak 2 172°C		161°C	
TB 7	2.83E-04		7.41E+00		1.83E-02		4.91E+00		3.28E+00	
	9.43E-05	2.83E-04	5.94E+00	7.49E+00	1.83E-02	1.83E-02	4.78E+00	5.95E+00	3.24E+00	3.30E+00
	9.43E-05	2.83E-04	5.33E+00	1.38E+01	1.82E-02	1.83E-02	4.57E+00	1.55E+01	2.95E+00	3.35E+00
TB 8	1.99E-04		6.91E+00		2.20E-02		5.22E+00		3.67E+00	
	9.94E-05	1.99E-04	6.33E+00	7.04E+00	2.20E-02	2.20E-02	5.05E+00	5.61E+00	3.61E+00	3.70E+00
	9.94E-05	1.99E-04	5.56E+00	1.08E+01	2.20E-02	2.20E-02	4.81E+00	1.56E+01	3.37E+00	3.78E+00
TB 9	2.98E-04		3.78E+00		2.89E-01		3.80E+01		2.79E+01	
	1.98E-04	2.98E-04	2.85E+01	4.44E+01	2.89E-01	2.89E-01	3.60E+01	5.25E+01	2.63E+01	2.91E+01
	9.92E-05	2.98E-04	2.01E+01	6.15E+01	2.85E-01	2.89E-01	2.73E+01	2.11E+02	2.01E+01	3.23E+01
TB 10	2.98E-04		4.41E+00		5.56E-03		3.06E+00		1.49E+00	
	2.98E-04	2.98E-04	1.46E+00	6.63E+00	5.56E-03	5.56E-03	2.97E+00	4.24E+00	1.33E+00	1.55E+00
	1.99E-04	2.98E-04	8.53E-01	1.18E+01	5.46E-03	5.56E-03	2.44E+00	2.32E+01	1.28E+00	1.64E+00
TB 11	3.96E-04		1.13E+00		4.95E-04		1.99E+00		7.13E-01	
	2.97E-04	3.96E-04	9.40E-01	1.13E+00	4.95E-04	4.95E-04	1.71E+00	2.59E+00	6.10E-01	7.67E-01
	2.97E-04	3.96E-04	7.20E-01	1.03E+01	3.96E-04	4.95E-04	1.49E+00	9.51E+00	4.93E-01	8.46E-01
TB 12	2.96E-04		8.65E-01		1.26E-01		1.66E+00		7.77E-01	
	1.97E-04	2.96E-04	7.20E-01	9.22E-01	1.26E-01	1.26E-01	1.56E+00	2.10E+00	7.32E-01	8.84E-01
	1.97E-04	2.96E-04	6.01E-01	1.44E+00	1.26E-01	1.26E-01	1.22E+00	1.14E+01	7.05E-01	9.93E-01

TABLE A1-1f

Five-Number Summaries of Leakage Current, Phase I Terminal Blocks
(mA)

TB	150°C		122°C		105°C	
7	2.14E+00		7.80E-01		4.07E-01	
	2.07E+00	2.15E+00	6.49E-01	9.20E-01	3.61E-01	4.89E-01
	1.59E+00	2.19E+00	1.04E-01	2.11E+00	3.22E-01	3.51E+00
8	2.53E+00		8.92E-01		4.33E-01	
	2.47E+00	2.60E+00	7.58E-01	1.07E+00	3.15E-01	6.43E-01
	2.04E+00	2.62E+00	4.83E-01	2.39E+00	2.71E-01	2.46E+01
9	1.87E+01		1.25E+01		5.05E+00	
	1.70E+01	2.52E+01	9.19E+00	1.35E+01	6.18E-01	1.18E+01
	1.44E+01	3.42E+01	5.83E+01	4.89E+01	1.36E-01	8.11E+01
10	7.70E-01		3.45E-01		4.84E-01	
	7.41E-01	9.22E-01	3.13E-01	4.13E-01	4.35E-01	6.41E-01
	6.74E-01	1.14E+00	2.57E-01	1.49E+00	3.84E-01	1.78E+01
11	2.85E-01		2.20E-01		2.04E-01	
	2.02E-01	3.23E-01	9.46E-02	2.45E-01	1.41E-01	3.11E-01
	1.25E-01	4.63E-01	9.41E-03	9.64E-01	7.66E-02	4.24E+00
12	7.23E-01		4.35E-01		1.68E-01	
	6.01E-01	8.42E-01	3.86E-01	4.85E-01	8.26E-02	3.52E-01
	3.96E-01	1.26E+00	2.45E-01	1.12E+00	6.60E-02	4.30E+00

TABLE A1-2a

Five-Number Summaries of Insulation Resistance, Phase I Terminal Blocks
(Kohms)

TB	Ambient		Peak 1 172°C		95°C		Peak 2 172°C		161°C	
1	5.40E+03		8.52E+00		1.98E+03		3.32E+00		8.46E+00	
	5.39E+03	5.40E+03	6.07E+00	8.96E+00	1.98E+03	1.98E+03	3.20E+00	4.24E+00	8.41E+00	8.81E+00
	5.39E+03	5.40E+03	3.61E+00	1.22E+01	1.96E+03	1.98E+03	2.97E+00	1.11E+01	8.01E+00	9.17E+00
2	5.27E+03		6.14E+00		4.09E-02		3.41E-01		2.12E+00	
	5.27E+03	5.27E+03	5.65E+00	6.23E+00	4.09E+02	4.09E+02	3.05E-01	4.40E-01	1.45E+00	2.46E+00
	5.27E+03	5.27E+03	3.39E+00	2.11E+01	3.99E+02	4.09E+02	2.66E-01	2.54E+00	7.33E-01	3.04E+00
3	4.92E+03		5.76E+00		2.30E+03		4.36E-01		2.48E-01	
	4.92E+03	4.92E+03	5.49E+00	6.01E+00	2.30E+03	2.30E+03	3.61E-01	5.26E-01	2.28E-01	2.84E-01
	4.92E+03	4.92E+03	3.55E+00	2.10E+01	2.28E+03	2.30E+03	2.95E-01	2.30E+00	2.02E-01	3.20E-01

TABLE A1-2b

Five-Number Summaries of Insulation Resistance, Phase I Terminal Blocks
(Kohms)

TB	150°C	122°C	105°C	105°C (4 Vdc)
1	1.12E+01 1.02E+01 1.21E+01 9.74E+00 1.50E+01	2.91E+01 1.55E+01 3.27E+01 9.57E+00 6.34E+01	Sub 1: 5.80E+01 5.05E+01 6.47E+01 1.04E+01 6.50E+01 Sub 2: 4.50E+01 3.05E+01 5.23E+01 1.57E+01 5.94E+01 Overall: 5.41E+01 4.32E+01 6.22E+01 1.04E+01 6.50E+01	1.85E+01 1.81E+01 1.93E+01 1.49E+01 3.66E+01
2	7.02E+00 6.12E+00 8.76E+00 2.03E+00 9.82E+00	1.51E+01 1.09E+01 2.08E+01 3.14E+00 7.10E+01	Sub 1: 1.58E+01 1.19E+01 1.87E+01 1.69E+00 1.88E+01 Sub 2: 1.43E+01 1.09E+01 1.56E+01 8.24E+00 1.63E+01 Overall: 1.47E+01 1.13E+01 1.74E+01 1.69E+00 1.88E+01	1.05E+01 1.01E+01 1.09E+01 7.55E+00 1.78E+01
3	4.24E-01 3.64E-01 8.22E-01 2.40E-01 1.45E+00	9.87E+00 7.67E+00 1.26E+01 5.72E+00 2.65E+01	Sub 1: 1.32E+01 1.00E+01 1.49E+01 1.45E+00 1.50E+01 Sub 2: 1.07E+01 7.28E+00 1.31E+01 3.69E+00 1.45E+01 Overall: 1.28E+01 9.21E+00 1.46E+01 1.45E+00 1.50E+01	4.99E+00 4.80E+00 5.35E+00 3.17E+00 1.30E+01

TABLE A1-2c

Five-Number Summaries of Insulation Resistance, Phase I Terminal Blocks
(Kohms)

TB	Ambient		Peak 1 172°C		95°C		Peak 2 172°C		161°C	
4	5.01E+03		5.05E+00		3.21E+03		2.41E+00		7.11E+00	
	5.01E+03	5.01E+03	4.71E+00	5.09E+00	3.21E+03	3.21E+03	2.27E+00	2.80E+00	7.00E+00	7.37E+00
	5.01E+03	5.01E+03	2.68E+00	1.24E+01	3.20E+03	3.21E+03	1.63E+00	7.65E+00	6.54E+00	7.67E+00
5	5.16E+03		5.28E+00		3.63E+03		2.55E+00		7.91E+00	
	5.16E+03	5.16E+03	5.04E+00	5.33E+00	3.63E+03	3.63E+03	2.39E+00	2.98E+00	7.75E+00	8.17E+00
	5.16E+03	5.16E+03	3.12E+00	1.74E+01	3.61E+03	3.63E+03	1.67E+00	7.32E+00	7.46E+00	8.56E+00
6	5.78E+03		1.14E+01		4.69E+03		8.20E+00		1.54E+01	
	5.78E+03	5.78E+03	1.01E+01	1.16E+01	4.69E+03	4.69E+03	7.69E+00	8.62E+00	1.53E+01	1.57E+01
	5.78E+03	5.78E+03	9.06E+00	1.57E+01	4.58E+03	4.69E+03	6.63E+00	1.93E+01	1.52E+01	1.61E+01

TABLE A1-2d

Five-Number Summaries of Insulation Resistance, Phase I Terminal Blocks
(Kohms)

TB	150°C		122°C		105°C		105°C (4 Vdc)	
TB					Sub 1:			
4	1.07E+01		3.10E+01		6.69E+01		4.38E+01	
	1.05E+01	1.09E+01	1.22E+01	4.39E+01	5.98E+01	7.28E+01	4.34E+01	4.46E+01
	9.94E+00	1.11E+01	6.76E+00	9.30E+01	1.41E+01	7.29E+01	3.46E+01	6.04E+01
					Sub 2:			
					1.14E+02			
					1.03E+02	1.17E+02		
					4.70E+01	1.23E+02		
					Overall:			
					7.00E+01			
					6.05E+01	1.17E+02		
					1.41E+01	1.23E+02		
TB					Sub 1:			
5	1.29E+01		4.67E+01		1.03E+02		4.17E+01	
	1.27E+01	1.31E+01	1.94E+01	5.90E+01	8.52E+01	1.17E+02	3.64E+01	6.43E+01
	1.25E+01	1.36E+01	1.12E+01	1.30E+02	1.40E+01	1.17E+02	2.21E+00	1.03E+02
					Sub 2:			
					6.32E+01			
					4.84E+01	6.83E+01		
					2.69E+01	7.88E+01		
					Overall:			
					8.85E+01			
					6.62E+01	1.13E+02		
					1.40E+01	1.17E+02		
TB					Sub 1:			
6	2.34E+01		1.25E+02		2.89E+02		6.41E+01	
	2.19E+01	2.55E+01	3.46E+01	3.51E+02	2.44E+02	3.33E+02	6.06E+01	6.89E+01
	2.11E+01	3.16E+01	3.32E+01	4.82E+03	1.98E+01	3.36E+02	2.52E+01	9.70E+01
					Sub 2:			
					2.78E+02			
					1.14E+02	3.03E+02		
					5.55E+01	3.79E+02		
					Overall:			
					2.79E+02			
					2.15E+02	3.25E+02		
					1.93E+01	3.79E+02		

TABLE A1-2e

Five-Number Summaries of Insulation Resistance, Phase I Terminal Blocks
(Kohms)

TB	Ambient		Peak 1 172°C		95°C		Peak 2 172°C		161°C	
TB 7	1.36E+06		1.63E+01		7.08E+03		1.09E+01		3.92E+01	
	1.36E+06	1.36E+06	1.48E+01	1.66E+01	7.08E+03	7.08E+03	9.25E+00	1.24E+01	3.90E+01	3.99E+01
	4.55E+05	1.36E+06	9.16E+00	2.40E+01	7.05E+03	7.08E+03	8.17E+00	2.81E+01	3.83E+01	4.35E+01
TB 8	1.29E+06		1.76E+01		5.87E+03		9.63E+00		3.51E+01	
	1.29E+06	1.29E+06	1.59E+01	1.77E+01	5.87E+03	5.87E+03	8.65E+00	1.21E+01	3.47E+01	3.56E+01
	6.47E+05	1.29E+06	1.17E+01	2.30E+01	5.86E+03	5.87E+03	8.12E+00	2.67E+01	3.39E+01	3.81E+01
TB 9	1.26E+06		1.98E+00		4.42E+02		6.17E-01		4.42E+00	
	6.31E+05	1.26E+06	1.97E+00	2.24E+00	4.42E+02	4.42E+02	5.80E-01	1.06E+00	4.25E+00	4.68E+00
	4.21E+05	1.26E+06	1.91E+00	6.04E+00	4.37E+02	4.42E+02	4.71E-01	4.50E+00	3.79E+00	6.16E+00
TB 10	6.31E+05		1.09E+01		2.31E+04		7.32E+00		8.50E+01	
	4.21E+05	6.31E+05	1.06E+01	1.13E+01	2.31E+04	2.31E+04	6.45E+00	1.07E+01	8.18E+01	9.56E+01
	4.21E+05	6.31E+05	1.05E+01	1.48E+02	2.27E+04	2.31E+04	5.31E+00	5.16E+01	7.70E+01	9.86E+01
TB 11	4.23E+05		1.10E+02		3.20E+05		2.15E+01		1.88E+02	
	4.23E+05	4.23E+05	1.03E+02	1.130+02	3.20E+05	3.20E+05	1.91E+01	3.64E+01	1.67E+02	2.16E+02
	3.17E+05	4.23E+05	1.21E+01	1.72E+02	2.56E+05	3.20E+05	1.32E+01	8.48E+01	1.50E+02	2.57E+02
TB 12	6.37E+05		1.33E+02		1.01E+03		2.71E+01		1.64E+02	
	6.37E+05	6.37E+05	1.29E+02	1.34E+02	1.01E+03	1.01E+03	2.31E+01	4.27E+01	1.52E+02	1.74E+02
	4.25E+05	6.37E+05	7.09E+01	2.09E+02	1.01E+03	1.01E+03	1.10E+01	1.04E+02	1.27E+02	1.80E+02

TABLE A1-2f

Five-Number Summaries of Insulation Resistance, Phase I Terminal Blocks
(Kohms)

	150°C		122°C		105°C	
TB 7	6.04E+01		1.31E+02		3.22E+02	
	5.98E+01	6.22E+01	1.21E+02	1.46E+02	2.77E+02	3.71E+02
	5.88E+01	8.12E+01	6.13E+01	1.25E+03	3.65E+01	3.93E+02
TB 8	5.10E+01		1.10E+02		3.34E+02	
	4.95E+01	5.20E+01	9.91E+01	1.30E+02	2.18E+02	4.43E+02
	4.90E+01	6.30E+01	5.41E+01	2.67E+02	5.01E+00	4.67E+02
TB 9	6.67E+00		8.15E+00		1.60E+02	
	4.90E+00	7.28E+00	6.57E+00	9.51E+00	1.27E+01	2.30E+02
	3.57E+00	8.65E+00	2.45E+00	2.15E+01	1.44E+00	9.31E+02
TB 10	1.66E+02		2.93E+02		2.75E+02	
	1.37E+02	1.70E+02	2.15E+02	3.32E+02	2.21E+02	2.96E+02
	1.10E+02	1.87E+02	8.48E+01	4.91E+02	6.96E+00	3.29E+02
TB 11	4.69E+02		4.93E+02		6.62E+02	
	3.92E+02	6.28E+02	4.05E+02	5.36E+02	4.65E+02	9.73E+02
	2.73E+02	1.02E+03	1.31E+02	1.35E+04	2.99E+01	1.65E+03
TB 12	1.77E+02		2.42E+02		1.28E+03	
	1.50E+02	2.11E+02	1.86E+02	2.75E+02	5.28E+02	1.65E+03
	1.00E+02	3.20E+02	1.13E+02	5.17E+02	2.95E+01	1.92E+03

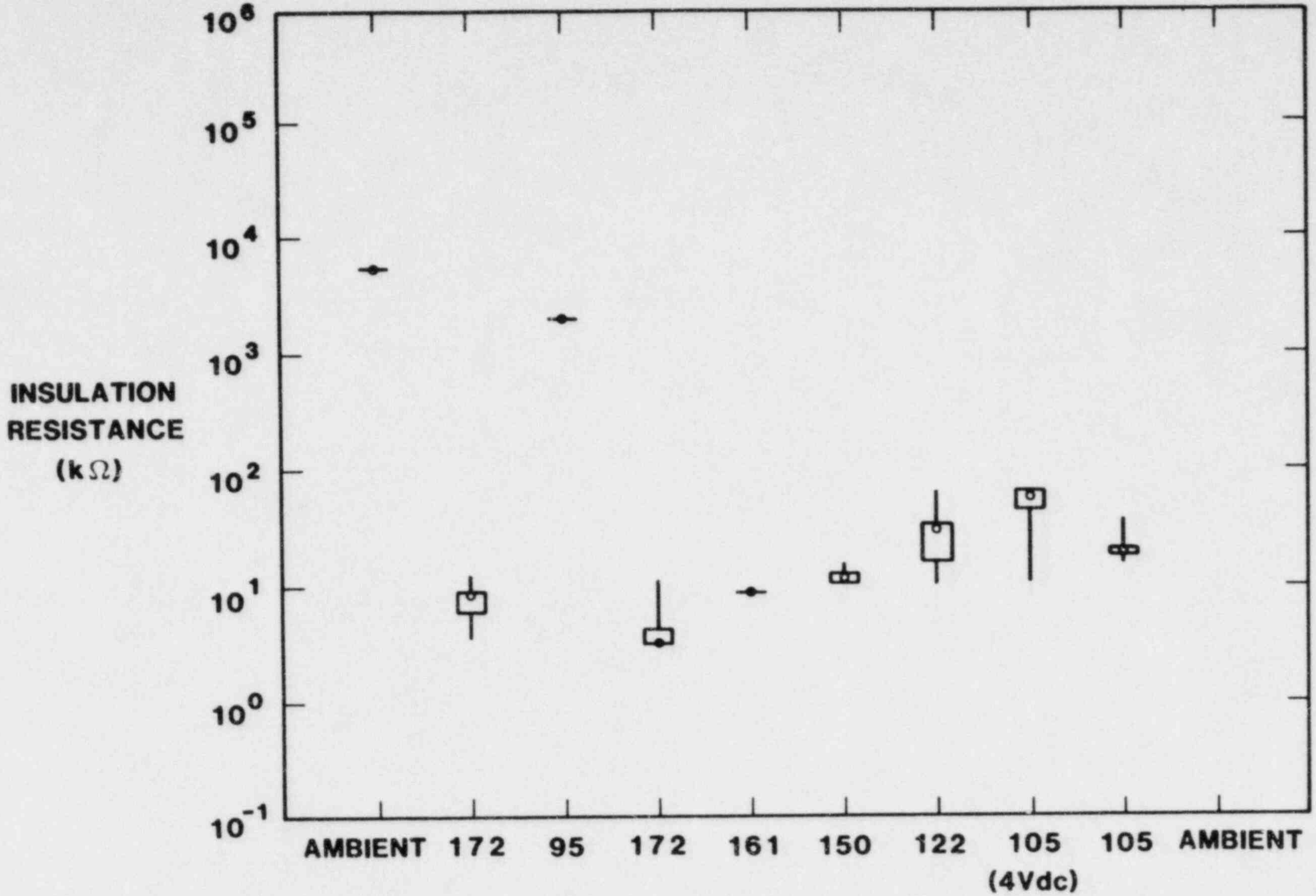

Figure A1-1

Box and Whisker Plot of Insulation Resistance for TB 1, Phase I

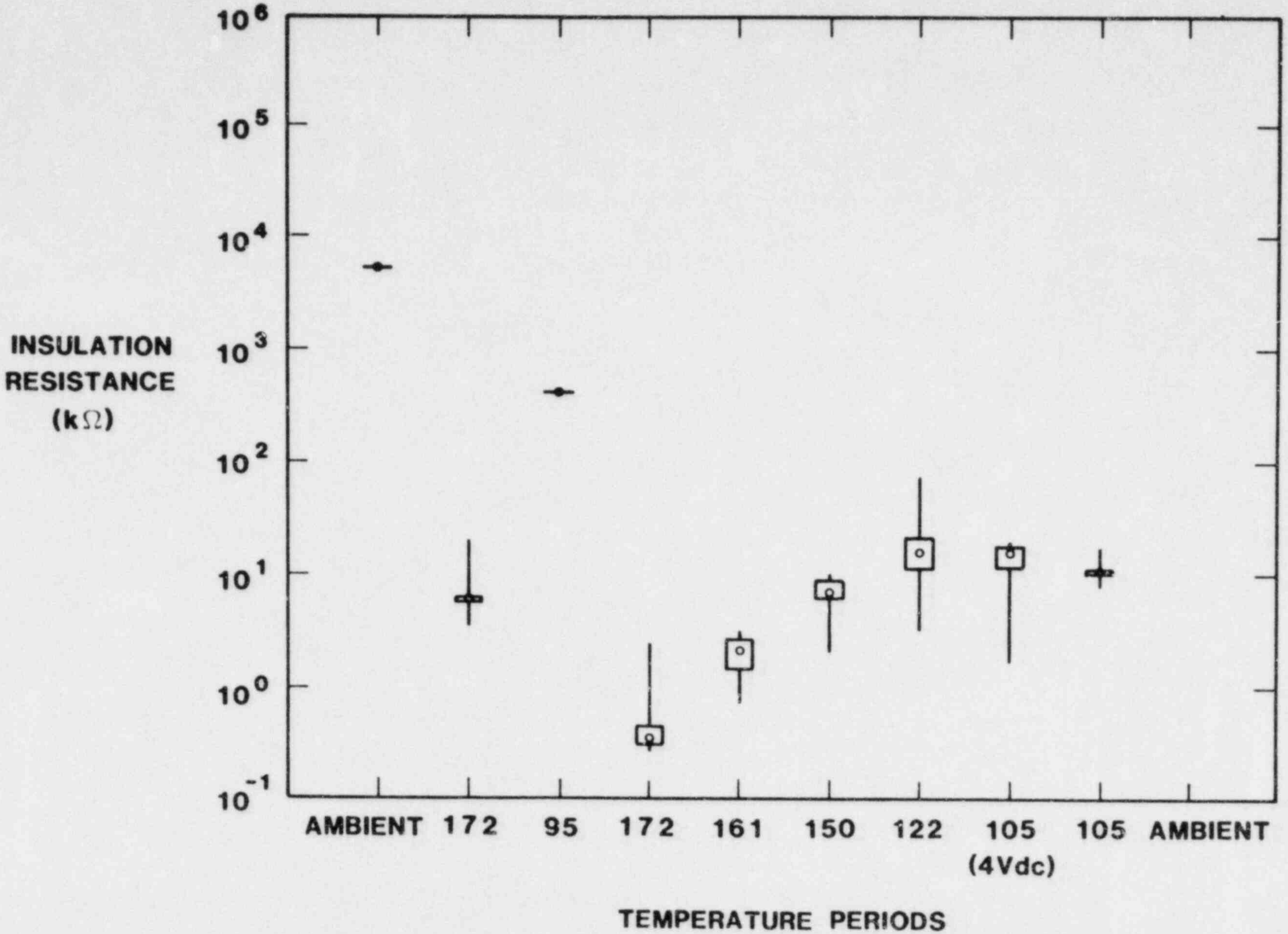

Figure A1-2

Box and Whisker Plot of Insulation Resistance for TB 2, Phase I

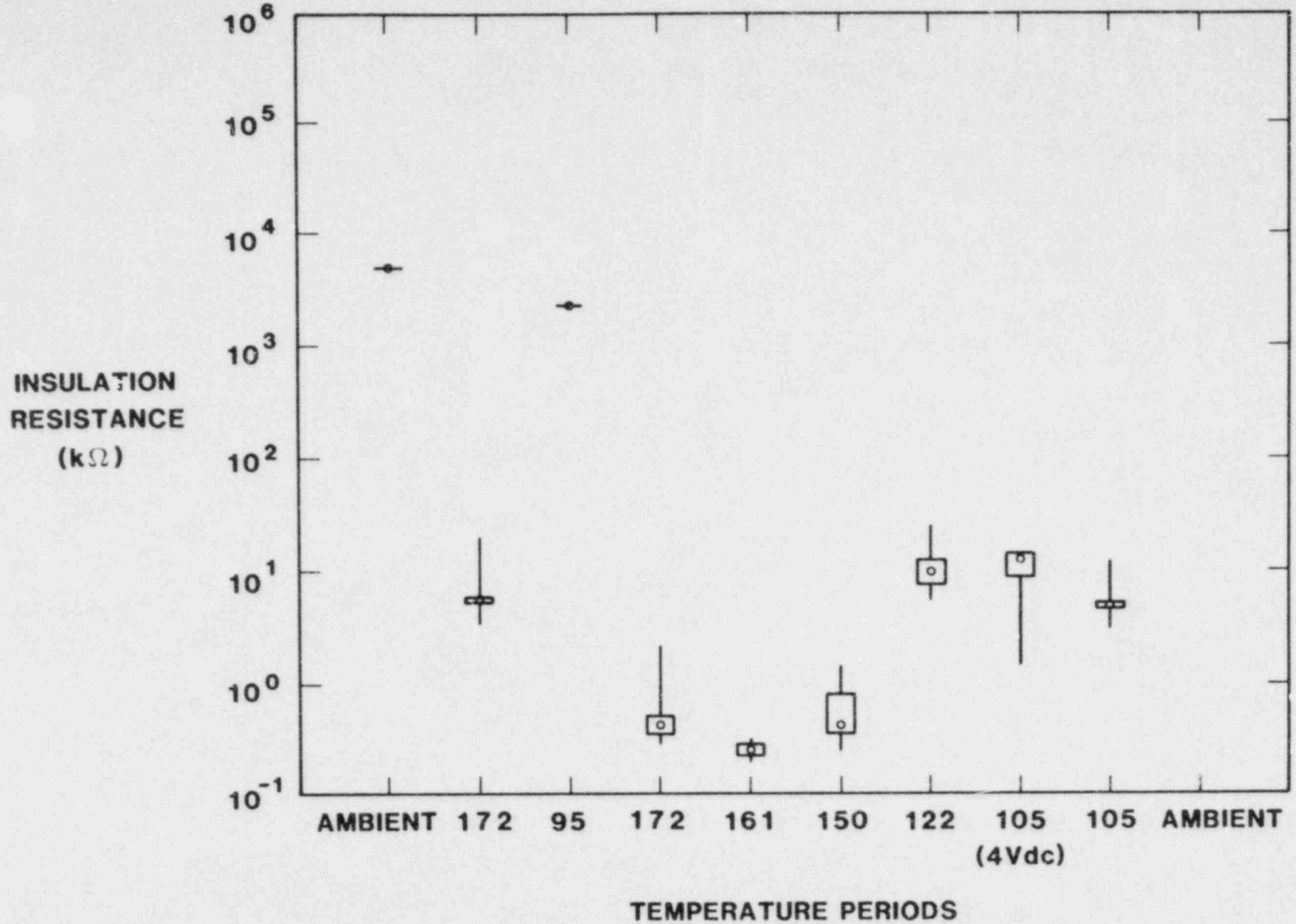

Figure A1-3

Box and Whisker Plot of Insulation Resistance for TB 3, Phase I

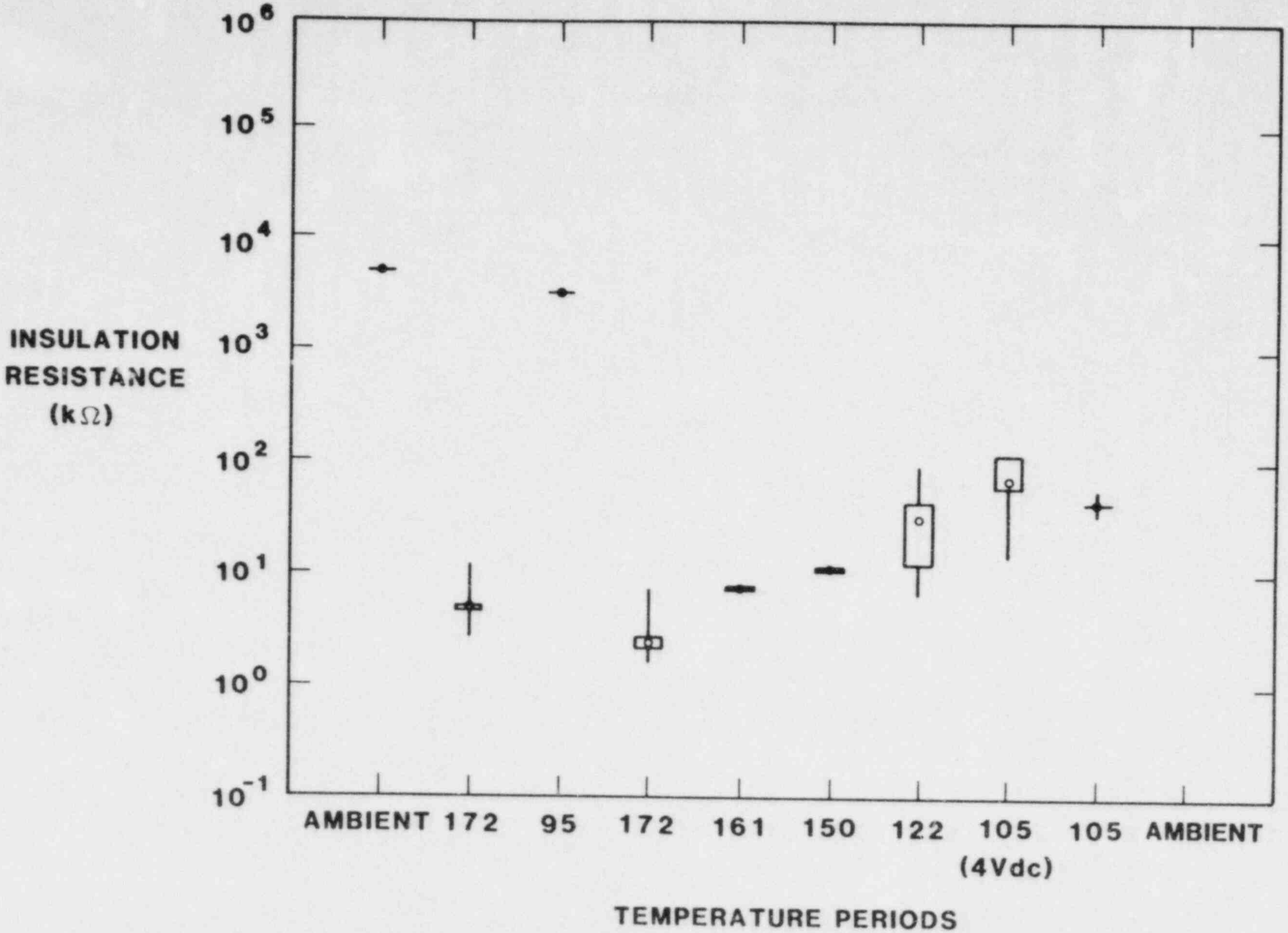

Figure A1-4

Box and Whisker Plot of Insulation Resistance for TB 4, Phase I

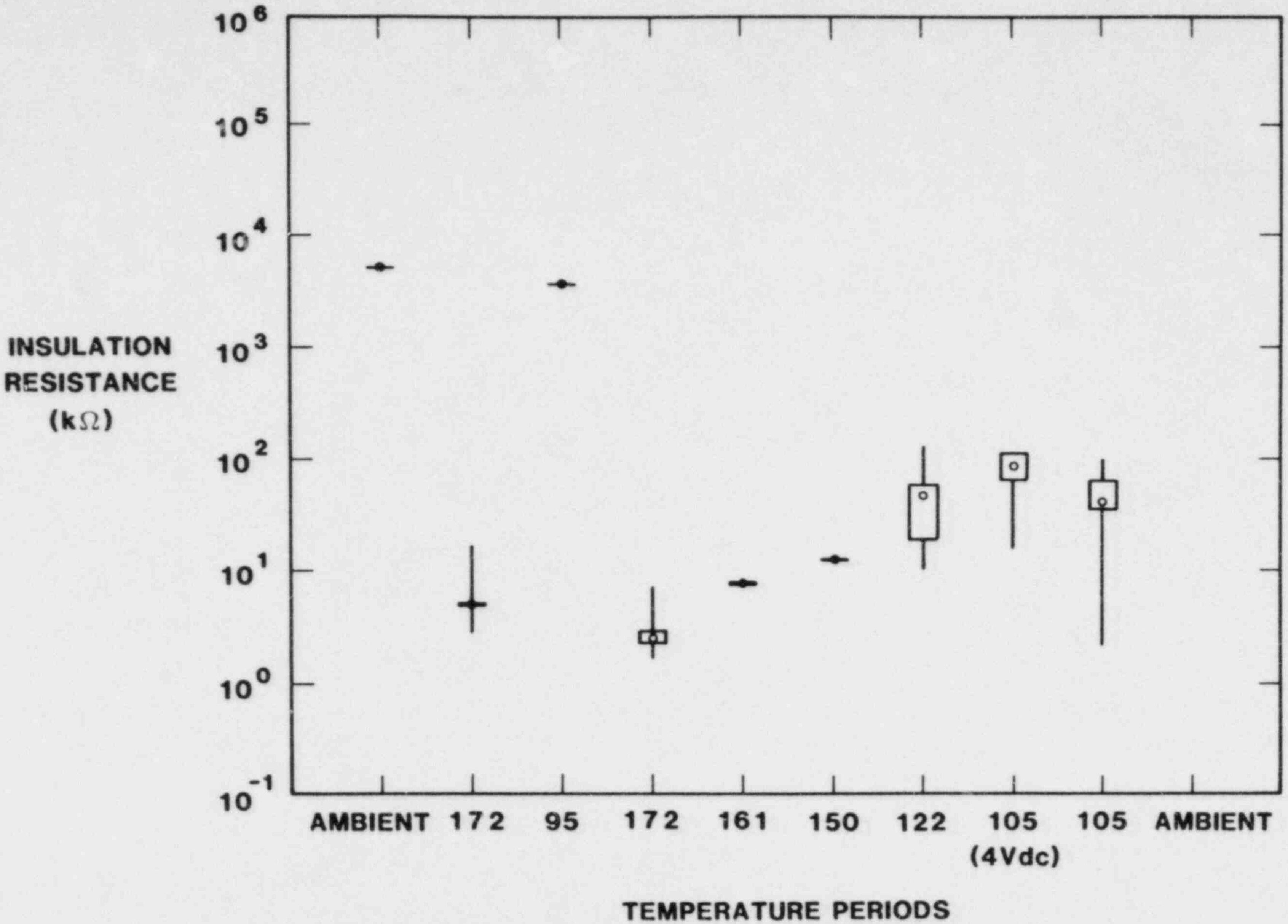

Figure A1-5

Box and Whisker Plot of Insulation Resistance for TB 5, Phase I

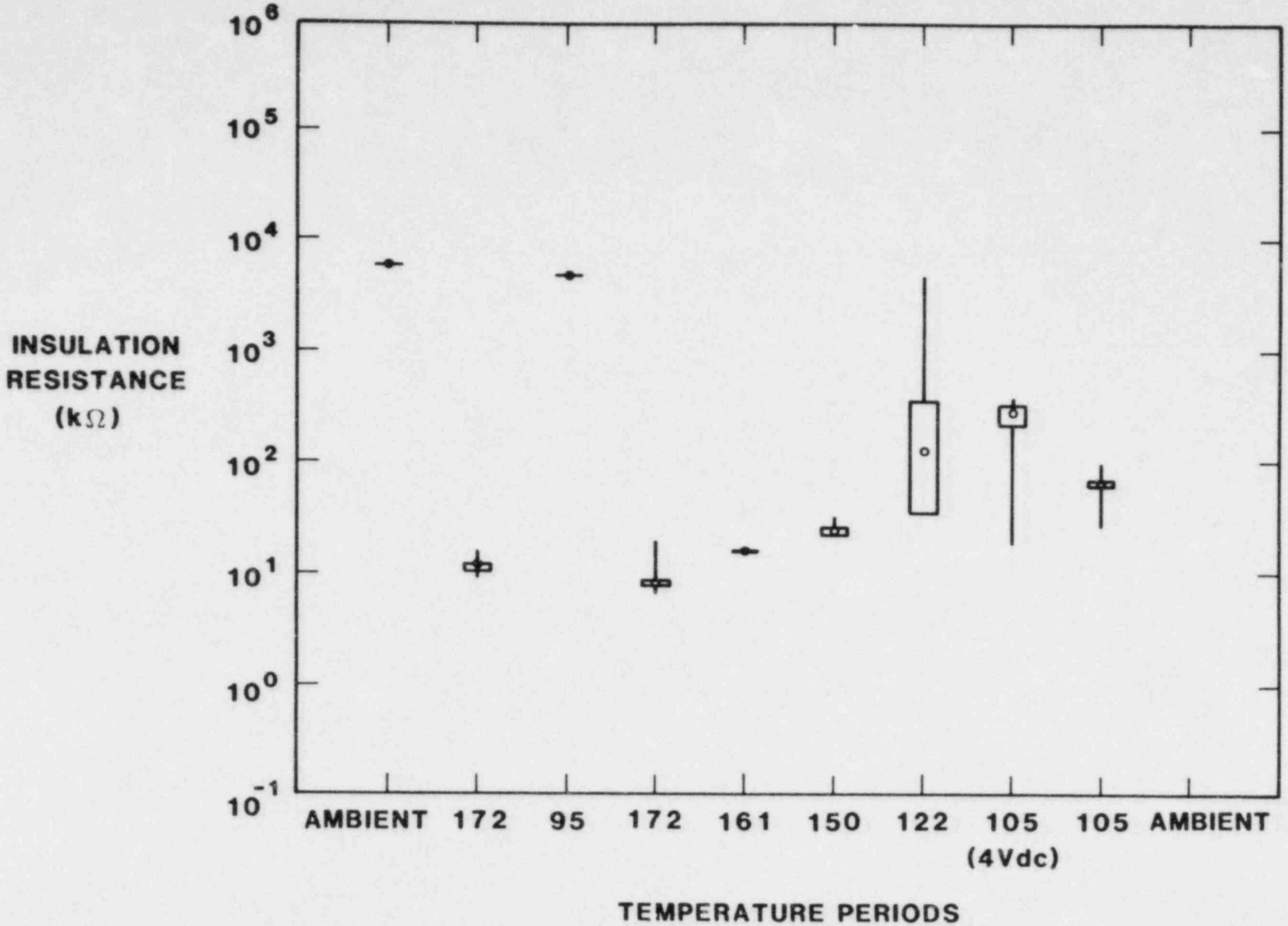

Figure A1-6

Box and Whisker Plot of Insulation Resistance for TB 6, Phase I

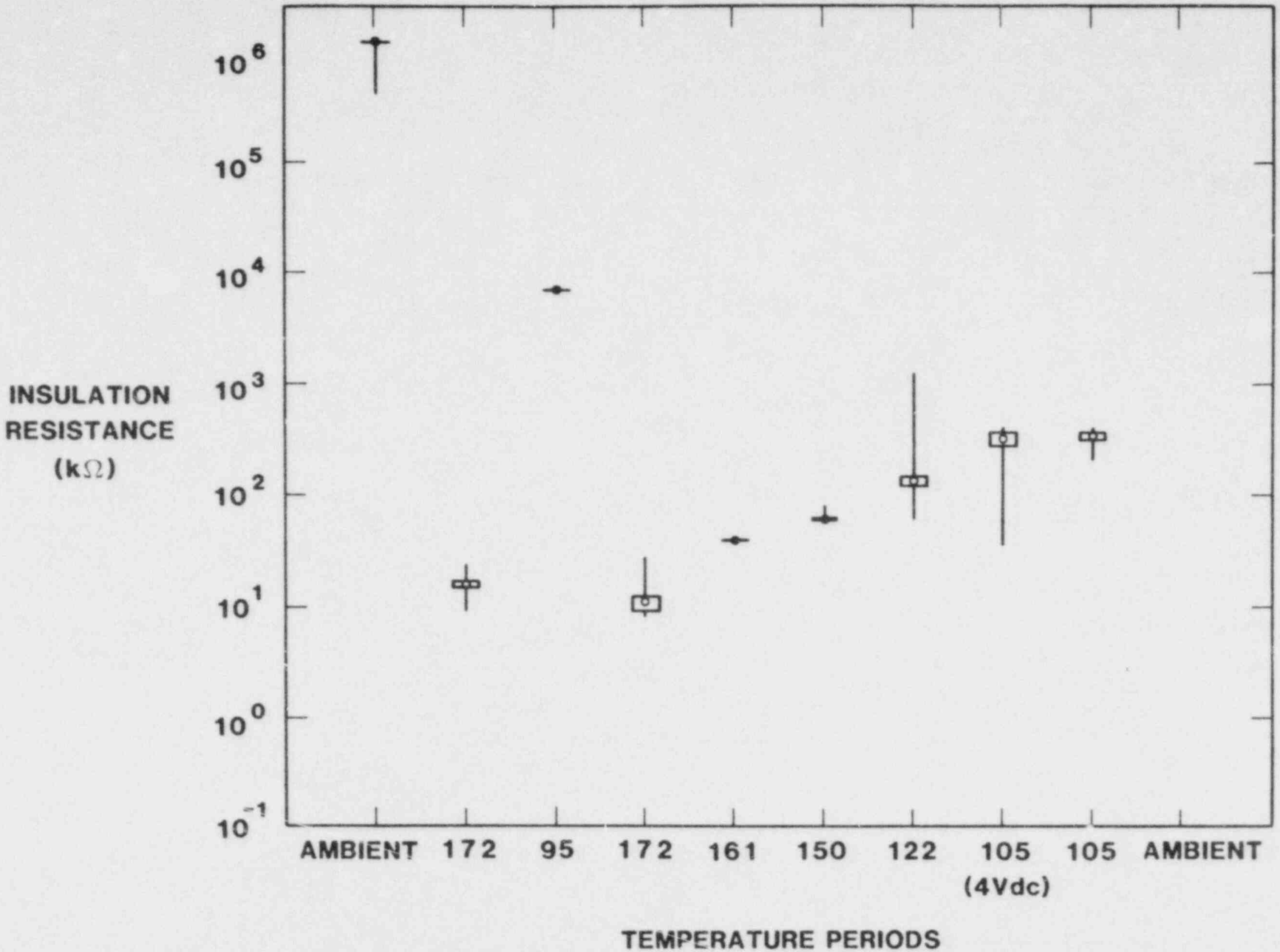

Figure A1-7

Box and Whisker Plot of Insulation Resistance for TB 7, Phase I

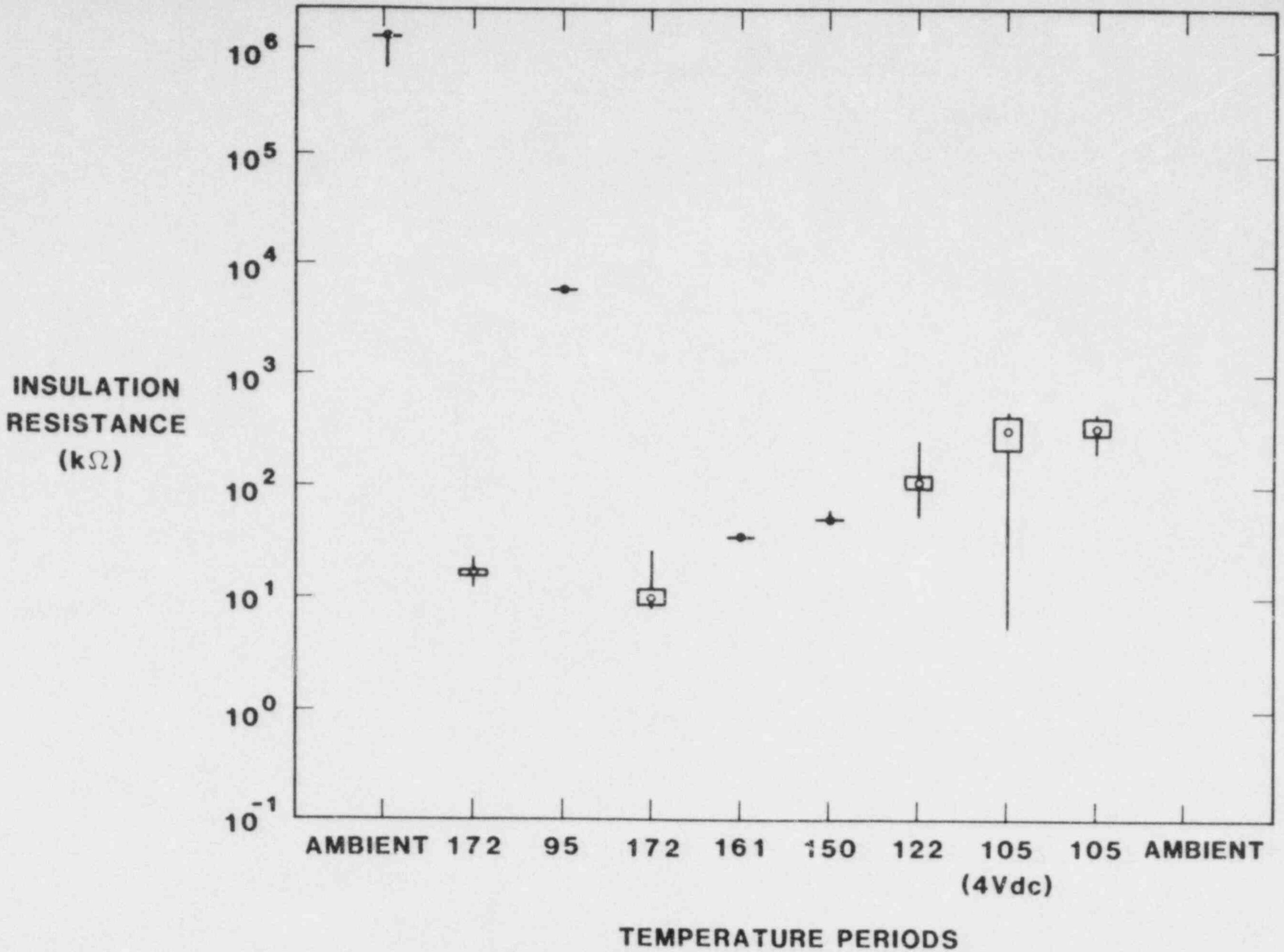

Figure A1-8

Box and Whisker Plot of Insulation Resistance for TB 8, Phase I

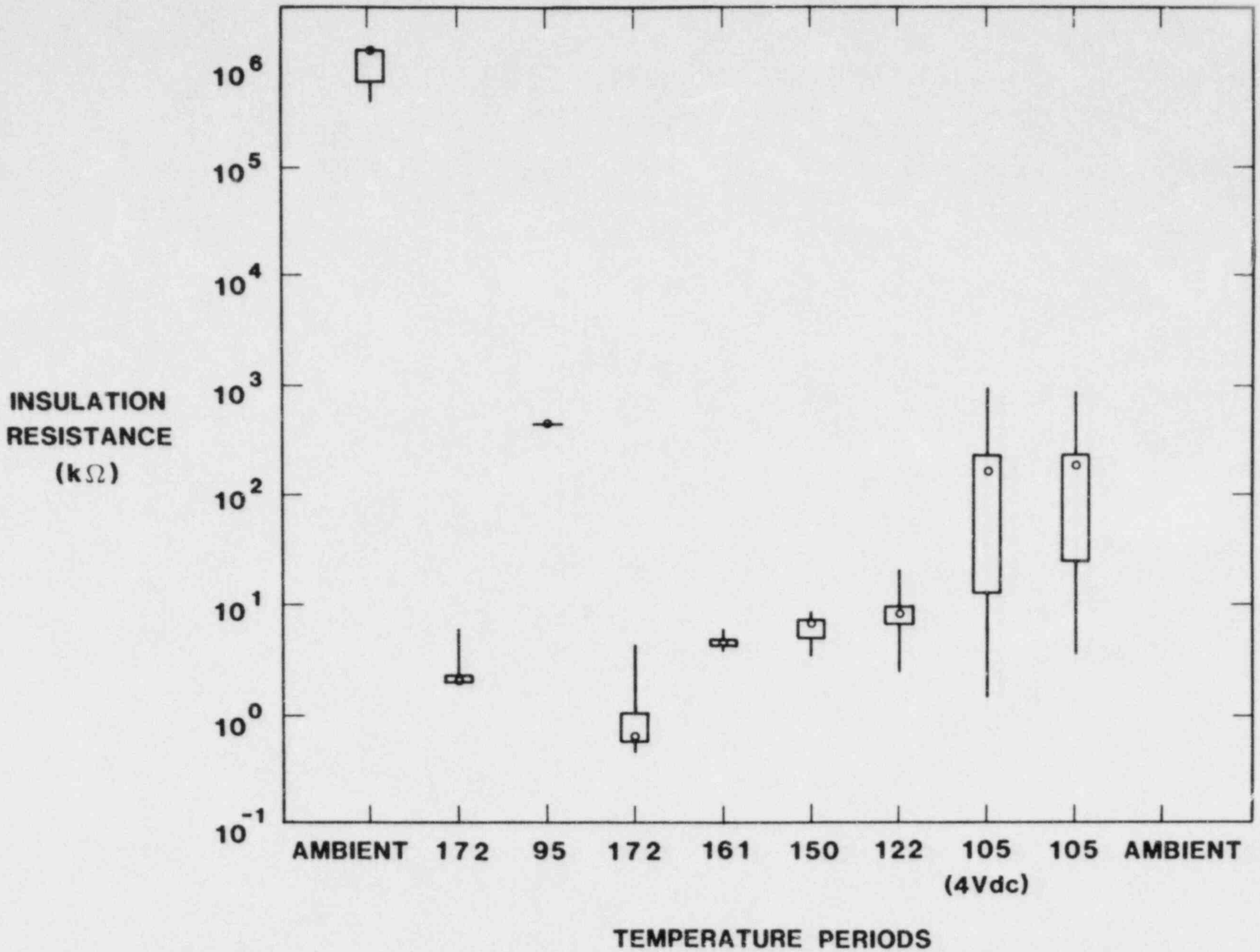

Figure A1-9

Box and Whisker Plot of Insulation Resistance for TB 9, Phase I

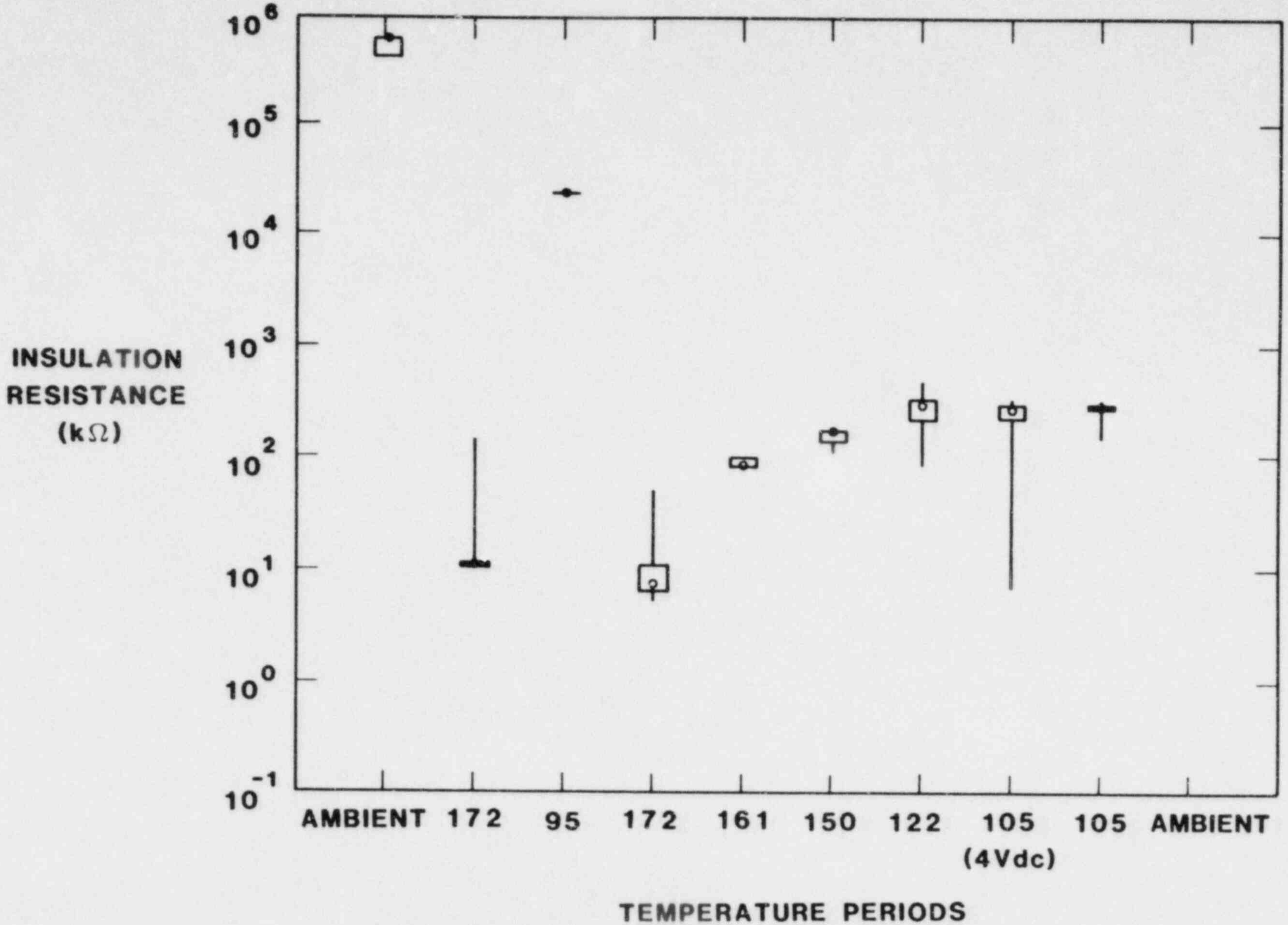

Figure A1-10

Box and Whisker Plot of Insulation Resistance for TB 10, Phase I

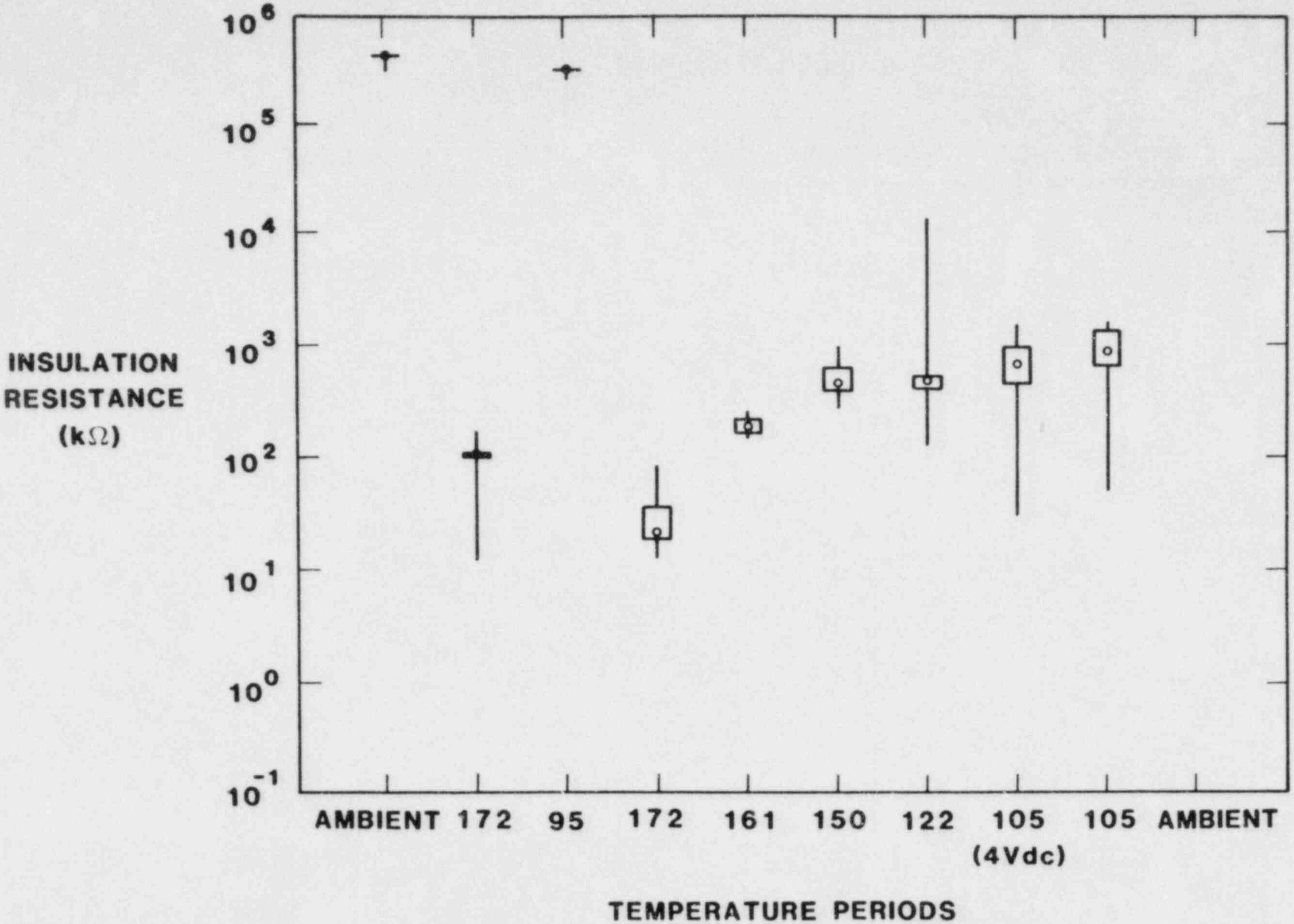

Figure A1-11

Box and Whisker Plot of Insulation Resistance for TB 11, Phase I

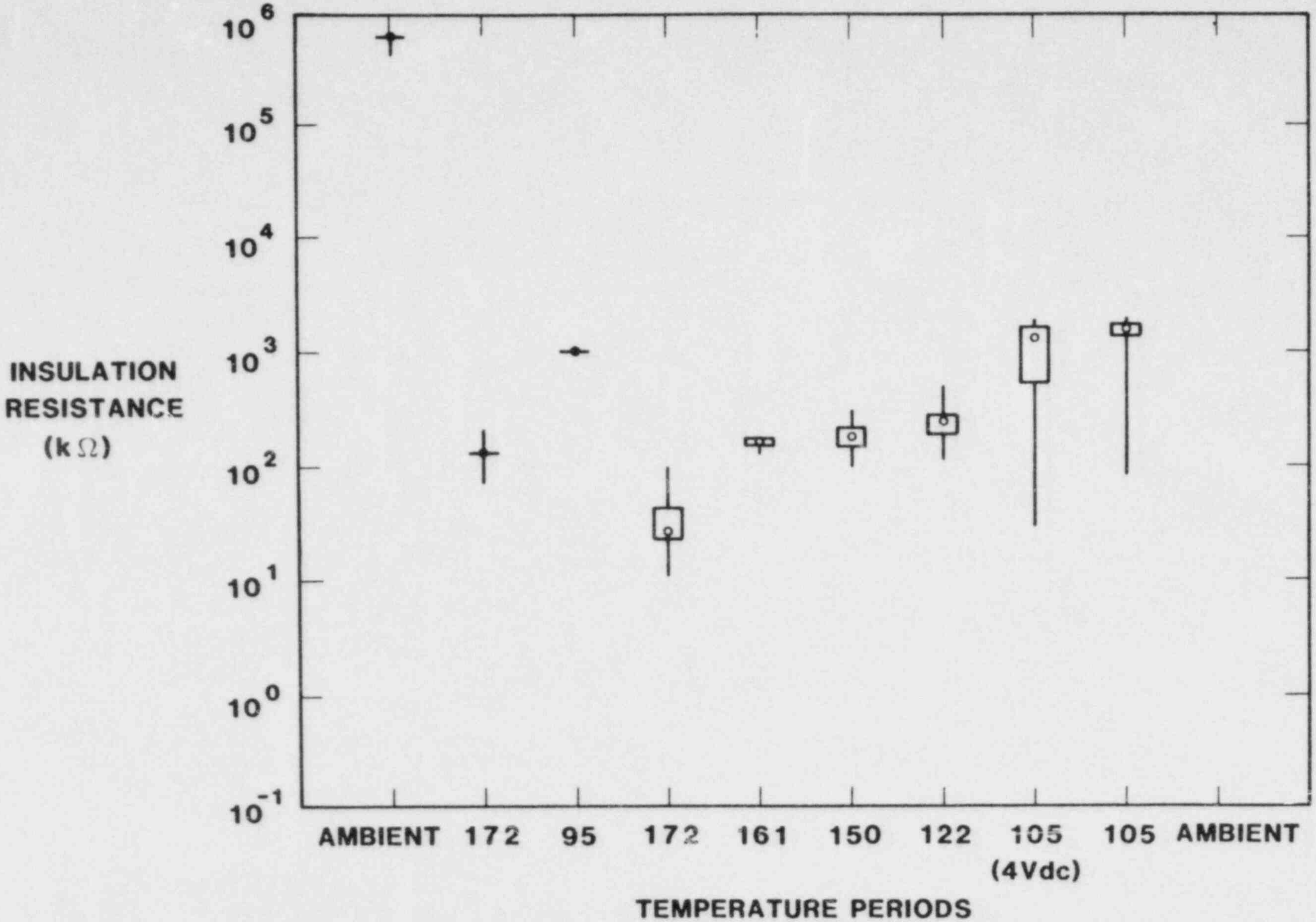

Figure A1-12

Box and Whisker Plot of Insulation Resistance for TB 12, Phase I

TABLE A1-3a

Five-Number Summaries of Insulation Resistance A, Phase II Terminal Blocks
(Kohms)

TB	Ambient	Peak 1 175°C	95°C	Peak 2 175°C	161°C
TB 1	3.26E+05 3.26E+05 3.26E+05 2.61E+05 3.26E+05	1.34E+02 2.77E+01 1.60E+02 7.91E+00 2.41E+04	5.67E+04 3.18E+04 7.67E+04 1.09E+03 8.69E+04	Sub 1: 1.11E+01 8.22E+00 1.34E+01 2.28E+00 2.35E+02 Sub 2: 1.39E+02 7.70E+01 1.55E+02 3.18E+01 2.24E+02 Overall: 4.88E+01 1.51E+01 8.26E+01 2.28E+00 2.35E+02	2.96E+02 2.45E+02 4.27E+02 1.85E+02 4.27E+02
TB 2	4.30E+05 3.23E+05 [illegible] 3.23E+05 [illegible]	5.67E+01 4.16E+01 7.57E+01 3.89E+01 1.58E+03	1.29E+05 1.08E+05 1.84E+05 4.61E+04 2.15E+05	Sub 1: 3.66E+01 3.31E+01 4.11E+01 3.08E+01 1.66E+02 Sub 2: 1.37E+02 1.03E+02 1.46E+02 9.20E+01 1.68E+02 Overall: 1.12E+02 4.27E+01 1.15E+02 3.08E+01 1.68E+02	2.45E+02 2.35E+02 3.05E+02 2.29E+02 3.05E+02
TB 3	6.57E+05 4.38E+05 6.58E+05 4.38E+05 6.58E+05	1.06E+02 9.60E+01 1.11E+02 8.90E+01 1.95E+03	8.22E+04 7.73E+04 9.39E+04 2.63E+04 1.01E+05	Sub 1: 5.53E+01 5.41E+01 5.88E+01 4.36E+01 8.41E+02 Sub 2: 1.66E+02 1.45E+02 1.77E+02 1.39E+02 2.34E+02 Overall: 1.33E+02 6.18E+01 1.56E+02 4.36E+01 8.41E+02	3.58E+02 3.40E+02 5.38E+02 3.21E+02 5.38E+02

TABLE A1-3b

Five-Number Summaries of Insulation Resistance A, Phase II Terminal Blocks
(Kohms)

	95°C	149°C	121°C	105°C	Ambient
TB 1	2.57E+03 2.12E+03 3.03E+03 1.79E+03 4.90E+03	1.72E+02 7.78E+00 2.14E+02 3.44E+00 3.75E+02			
TB 2	3.49E+04 3.15E+04 3.69E+04 2.87E+04 4.45E+04	2.22E+02 2.10E+02 2.26E+02 1.00E+02 2.30E+02	Sub 1: 5.25E+02 5.11E+02 5.42E+02 4.59E+02 6.25E+02 Sub 2: 7.98E+02 6.41E+02 8.83E+02 3.82E+02 9.83E+02 Overall: 6.59E+02 5.37E+02 8.21E+02 3.82E+02 9.83E+02	1.26E+03 1.17E+03 1.41E+03 2.92E+02 1.49E+03	4.30E+04 4.03E+04 4.45E+04 3.80E+04 4.78E+04
TB 3	4.70E+04 4.24E+04 6.26E+04 3.87E+04 6.26E+04	2.12E+02 1.51E+02 2.33E+02 7.58E+01 2.56E+02	Sub 1: 5.10E+02 4.87E+02 5.44E+02 4.66E+02 1.40E+03 Sub 2: 4.88E+02 4.36E+02 5.26E+02 2.10E+02 7.79E+02 Overall: 4.85E+02 4.44E+02 5.11E+02 2.10E+02 1.40E+03	Sub 1: 8.07E+02 7.03E+02 9.14E+02 6.80E+02 9.68E+02 Sub 2: 1.25E+03 1.15E+03 1.32E+03 3.67E+02 1.35E+03 Overall: 9.54E+02 8.07E+02 1.20E+03 3.67E+02 1.35E+03	8.20E+04 5.70E+04 8.20E+04 5.47E+04 8.75E+04

TABLE A1-3c

Five-Number Summaries of Insulation Resistance A, Phase II Terminal Blocks
(Kohms)

TB	Ambient	Peak 1 175°C	95°C	Peak 2 175°C	161°C
4	6.58E+05 6.57E+05 6.58E+05 4.38E+05 6.58E+05	3.06E+01 2.87E+01 3.13E+01 1.83E+01 1.37E+04	1.78E+04 1.06E+04 2.31E+04 4.66E+03 3.06E+04	Sub 1: 1.40E+01 1.35E+01 1.47E+01 1.07E+01 4.79E+01 Sub 2: 2.19E+01 1.19E+01 2.54E+01 1.10E+01 2.95E+01 Overall: 1.66E+01 1.47E+01 1.75E+01 1.07E+01 4.97E+01	3.66E+01 3.54E+01 4.59E+01 3.42E+01 4.59E+01
5	4.34E+05 3.26E+05 4.34E+05 3.26E+05 4.34E+05	5.62E+01 4.14E+01 1.08E+02 3.45E+01 1.62E+03	5.91E+04 5.42E+04 8.13E+04 4.48E+04 1.00E+05	Sub 1: 3.61E+02 3.03E+02 3.77E+02 3.34E+00 4.14E+02 Sub 2: 3.72E+02 2.77E+02 4.09E+02 1.56E+02 5.35E+02 Overall: 4.35E+02 3.93E+02 4.65E+02 3.34E+00 5.35E+02	6.47E+02 5.59E+02 9.09E+02 5.27E+02 9.09E+02
6	4.39E+05 4.39E+05 6.58E+05 4.39E+05 6.58E+05	8.20E+01 6.83E+01 9.97E+01 5.87E+01 2.67E+03	3.86E+04 3.65E+04 4.38E+04 2.12E+04 4.86E+04	Sub 1: 2.15E+01 2.04E+00 3.13E+01 6.75E-01 5.81E+01 Sub 2: 1.06E+01 5.06E+00 1.13E+01 1.52E+00 1.72E+01 Overall: 1.60E+01 1.16E+01 2.79E+01 6.75E-01 5.81E+01	1.30E+01 1.07E+01 1.96E+01 8.85E+00 1.96E+01

TABLE A1-3d

Five-Number Summaries of Insulation Resistance A, Phase II Terminal Blocks
(Kohms)

	95°C	149°C	121°C	105°C	Ambient
TB 4	1.13E+03 1.01E+03 1.19E+03 9.73E+02 1.48E+03	3.11E+01 1.81E+01 3.58E+01 1.10E+01 4.02E+01	Sub 1: 4.55E+01 3.63E+01 4.96E+00 3.06E+01 5.99E+01 Sub 2: 9.53E+01 7.27E+01 1.06E+02 3.20E+01 1.29E+02 Overall: 7.30E+01 5.03E+01 9.84E+01 3.06E+01 1.29E+02	Sub 1: 1.94E+02 1.24E+02 2.98E+02 1.08E+02 3.37E+02 Sub 2: 1.79E+02 1.55E+02 1.87E+02 6.46E+01 1.96E+02 Overall: 1.68E+02 1.43E+02 1.84E+02 6.46E+01 3.37E+02	6.94E+02 6.83E+02 6.97E+02 6.76E+02 7.02E+02
TB 5	9.35E+04 9.35E+04 1.01E+05 8.19E+04 1.19E+05	1.95E+02 1.27E+02 2.41E+02 4.10E+01 2.55E+02	Sub 1: 1.12E+02 9.04E+01 1.50E+02 7.68E+01 2.39E+02 Sub 2: 7.81E+01 6.93E+01 8.34E+01 5.99E+01 9.73E+01 Sub 3: 4.31E+02 1.62E+02 5.45E+02 7.21E+01 6.54E+02 Overall: 2.38E+02 1.36E+02 4.66E+02 5.99E+01 6.54E+02	Sub 1: 2.57E+02 1.91E+02 3.86E+02 1.56E+02 4.79E+02 Sub 2: 4.95E+02 4.42E+02 6.08E+02 1.19E+02 7.73E+02 Overall: 4.42E+02 3.86E+02 4.79E+02 1.19E+02 7.73E+02	9.99E+03 9.77E+03 1.03E+04 9.56E+03 1.05E+04
TB 6	9.33E+01 8.85E+01 1.14E+02 8.00E+01 2.30E+02	2.24E+00 8.12E-01 7.45E+00 2.70E-01 8.74E+00	Sub 1: 1.70E+00 7.65E-01 3.16E+00 6.28E-01 4.95E+00 Sub 2: 7.43E+00 6.53E+00 8.15E+00 4.43E+00 1.60E+01 Sub 3: 3.33E+01 3.10E+01 3.82E+01 3.99E+00 4.81E+01 Overall: 3.19E+01 2.01E+01 3.43E+01 6.28E-01 4.81E+01	2.17E+01 1.60E+01 2.43E+01 1.65E+00 3.62E+01	1.44E+02 1.36E+02 1.50E+02 1.32E+02 3.99E+02

TABLE A1-3e

Five-Number Summaries of Insulation Resistance A, Phase II Terminal Blocks
(Kohms)

TB	Ambient	Peak 1 175°C	95°C	Peak 2 175°C	161°C
7	2.30E+06 2.30E+06 2.55E+06 2.09E+06 2.55E+06	1.01E+02 6.94E+01 1.10E+02 5.48E+01 3.53E+02	8.85E+05 6.57E+05 1.35E+06 2.24E+03 1.44E+06	Sub 1: 5.32E+01 4.99E+01 5.68E+01 4.21E+01 1.34E+02 Sub 2: 6.41E+01 5.63E+01 6.71E+01 4.66E+01 7.13E+01 Overall: 6.34E+01 5.95E+01 6.39E+01 4.21E+01 1.34E+02	6.34E+01 4.58E+01 7.14E+01 3.75E+01 9.26E+01
8	2.29E+06 2.29E+06 2.55E+06 2.09E+06 2.87E+06	6.79E+01 3.82E+01 8.00E+01 2.86E+00 8.54E+02	1.21E+06 1.04E+06 1.53E+06 2.63E+03 1.64E+06	Sub 1: 1.26E+01 1.18E+01 1.31E+01 8.35E+00 4.36E+01 Sub 2: 4.74E+01 2.44E+01 6.17E+01 1.31E+01 7.31E+01 Overall: 1.46E+01 1.36E+01 1.58E+01 8.35E+00 7.31E+01	1.46E+02 1.37E+02 1.50E+02 1.31E+02 1.94E+02
9	3.83E+06 2.09E+06 3.83E+06 2.09E+06 4.60E+06	3.42E+01 3.38E+01 3.49E+01 3.37E+01 1.13E+03	1.00E+05 7.37E+04 1.59E+05 1.93E+04 1.86E+05	Sub 1: 1.83E+01 1.66E+01 1.93E+01 1.61E+01 1.64E+02 Sub 2: 3.48E+01 3.21E+01 3.57E+01 3.09E+01 4.03E+01 Overall: 2.72E+01 2.30E+01 3.09E+01 1.61E+01 1.64E+02	7.23E+01 5.11E+01 8.03E+01 4.74E+01 8.15E+01

TABLE A1-3f

Five-Number Summaries of Insulation Resistance A, Phase II Terminal Blocks
(Kohms)

	95°C	149°C	121°C	105°C	Ambient
TB 7	9.25E+03 6.78E+02 8.68E+04 4.79E+02 8.68E+04	1.17E+02 8.01E+01 1.48E+02 4.98E+01 2.00E+02	Sub 1: 1.25E+02 1.23E+02 1.29E+02 3.15E+01 1.53E+02 Sub 2: 2.47E+02 1.53E+02 4.97E+02 4.15E+01 1.08E+03 Overall: 1.14E+02 7.06E+01 1.28E+02 3.15E+01 1.08E+03	Sub 1: 9.05E+01 8.72E+01 1.07E+02 8.02E+01 2.63E+02 Sub 2: 3.21E+02 1.92E+02 3.95E+02 8.34E+01 5.34E+02 Sub 3: 7.82E+02 5.27E+02 7.82E+02 5.27E+02 7.82E+02 Overall: 1.06E+02 8.85E+01 1.52E+02 8.02E+01 7.82E+02	6.83E+04 6.79E+04 6.95E+04 6.75E+04 7.06E+04
TB 8	4.18E+04 3.49E+04 1.23E+05 1.90E+04 1.23E+05	5.50E+01 4.63E+01 7.46E+01 4.13E+01 8.86E+01	Sub 1: 3.59E+01 3.29E+01 4.13E+01 3.54E+00 5.86E+01 Sub 2: 2.90E+02 2.34E+02 4.72E+02 3.31E+01 5.48E+02 Overall: 3.56E+01 2.35E+01 1.46E+02 3.54E+00 5.48E+02	Sub 1: 3.45E+02 3.45E+02 5.03E+02 1.37E+02 5.03E+02 Sub 2: 1.02E+03 8.91E+02 1.08E+03 7.62E+02 1.10E+03 Sub 3: 1.77E+03 1.58E+03 1.81E+03 5.71E+02 1.97E+03 Sub 4: 5.31E+02 2.67E+02 5.31E+02 2.67E+02 5.31E+02 Overall: 1.24E+03 9.82E+02 1.70E+03 1.37E+02 1.97E+03	5.85E+04 5.75E+04 5.91E+04 5.61E+04 5.94E+04
TB 9	1.21E+04 1.19E+04 1.47E+04 5.06E+03 1.47E+04	4.16E+01 3.11E+01 5.00E+01 2.48E+01 5.55E+01	Sub 1: 3.52E+01 3.43E+01 4.33E+01 1.48E+01 1.19E+02 Sub 2: 8.06E+01 3.35E+01 9.66E+01 1.09E+01 1.28E+02 Overall: 3.31E+01 2.82E+01 3.50E+01 1.09E+01 1.28E+02	Sub 1: 7.05E+01 6.27E+01 7.80E+01 5.33E+01 8.46E+01 Sub 2: 1.54E+02 1.45E+02 1.69E+02 8.28E+01 1.86E+02 Sub 3: 4.20E+01 3.14E+01 4.20E+01 3.14E+01 4.20E+01 Overall: 8.10E+01 6.96E+01 1.42E+02 3.14E+01 1.86E+02	2.21E+04 2.13E+04 2.24E+04 2.04E+04 2.25E+04

TABLE A1-3g

Five-Number Summaries of Insulation Resistance A, Phase II Terminal Blocks
(Kohms)

TB	Ambient	Peak 1 175°C	95°C	Peak 2 175°C	161°C
10	2.08E+06 2.08E+06 2.29E+06 2.08E+06 2.29E+06	2.84E+01 2.63E+01 2.88E+01 2.49E+01 1.68E+03	8.12E+04 7.65E+04 1.07E+05 2.83E+04 1.13E+05	Sub 1: 1.94E+01 1.84E+01 2.10E+01 1.74E+01 2.47E+02 Sub 2: 5.78E+01 4.64E+01 6.06E+01 4.33E+01 6.51E+01 Overall: 2.86E+01 2.35E+01 3.18E+01 1.74E+01 2.47E+02	1.60E+02 1.01E+02 1.12E+02 1.01E+02 1.22E+02
11	3.51E+04 2.07E+04 6.68E+04 1.61E+04 6.71E+04	1.33E+01 1.14E+01 1.40E+01 1.10E+01 3.23E+03	1.14E+05 1.11E+05 2.21E+05 1.11E+04 2.24E+05	Sub 1: 8.46E+00 8.40E+00 8.93E+00 8.19E+00 6.65E+01 Sub 2: 2.40E+01 2.05E+01 2.64E+01 1.86E+01 2.98E+01 Overall: 1.12E+01 9.69E+00 1.28E+01 8.19E+00 6.65E+01	5.45E+01 5.23E+01 6.61E+01 4.78E+01 8.61E+01
12	2.56E+06 2.31E+06 2.56E+06 2.31E+06 2.88E+06	2.21E+01 2.18E+01 2.27E+01 2.17E+01 7.44E+02	2.35E+04 1.75E+04 3.17E+04 1.86E+02 4.03E+04	Sub 1: 1.50E+00 1.43E+00 1.56E+00 1.34E+00 5.46E+00 Sub 2: 3.27E+00 1.72E+00 3.73E+00 1.36E+00 4.90E+00 Overall: 2.44E+00 1.97E+00 2.58E+00 1.34E+00 5.46E+00	1.70E+01 1.66E+01 1.73E+01 1.62E+01 1.92E+01

TABLE A1-3h

Five-Number Summaries of Insulation Resistance A, Phase II Terminal Blocks
(Kohms)

	95°C	149°C	121°C	105°C	Ambient
TB 10	2.86E+04 2.21E+04 5.81E+04 2.05E+04 5.81E+04	7.86E+01 5.02E+01 8.68E+01 3.87E+01 9.37E+01	Sub 1: 4.31E+02 3.71E+02 7.84E+02 8.73E+01 5.89E+03 Sub 2: 2.28E+02 2.04E+02 2.50E+02 1.30E+02 3.10E+03 Overall: 2.20E+02 1.86E+02 2.46E+02 8.73E+01 5.89E+03	Sub 1: 1.01E+02 9.05E+01 1.06E+02 8.41E+01 1.08E+02 Sub 2: 3.55E+02 3.27E+02 3.82E+02 1.89E+02 4.10E+02 Sub 3: 2.21E+02 1.53E+02 2.21E+02 1.53E+01 2.21E+02 Overall: 3.15E+02 1.53E+02 3.41E+02 8.41E+01 4.10E+02	4.71E+04 4.53E+04 4.75E+04 4.29E+04 4.76E+04
TB 11	3.14E+04 2.44E+04 1.09E+05 4.60E+03 1.09E+05	3.04E+01 2.49E+01 3.13E+01 2.30E+01 9.07E+01	Sub 1: 4.87E+01 4.59E+01 5.32E+01 2.20E+01 1.12E+02 Sub 2: 8.55E+01 7.52E+01 1.36E+02 3.07E+01 2.04E+02 Overall: 4.85E+01 3.89E+01 6.97E+01 2.20E+01 2.04E+02	Sub 1: 4.61E+01 4.30E+01 5.92E+01 3.56E+01 2.95E+02 Sub 2: 4.87E+01 4.14E+01 4.87E+01 4.14E+01 4.87E+01 Overall: 4.61E+01 4.28E+01 5.32E+01 3.56E+01 2.95E+02	1.22E+04 1.20E+04 1.23E+04 1.12E+04 1.26E+04
TB 12	9.47E+02 8.76E+02 2.24E+03 7.67E+02 2.24E+03	9.06E-02 6.17E-02 1.76E-01 4.71E-02 7.55E+00	Sub 1: 2.57E-01 2.49E-01 2.63E-01 1.03E-01 2.88E-01 Sub 2: 2.10E+00 1.72E+00 1.16E+01 1.36E+00 1.79E+01 Overall: 2.57E-01 2.39E-01 1.48E+00 1.03E-01 1.79E+01	Sub 1: 6.93E+00 4.52E+00 9.38E+00 3.94E+00 1.02E+01 Sub 2: 2.73E+01 2.67E+01 2.78E+01 2.61E+01 3.01E+01 Overall: 9.87E+00 7.45E+00 2.65E+01 3.94E+00 3.01E+01	8.48E+02 8.44E+02 8.54E+02 8.34E+02 8.79E+02

TABLE A1-4a

Five-Number Summaries of Insulation Resistance B, Phase II Terminal Blocks
(Kohms)

TB	Ambient	Peak 1 175°C	95°C	Peak 2 175°C	161°C
TB 1				Sub 1:	
	4.35E+05	1.23E+02	1.00E+05	1.26E+01	1.75E+02
	4.35E+05 6.52E+05	9.84E+00 2.39E+02	5.93E+04 1.30E+05	9.72E+00 1.45E+01	1.56E+02 2.01E+02
	4.34E+05 6.52E+05	2.69E+00 1.76E+04	3.69E+03 1.45E+05	1.72E+00 3.81E+01	1.29E+02 2.01E+02
				Sub 2:	
				1.94E+01	
				7.03E+00 2.42E+01	
				5.11E+00 7.31E+01	
				Overall:	
				2.12E+01	
				1.47E+01 2.39E+01	
				1.72E+00 7.31E+01	
TB 2				Sub 1:	
	4.35E+05	4.48E+01	1.09E+05	2.96E+01	1.99E+02
	4.35E+05 6.52E+05	4.16E+01 5.48E+01	9.31E+04 1.45E+05	2.80E+01 3.29E+01	1.86E+02 2.59E+02
	3.26E+05 6.52E+05	4.07E+01 1.86E+03	4.35E+04 1.86E+05	2.52E+01 1.83E+02	1.79E+02 2.59E+02
				Sub 2:	
				1.14E+02	
				8.31E+01 1.23E+02	
				7.50E+01 1.41E+02	
				Overall:	
				8.95E+01	
				3.46E+01 9.86E+01	
				2.52E+01 1.83E+02	
TB 3				Sub 1:	
	4.34E+05	7.13E+01	6.85E+04	5.30E+01	2.41E+02
	4.34E+05 6.51E+05	6.53E+01 7.98E+01	5.92E+04 8.14E+04	5.04E+01 5.48E+01	2.27E+02 3.68E+02
	4.34E+05 6.51E+05	6.12E+01 3.16E+03	2.03E+04 8.68E+04	4.25E+01 6.72E+02	2.20E+02 3.68E+02
				Sub 2:	
				1.39E+02	
				1.16E+02 1.48E+02	
				1.10E+02 1.78E+02	
				Overall:	
				1.20E+02	
				5.65E+01 1.34E+02	
				4.25E+01 6.72E+02	

TABLE A1-4b

Five-Number Summaries of Insulation Resistance B, Phase II Terminal Blocks
(Kohms)

TB	95°C	149°C	121°C	105°C	Ambient
1	2.46E+02 1.90E+02 2.75E+02 1.50E+02 9.65E+02	6.79E+00 1.20E+00 1.75E+01 6.11E-01 7.11E+01			
2	3.10E+04 2.90E+04 3.83E+04 2.51E+04 4.07E+04	1.73E+02 1.58E+02 1.77E+02 6.72E+01 1.92E+02	Sub 1: 4.61E+02 4.51E+02 4.73E+02 4.01E+02 5.59E+02 Sub 2: 6.10E+02 5.59E+02 6.50E+02 2.71E+02 7.10F+02 Overall: 5.62E+02 4.73E+02 6.17E+02 2.71E+02 7.10E+02	1.10E+03 1.01E+03 1.18E+03 2.22E+02 1.22E+03	3.43E+04 3.18E+04 3.52E+04 3.10E+04 3.62E+04
3	2.96E+04 1.67E+04 3.03E+04 1.43E+04 3.62E+04	1.57E+02 1.20E+02 1.93E+02 7.62E+01 2.27E+02	Sub 1: 5.35E+02 5.27E+02 5.43E+02 4.74E+02 9.38E+02 Sub 2: 8.19E+02 6.47E+02 9.72E+02 2.35E+02 1.27E+03 Overall: 6.67E+02 5.39E+02 8.49E+02 2.35E+02 1.27E+03	Sub 1: 5.58E+02 4.90E+02 6.26E+02 4.73E+02 6.65E+02 Sub 2: 9.93E+02 9.16E+02 1.04E+03 2.43E+02 1.13E+03 Overall: 6.65E+02 5.72E+02 9.49E+02 2.43E+02 1.13E+03	8.66E+04 4.81E+04 8.66E+04 4.64E+04 9.28E+04

TABLE A1-4c

Five-Number Summaries of Insulation Resistance B, Phase II Terminal Blocks
(Kohms)

	Ambient	Peak 1 175°C	95°C	Peak 2 175°C	161°C
TB 4	6.51E+05 4.34E+05 1.30E+06 4.34E+05 1.30E+06	3.52E+01 3.43E+01 3.59E+01 3.41E+01 3.08E+03	3.26E+04 3.10E+04 3.95E+04 1.04E+04 4.65E+04	Sub 1: 2.70E+01 2.57E+01 2.79E+01 2.14E+01 2.21E+02 Sub 2: 1.04E+02 7.62E+01 1.12E+02 6.85E+01 1.53E+02 Overall: 7.27E+01 3.18E+01 8.66E+01 2.14E+01 2.21E+02	1.77E+02 1.75E+02 2.24E+02 1.71E+02 2.24E+02
TB 5	3.26E+05 3.26E+05 4.34E+05 3.26E+05 4.34E+05	2.78E+01 7.55E+00 4.19E+01 3.03E+00 2.27E+03	2.87E+02 2.86E+02 3.27E+02 2.65E+02 3.47E+02	Sub 1: 3.96E+01 3.78E+01 4.21E+01 8.96E-01 4.47E+01 Sub 2: 4.30E+01 3.37E+01 4.56E+01 1.72E+01 5.41E+01 Overall: 4.71E+01 4.37E+01 4.83E+01 8.96E-01 5.41E+01	5.06E+01 4.83E+01 8.55E+01 4.30E+01 8.55E+01
TB 6	4.34E+05 3.26E+05 4.34E+05 3.26E+05 4.34E+05	2.84E+01 1.56E+01 3.87E+01 9.18E+00 1.37E+04	4.51E+03 3.75E+03 5.63E+03 8.59E+01 6.91E+03	Sub 1: 7.25E-01 5.72E-01 2.74E+00 3.68E-01 8.67E+00 Sub 2: 2.40E+00 1.41E+00 3.03E+00 4.73E-01 4.65E+00 Overall: 3.59E+00 2.94E+00 4.13E+00 3.68E-01 8.67E+00	1.95E+00 1.94E+00 4.83E+00 1.14E+00 4.83E+00

TABLE A1-4d

Five-Number Summaries of Insulation Resistance B, Phase II Terminal Blocks
(Kohms)

	95°C	149°C	121°C	105°C	Ambient
TB 4	1.51E+04 1.36E+04 2.33E+04 1.36E+04 3.95E+04	1.35E+02 9.76E+01 1.96E+02 6.37E+01 2.26E+02	Sub 1: 3.09E+02 2.96E+02 3.28E+02 2.03E+02 3.62E+02 Sub 2: 5.25E+02 4.75E+02 5.79E+02 1.51E+02 6.33E+02 Overall: 4.76E+02 3.38E+02 5.32E+02 1.51E+02 6.33E+02	Sub 1: 2.38E+02 1.61E+02 3.63E+02 1.39E+02 4.18E+02 Sub 2: 9.57E+02 8.80E+02 1.00E+03 2.41E+02 1.05E+03 Overall: 4.18E+02 2.67E+02 8.89E+02 1.39E+02 1.05E+03	5.20E+04 5.20E+04 5.42E+04 4.81E+04 5.42E+04
TB 5	6.40E+02 5.71E+02 9.78E+02 3.64E+02 2.60E+03	6.05E+01 5.47E+01 6.47E+01 1.45E+01 6.67E+01	Sub 1: 7.76E+01 5.01E+01 1.08E+02 2.26E+01 1.54E+02 Sub 2: 1.79E+01 1.25E+01 2.38E+01 1.09E+01 2.75E+01 Sub 3: 1.41E+02 1.07E+02 1.80E+02 4.01E+01 2.58E+02 Overall: 1.18E+02 7.08E+01 1.56E+02 1.09E+01 2.58E+02	Sub 1: 9.90E+01 8.54E+01 1.34E+02 6.72E+01 1.67E+02 Sub 2: 3.26E+02 2.72E+02 3.13E+02 6.49E+01 3.91E+02 Overall: 2.61E+02 1.43E+02 3.13E+02 6.49E+01 3.91E+02	6.96E+03 6.85E+03 7.36E+03 6.78E+03 7.36E+03
TB 6	4.30E+01 2.43E+01 5.50E+01 1.62E+01 7.68E+01	5.46E-01 3.36E-01 3.20E+00 2.32E-01 4.71E+00	Sub 1: 3.30E-01 2.50E-01 4.09E-01 1.43E-01 4.34E-01 Sub 2: 8.10E-01 5.30E-01 1.04E+00 4.04E-01 3.70E+00 Sub 3: 1.70E+01 1.37E+01 2.34E+01 1.72E-01 2.94E+01 Overall: 1.46E+01 9.54E+00 2.03E+01 1.43E-01 2.94E+01	1.15E+01 8.67E+00 1.76E+01 7.08E-02 3.22E+01	1.05E+02 1.00E+02 1.22E+02 9.35E+01 9.15E+02

TABLE A1-4e

Five-Number Summaries of Insulation Resistance B, Phase II Terminal Blocks
(Kohms)

TB	Ambient	Peak 1 175°C	95°C	Peak 2 175°C	161°C
TB 7	5.70E+06 5.70E+06 7.60E+06 5.70E+06 1.14E+07	8.01E+01 6.96E+01 8.79E+01 5.49E+01 4.34E+02	5.71E+06 5.71E+06 7.61E+06 9.53E+03 7.61E+06	Sub 1: 2.97E+01 2.90E+01 3.10E+01 2.59E+01 6.47E+01 Sub 2: 3.80E+01 3.15E+01 4.05E+01 2.57E+01 4.52E+01 Overall: 3.62E+01 3.30E+01 3.80E+01 2.57E+01 6.47E+01	5.02E+01 4.32E+01 6.21E+01 2.32E+01 6.54E+01
TB 8	7.67E+06 5.75E+06 7.67E+06 5.75E+06 2.30E+07	1.04E+02 5.53E+01 1.23E+02 8.05E+00 8.60E+02	1.77E+06 1.35E+06 3.29E+06 1.25E+03 5.76E+06	Sub 1: 1.32E+01 1.22E+01 1.41E+01 9.33E+00 2.23E+01 Sub 2: 1.67E+01 8.39E+00 2.16E+01 6.29E+00 2.66E+01 Overall: 1.53E+01 1.41E+01 1.69E+01 6.29E+00 2.66E+01	6.72E+01 5.22E+01 6.82E+01 4.72E+01 7.46E+01
TB 9	7.68E+06 5.76E+06 7.68E+06 5.76E+06 1.15E+07	3.02E+01 2.98E+01 3.11E+01 2.97E+01 1.12E+03	1.52E+05 1.47E+05 2.48E+05 4.04E+04 2.56E+05	Sub 1: 2.16E+01 2.14E+01 2.19E+01 2.08E+01 1.58E+02 Sub 2: 3.41E+01 3.23E+01 3.67E+01 3.06E+01 4.00E+01 Overall: 3.06E+01 2.67E+01 3.19E+01 2.08E+01 1.58E+02	8.60E+01 8.24E+01 1.07E+02 8.14E+01 1.16E+02

TABLE A1-4f

Five-Number Summaries of Insulation Resistance B, Phase II Terminal Blocks
(Kohms)

	95°C	149°C	121°C	105°C	Ambient
TB 7	2.15E+03 1.78E+03 5.97E+03 6.92E+02 5.97E+03	1.03E+02 5.92E+01 1.10E+02 2.97E+01 1.15E+02	Sub 1: 1.06E+03 8.06E+02 1.17E+03 3.37E+01 1.51E+03 Sub 2: 8.19E+02 4.78E+02 1.28E+03 1.32E+02 3.62E+03 Overall: 5.34E+02 2.84E+02 7.42E+02 3.37E+01 3.62E+03	Sub 1: 3.46E+03 2.90E+03 3.92E+03 2.26E+03 4.28E+03 Sub 2: 4.36E+03 2.72E+03 6.07E+03 2.59E+02 7.34E+03 Sub 3: 5.88E+03 4.44E+03 5.88E+03 4.44E+03 5.88E+03 Overall: 3.02E+03 2.53E+03 3.70E+03 2.59E+02 7.34E+03	2.75E+04 2.73E+04 2.76E+04 2.67E+04 2.81E+04
TB 8	1.91E+04 1.11E+04 4.86E+04 8.86E+03 4.86E+04	1.82E+01 1.20E+01 3.29E+01 1.01E+01 4.58E+01	Sub 1: 1.69E+01 1.29E+01 2.09E+01 4.07E+00 2.60E+01 Sub 2: 9.84E+01 8.54E+01 1.12E+02 1.73E+01 1.42E+02 Overall: 1.69E+01 9.24E+00 6.17E+01 4.07E+00 1.42E+02	Sub 1: 4.72E+01 4.72E+01 7.07E+01 1.53E+01 7.07E+01 Sub 2: 3.97E+02 2.80E+02 4.30E+02 1.98E+02 4.44E+02 Sub 3: 6.05E+02 4.38E+02 1.15E+03 2.80E+02 1.25E+03 Sub 4: 7.16E+02 5.64E+02 7.16E+02 5.64E+02 7.16E+02 Overall: 4.30E+02 3.86E+02 5.13E+02 1.53E+01 1.25E+03	1.49E+04 1.47E+04 1.50E+04 1.45E+04 1.53E+04
TB 9	2.62E+04 2.48E+04 3.22E+04 2.12E+04 3.22E+04	5.07E+01 3.07E+01 5.58E+01 2.70E+01 6.01E+01	Sub 1: 1.31E+02 1.22E+02 1.42E+02 3.60E+01 2.42E+02 Sub 2: 1.26E+02 6.91E+01 1.43E+02 3.20E+01 8.54E+02 Overall: 7.40E+01 6.00E+01 1.13E+02 3.20E+01 8.54E+02	Sub 1: 9.53E+01 8.32E+01 1.05E+02 6.64E+01 1.14E+02 Sub 2: 2.49E+02 2.39E+02 2.59E+02 1.15E+02 2.92E+02 Sub 3: 5.51E+01 4.44E+01 5.51E+01 4.44E+01 5.51E+01 Overall: 1.09E+02 9.36E+01 2.33E+02 4.44E+01 2.92E+02	2.00E+04 1.94E+04 2.03E+04 1.86E+04 2.03E+04

TABLE A1-4g

Five-Number Summaries of Insulation Resistance B, Phase II Terminal Blocks
(Kohms)

	Ambient	Peak 1 175°C	95°C	Peak 2 175°C	161°C
TB				Sub 1:	
10	5.71E+06	3.39E+01	8.17E+04	2.35E+01	1.13E+02
	4.57E+06 5.71E+06	3.30E+01 3.46E+01	7.99E+04 9.18E+04	2.15E+01 2.48E+01	1.03E+02 1.22E+02
	4.57E+06 5.71E+06	3.19E+01 1.90E+03	2.47E+04 1.01E+05	2.06E+01 2.41E+02	1.03E+02 1.36E+02
				Sub 2:	
				6.18E+01	
				5.14E+01 6.38E+01	
				4.77E+01 7.80E+01	
				Overall:	
				3.19E+01	
				2.63E+01 3.78E+01	
				2.06E+01 2.41E+02	
TB 11	NO B PATH ON TERMINAL BLOCK 11				
TB				Sub 1:	
12	5.71E+06	3.06E+01	2.67E+03	2.18E+00	3.78E+01
	5.71E+06 7.62E+06	3.02E+01 3.11E+01	2.50E+03 3.68E+03	2.16E+00 2.20E+00	3.24E+01 4.02E+01
	5.71E+06 7.62E+06	3.01E+01 5.79E+02	9.03E+01 4.28E+03	2.14E+00 1.18E+01	3.21E+01 4.88E+01
				Sub 2:	
				1.61E+01	
				1.10E+01 2.04E+01	
				1.00E+01 2.40E+01	
				Overall:	
				2.40E+00	
				2.23E+00 2.52E+00	
				2.14E+00 2.40E+01	

TABLE A1-4h

Five-Number Summaries of Insulation Resistance B, Phase II Terminal Blocks
(Kohms)

	95°C	149°C	121°C	105°C	Ambient
TB 10	2.42E+04 2.29E+04 8.93E+04 2.01E+04 8.93E+04	8.65E+01 4.48E+01 1.01E+02 3.34E+01 1.11E+02	Sub 1: 5.05E+02 3.85E+02 7.83E+02 9.43E+01 1.60E+03 Sub 2: 2.81E+02 2.53E+02 3.23E+02 2.06E+02 1.02E+03 Overall: 2.73E+02 2.41E+02 3.06E+02 9.43E+01 1.60E+03	Sub 1: 1.58E+02 1.45E+02 1.67E+02 1.36E+02 1.72E+02 Sub 2: 6.46E+02 5.85E+02 6.88E+02 4.18E+02 7.27E+02 Sub 3: 2.62E+02 1.80E+02 2.62E+02 1.80E+02 2.62E+02 Overall: 5.68E+02 1.80E+02 6.41E+02 1.36E+02 7.27E+02	7.10E+04 6.89E+04 7.24E+04 6.67E+04 7.31E+04
TB 11	NO B PATH ON TERMINAL BLOCK 11				
TB 12	9.75E+03 9.37E+03 2.46E+04 3.28E+03 2.46E+04	3.57E+01 2.26E+01 3.83E+01 1.13E+01 4.64E+01	Sub 1: 1.17E+02 9.95E+01 1.27E+02 8.06E+01 2.87E+02 Sub 2: 7.48E+01 6.89E+01 7.84E+01 4.51E+01 8.54E+01 Overall: 7.53E+01 6.96E+01 8.02E+01 4.51E+01 2.87E+02	Sub 1: 5.57E+01 4.50E+01 6.09E+01 3.77E+01 6.36E+01 Sub 2: 1.04E+02 9.90E+01 1.06E+02 9.17E+01 1.10E+02 Overall: 6.23E+01 5.65E+01 9.75E+01 3.77E+01 1.10E+02	1.41E+03 1.40E+03 1.41E+03 1.37E+03 1.41E+03

TABLE A1-5a

Five-Number Summaries of Insulation Resistance G, Phase II Terminal Blocks
(Kohms)

TB	Ambient	Peak 1 175°C	95°C	Peak 2 175°C	161°C
1	4.34E+05 3.26E+05 4.35E+05 3.26E+05 4.35E+05	1.98E+02 3.52E+00 3.56E+02 4.59E-01 8.65E+02	2.29E+04 1.63E+04 3.95E+04 2.72E+03 4.83E+04	Sub 1: 9.87E+00 9.00E+00 1.08E+01 2.17E+00 5.98E+01 Sub 2: 3.79E+01 1.63E+01 4.87E+01 1.03E+01 9.77E+01 Overall: 1.77E+01 1.14E+01 2.01E+01 2.17E+00 9.77E+01	1.45E+02 1.43E+02 2.11E+02 1.37E+02 2.11E+02
2	4.35E+05 4.35E+05 6.52E+05 3.26E+05 6.52E+05	1.22E+02 1.16E+02 1.67E+02 7.22E+01 4.34E+04	4.66E+04 3.72E+04 5.93E+04 2.25E+04 6.52E+04	Sub 1: 8.06E+01 7.68E+01 9.31E+01 3.60E+01 1.78E+04 Sub 2: 6.97E+01 6.54E+01 7.35E+01 6.47E+01 1.33E+02 Overall: 8.48E+01 7.51E+01 9.64E+01 3.60E+01 1.78E+04	1.18E+02 1.05E+02 1.39E+02 9.90E+01 1.39E+02
3	6.51E+05 4.34E+05 6.51E+05 4.34E+05 6.51E+05	6.27E+01 5.89E+01 6.65E+01 5.51E+01 7.25E+02	2.17E+05 1.86E+05 2.60E+05 6.51E+04 6.51E+05	Sub 1: 5.09E+01 4.45E+01 5.38E+01 3.05E+01 2.39E+02 Sub 2: 7.01E+01 5.82E+01 7.49E+01 5.54E+01 8.09E+01 Overall: 7.07E+01 5.57E+01 7.29E+01 3.05E+01 2.39E+02	1.94E+02 1.88E+02 2.45E+02 1.66E+02 2.45E+02

TABLE A1-5b

Five-Number Summaries of Insulation Resistance G, Phase II Terminal Blocks
(Kohms)

	95°C	149°C	121°C	105°C	Ambient
TB 1	1.22E+03 1.09E+03 2.14E+03 1.05E+03 1.21E+04	2.98E+01 3.27E+00 4.37E+01 1.28E+00 1.04E+02			
TB 2	1.42E+03 1.36E+03 1.54E+03 1.35E+03 1.94E+03	8.25E+01 7.74E+01 9.03E+01 7.48E+01 1.14E+02	Sub 1: 5.22E+01 4.19E+01 5.79E+01 3.37E+01 7.47E+01 Sub 2: 1.56E+02 1.18E+02 1.84E+02 5.09E+01 2.51E+02 Overall: 1.19E+02 6.46E+01 1.64E+02 3.37E+01 2.51E+02	2.74E+02 2.35E+02 2.88E+02 1.32E+02 3.40E+02	6.50E+02 6.41E+02 6.52E+02 6.33E+02 6.54E+02
TB 3	6.68E+03 5.66E+03 9.86E+03 5.13E+03 1.34E+04	9.43E+01 7.15E+01 1.09E+02 5.04E+01 1.22E+02	Sub 1: 2.04E+02 2.01E+02 2.11E+02 1.78E+02 2.41E+02 Sub 2: 2.21E+02 2.10E+02 2.29E+02 1.37E+02 3.01E+02 Overall: 2.13E+02 2.03E+02 2.23E+02 1.37E+02 3.01E+02	Sub 1: 2.56E+02 2.28E+02 2.85E+02 2.22E+02 2.98E+02 Sub 2: 3.47E+02 3.38E+02 3.62E+02 1.43E+02 3.80E+02 Overall: 2.98E+02 2.65E+02 3.38E+02 1.43E+02 3.80E+02	1.01E+04 8.90E+03 1.02E+04 8.84E+03 1.02E+04

TABLE A1-5c

Five-Number Summaries of Insulation Resistance G, Phase II Terminal Blocks (Kohms)

TB	Ambient	Peak 1 175°C	95°C	Peak 2 175°C	161°C
4	1.30E+06 6.51E+05 1.30E+06 6.51E+05 1.30E+06	8.45E+01 7.77E+01 8.76E+01 7.58E+01 2.77E+03	8.14E+04 6.20E+04 1.18E+05 2.21E+04 1.86E+05	Sub 1: 5.26E+01 5.19E+01 5.45E+01 4.51E+01 1.54E+02 Sub 2: 6.96E+01 5.11E+01 9.00E+01 4.69E+01 1.10E+02 Overall: 7.30E+01 5.50E+01 7.48E+01 4.51E+01 1.54E+02	1.46E+02 1.45E+02 1.49E+02 1.37E+02 1.49E+02
5	6.58E+05 6.58E+05 6.58E+05 4.39E+05 6.58E+05	1.36E+01 1.08E+01 2.11E+01 7.83E+00 3.83E+02	1.03E+04 1.02E+04 1.07E+04 8.25E+03 1.27E+04	Sub 1: 7.59E+00 7.00E+00 7.78E+00 3.98E+00 1.02E+01 Sub 2: 6.69E+00 6.[illegible]2E+00 6.78E+00 5.94E+00 7.09E+00 Overall: 7.10E+00 6.81E+00 7.68E+00 3.98E+00 1.02E+01	1.78E+00 1.65E+00 2.05E+00 1.44E+00 2.05E+00
6	4.34E+05 4.34E+05 4.34E+05 3.26E+05 4.34E+05	3.53E+00 3.10E+00 6.60E+00 2.87E+00 6.79E+02	4.19E+02 1.90E+02 1.25E+03 2.55E+01 1.35E+03	Sub 1: 8.87E-01 6.19E-01 1.43E+00 4.58E-01 2.52E+00 Sub 2: 1.82E+00 1.27E+00 2.03E+00 6.04E-01 3.23E+00 Overall: 2.27E+00 1.90E+00 2.55E+00 4.58E-01 3.23E+00	1.96E+00 1.77E+00 2.18E+00 1.37E+00 2.18E+00

TABLE A1-5d

Five-Number Summaries of Insulation Resistance G, Phase II Terminal Blocks
(Kohms)

	95°C	149°C	121°C	105°C	Ambient
TB 4	6.41E+03 5.01E+03 6.41E+03 4.91E+03 9.23E+03	1.25E+02 7.80E+01 1.76E+02 4.66E+01 2.09E+02	Sub 1: 2.91E+02 2.63E+02 3.13E+02 2.04E+02 3.36E+02 Sub 2: 4.94E+02 4.50E+02 5.67E+02 1.87E+02 6.56E+02 Overall: 4.51E+02 3.29E+02 5.01E+02 1.87E+02 6.56E+02	Sub 1: 4.45E+02 2.94E+02 6.70E+02 2.52E+02 7.34E+02 Sub 2: 1.08E+03 1.01E+03 1.14E+03 4.08E+02 1.20E+03 Overall: 7.34E+02 4.87E+02 1.01E+03 2.52E+02 1.20E+03	7.64E+04 7.22E+04 8.12E+04 7.22E+04 8.12E+04
TB 5	1.60E+02 1.33E+02 1.92E+02 1.12E+02 2.73E+02	1.49E+00 1.41E+00 3.66E+00 1.08E+00 5.13E+00	Sub 1: 1.30E+00 1.19E+00 1.54E+00 9.62E-01 1.68E+00 Sub 2: 1.10E+00 1.03E+00 1.19E+00 9.70E-01 3.41E+00 Sub 3: 2.11E+01 1.90E+01 2.19E+01 7.25E+00 2.49E+01 Overall: 2.01E+01 1.24E+01 2.15E+01 9.62E-01 2.49E+01	Sub 1: 2.87E+01 2.74E+01 3.23E+01 2.31E+01 3.47E+01 Sub 2: 2.74E+01 2.56E+01 2.87E+01 1.36E+01 3.15E+01 Overall: 2.74E+01 2.51E+01 2.85E+01 1.36E+01 3.47E+01	2.86E+02 2.74E+02 3.06E+02 2.45E+02 3.31E+02
TB 6	5.09E+01 2.84E+01 5.30E+01 1.34E+01 6.82E+01	9.10E-01 5.08E-01 2.46E+00 3.06E-01 2.80E+00	Sub 1: 2.97E-01 2.61E-01 3.12E-01 1.27E-01 6.57E-01 Sub 2: 6.68E-01 4.78E-01 7.36E-01 3.45E-01 2.75E+00 Sub 3: 1.96E+01 1.68E+01 2.27E+01 1.27E+00 2.98E+01 Overall: 1.81E+01 9.03E+00 2.07E+01 1.27E-01 2.98E+01	1.56E+01 1.38E+01 1.67E+01 6.73E-01 2.23E+01	1.47E+02 1.44E+02 1.61E+02 7.46E+01 1.86E+03

TABLE A1-5e

Five-Number Summaries of Insulation Resistance G, Phase II Terminal Blocks
(Kohms)

	Ambient	Peak 1 175°C	95°C	Peak 2 175°C	161°C
TB 7	7.66E+06 7.66E+06 1.15E+07 3.28E+06 1.15E+07	4.04E+01 3.48E+01 4.09E+01 1.28E+01 9.94E+02	8.98E+03 6.81E+03 1.50E+04 7.99E+02 1.84E+04	Sub 1: 1.08E+01 1.01E+01 1.27E+01 9.54E+00 2.01E+01 Sub 2: 1.30E+01 1.07E+01 1.34E+01 7.90E+00 1.58E+01 Overall: 1.33E+01 1.26E+01 1.38E+01 7.90E+00 2.01E+01	2.33E+01 2.15E+01 2.37E+01 1.82E+01 2.80E+01
TB 8	2.30E+07 1.15E+07 2.30E+07 5.75E+06 2.30E+07	9.93E+01 1.17E+01 1.14E+02 2.34E+00 6.25E+02	5.76E+06 4.60E+06 5.76E+06 2.97E+03 1.15E+07	Sub 1: 8.52E+00 7.68E+00 8.93E+00 5.84E+00 1.99E+01 Sub 2: 2.02E+01 1.17E+01 2.70E+01 6.44E+00 3.42E+01 Overall: 1.23E+01 1.04E+01 1.28E+01 5.84E+00 3.42E+01	4.37E+01 4.33E+01 4.61E+01 4.26E+01 4.90E+01
TB 9	2.30E+07 2.30E+07 2.30E+07 2.30E+07 2.30E+07	5.92E+01 5.66E+01 6.08E+01 5.58E+01 1.96E+03	2.23E+05 1.83E+05 3.83E+05 3.72E+04 4.89E+05	Sub 1: 2.40E+01 2.27E+01 2.58E+01 2.21E+01 2.26E+02 Sub 2: 4.00E+01 3.81E+01 4.15E+01 3.38E+01 4.46E+01 Overall: 3.67E+01 3.30E+01 3.81E+01 2.21E+01 2.26E+02	1.11E+02 9.28E+01 1.19E+02 9.28E+01 1.26E+02

TABLE A1-5f

Five-Number Summaries of Insulation Resistance G, Phase II Terminal Blocks
(Kohms)

	95°C	149°C	121°C	105°C	Ambient
TB 7	4.73E+02 4.56E+02 6.52E+02 4.42E+02 6.52E+02	1.57E+01 1.54E+01 1.61E+01 1.41E+01 1.77E+01	Sub 1: 1.56E+01 1.48E+01 1.76E+01 8.00E+00 4.72E+01 Sub 2: 3.73E+01 2.39E+01 4.14E+01 1.08E+01 5.23E+01 Overall: 1.53E+01 1.38E+01 2.10E+01 8.00E+00 5.23E+01	Sub 1: 1.58E+02 1.38E+02 1.80E+02 8.97E+01 1.97E+02 Sub 2: 6.52E+01 6.13E+01 6.77E+01 2.74E+01 7.28E+01 Sub 3: 4.73E+01 3.73E+01 4.73E+01 3.73E+01 4.73E+01 Overall: 6.48E+01 5.89E+01 6.77E+01 2.74E+01 1.97E+02	1.99E+02 1.95E+02 2.00E+02 1.93E+02 2.01E+02
TB 8	3.17E+04 1.99E+04 9.67E+04 1.69E+04 9.67E+04	3.52E+01 2.93E+01 4.59E+01 2.68E+01 4.88E+01	Sub 1: 2.21E+01 1.91E+01 2.48E+01 3.77E+00 3.09E+01 Sub 2: 2.34E+02 1.73E+02 3.05E+02 2.13E+01 3.50E+02 Overall: 2.18E+01 1.46E+01 7.61E+01 3.77E+00 3.50E+02	Sub 1: 2.14E+02 2.14E+02 2.73E+02 7.57E+01 2.73E+02 Sub 2: 7.65E+02 6.35E+02 8.16E+02 5.23E+02 8.31E+02 Sub 3: 1.18E+03 9.88E+02 1.40E+03 4.58E+02 1.49E+03 Sub 4: 8.33E+02 5.58E+02 8.33E+02 5.59E+02 8.33E+02 Overall: 8.60E+02 7.36E+02 1.09E+03 7.57E+01 1.49E+03	5.06E+05 4.46E+05 7.12E+05 3.35E+05 2.85E+06
TB 9	2.24E+04 2.21E+04 3.60E+04 1.54E+04 3.60E+04	5.95E+01 4.44E+01 6.38E+01 4.03E+01 9.97E+01	Sub 1: 1.97E+02 1.86E+02 2.18E+02 1.11E+02 3.17E+02 Sub 2: 1.63E+02 1.18E+02 1.98E+02 6.77E+01 2.27E+02 Overall: 1.37E+02 1.15E+02 1.71E+02 6.77E+01 3.17E+02	Sub 1: 1.45E+02 1.26E+02 1.65E+02 1.03E+02 1.82E+02 Sub 2: 3.98E+02 3.91E+02 4.09E+02 2.03E+02 5.20E+02 Sub 3: 8.78E+01 6.41E+01 8.78E+01 6.41E+01 8.78E+01 Overall: 1.72E+02 1.42E+02 3.81E+02 6.41E+01 5.20E+02	1.14E+05 1.12E+05 1.14E+05 1.09E+05 1.16E+05

TABLE A1-5g

Five-Number Summaries of Insulation Resistance G, Phase II Terminal Blocks
(Kohms)

	Ambient	Peak 1 175°C	95°C	Peak 2 175°C	161°C
TB				Sub 1:	
10	2.29E+07	6.38E+01	2.64E+05	2.85E+01	1.67E+02
	1.15E+07 2.29E+07	5.91E+01 6.65E+01	2.20E+05 4.25E+05	2.72E+01 3.01E+01	1.64E+02 1.76E+02
	1.15E+07 2.29E+07	5.78E+01 1.57E+03	7.44E+04 4.88E+05	2.54E+01 2.23E+02	1.54E+02 1.90E+92
				Sub 2:	
				9.20E+01	
				7.79E+01 9.44E+01	
				6.27E+01 1.02E+02	
				Overall:	
				3.95E+01	
				3.55E+01 4.18E+01	
				2.54E+01 2.23E+02	
TB				Sub 1:	
11	7.64E+06	2.47E+01	4.34E+04	1.32E+01	6.40E+01
	5.73E+06 7.64E+06	2.17E+01 2.66E+01	4.12E+04 7.01E+04	1.24E+01 1.37E+01	5.49E+01 6.56E+01
	5.73E+06 7.64E+06	2.15E+01 5.88E+05	1.57E+04 7.40E+04	1.12E+01 7.58E+01	5.20E+01 7.68E+01
				Sub 2:	
				2.94E+01	
				2.46E+01 3.12E+01	
				2.01E+01 3.57E+01	
				Overall:	
				1.76E+01	
				1.55E+01 1.93E+01	
				1.12E+01 7.58E+01	
TB				Sub 1:	
12	2.28E+07	1.79E+01	7.63E+03	5.17E+00	2.08E+01
	1.14E+07 2.28E+07	1.77E+01 1.83E+01	7.55E+03 1.21E+04	5.02E+00 5.25E+00	1.84E+01 2.27E+01
	1.14E+07 2.28E+07	1.77E+01 2.13E+02	4.44E+03 1.49E+04	4.91E+00 1.41E+01	1.76E+01 2.46E+01
				Sub 2:	
				7.21E+00	
				6.69E+00 7.79E+00	
				6.19E+00 5.35E+01	
				Overall:	
				6.42E+00	
				5.97E+00 6.55E+00	
				4.91E+00 5.35E+01	

TABLE A1-5h

Five-Number Summaries of Insulation Resistance G, Phase II Terminal Blocks
(Kohms)

TB	95°C	149°C	121°C	105°C	Ambient
10	2.02E+04 1.94E+04 7.64E+05 1.33E+04 7.64E+05	1.20E+02 8.22E+01 1.25E+02 6.28E+01 1.42E+02	Sub 1: 1.96E+03 8.82E+02 5.55E+03 5.63E+01 9.76E+04 Sub 2: 5.75E+02 5.08E+02 6.85E+02 1.54E+02 4.35E+03 Overall: 4.78E+02 2.53E+02 5.66E+02 5.63E+01 9.76E+04	Sub 1: 2.04E+02 1.84E+02 2.18E+02 1.70E+02 2.26E+02 Sub 2: 1.05E+03 8.38E+02 1.16E+03 4.75E+02 1.27E+03 Sub 3: 2.63E+02 1.70E+02 2.63E+02 1.70E+02 2.63E+02 Overall: 8.20E+02 2.26E+02 9.17E+02 1.70E+02 1.27E+03	1.91E+06 1.35E+06 3.28E+06 1.09E+06 7.65E+06
11	1.04E+04 4.41E+03 1.48E+04 3.35E+03 1.48E+04	3.09E+01 2.76E+01 3.41E+01 2.14E+01 4.09E+01	Sub 1: 1.69E+02 1.23E+02 2.51E+02 3.42E+01 1.06E+04 Sub 2: 7.94E+01 7.62E+01 8.41E+01 6.71E+01 1.36E+02 Overall: 7.65E+01 7.00E+01 8.01E+01 3.42E+01 1.06E+04	Sub 1: 3.15E+01 2.97E+01 3.27E+01 2.78E+01 1.22E+02 Sub 2: 5.68E+01 3.80E+01 5.68E+01 3.80E+01 5.68E+01 Overall: 3.17E+01 2.97E+01 3.28E+01 2.78E+01 1.22E+02	1.77E+03 1.58E+03 2.02E+03 1.52E+03 2.37E+03
12	2.24E+03 1.79E+03 3.34E+03 1.50E+03 3.34E+03	7.04E+00 6.03E+00 8.17E+00 5.76E+00 1.39E+01	Sub 1: 2.71E+01 2.65E+01 3.28E+01 2.44E+01 7.99E+01 Sub 2: 2.72E+01 2.42E+01 3.04E+01 1.84E+01 3.53E+01 Overall: 2.56E+01 2.43E+01 2.62E+01 1.84E+01 7.99E+01	Sub 1: 1.69E+01 1.60E+01 1.73E+01 1.53E+01 1.77E+01 Sub 2: 2.91E+01 2.45E+01 3.07E+01 1.86E+01 3.25E+01 Overall: 1.74E+01 1.69E+01 2.07E+01 1.53E+01 3.25E+01	2.11E+03 2.08E+03 2.13E+03 2.06E+03 2.14E+03

TABLE A1-6a

Five-Number Summaries of Leakage Current A, Phase II Terminal Blocks
(mA)

	Ambient	Peak 1 175°C	95°C	Peak 2 175°C	161°C
TB 1	3.88E-04 3.88E-04 4.85E-04 3.88E-04 4.85E-04	4.15E-01 3.02E-01 5.83E-01 5.24E-03 1.57E+01	5.36E-02 2.66E-02 9.42E-02 1.46E-03 1.16E-01	Sub 1: 1.65E+00 9.14E-01 2.58E+00 5.38E-01 5.26E+01 Sub 2: 6.47E-01 5.71E-01 7.32E-01 5.65E-01 3.27E+00 Overall: 1.24E+00 7.99E-01 2.55E+00 5.38E-01 5.26E+01	5.17E-01 4.27E-01 6.84E-01 2.96E-01 6.84E-01
TB 2	3.92E-04 2.94E-04 3.92E-04 2.94E-04 3.92E-04	7.47E-01 3.76E-01 1.09E+00 8.03E-02 3.24E+00	2.16E-03 1.76E-03 2.55E-03 5.88E-04 2.75E-03	Sub 1: 1.09E+00 9.56E-01 1.12E+00 7.63E-01 4.08E+00 Sub 2: 8.07E-01 7.85E-01 8.41E-01 7.51E-01 1.37E+00 Overall: 1.09E+00 9.06E-01 1.13E+00 7.51E-01 4.08E+00	5.38E-01 5.16E-01 5.53E-01 4.15E-01 5.53E-01
TB 3	2.88E-04 1.92E-04 2.88E-04 1.92E-04 2.88E-04	4.27E-01 1.35E-01 5.29E-01 6.48E-02 1.42E+00	3.08E-03 2.31E-03 3.94E-03 1.25E-03 4.81E-03	Sub 1: 7.93E-01 7.32E-01 9.47E-01 1.50E-01 2.89E+00 Sub 2: 6.10E-01 5.62E-01 6.83E-01 5.40E-01 9.08E-01 Overall: 7.94E-01 7.21E-01 9.07E-01 1.50E-01 2.89E+00	3.72E-01 3.53E-01 3.94E-01 2.35E-01 3.94E-01

TABLE A1-6b

Five-Number Summaries of Leakage Current A, Phase II Terminal Blocks
(mA)

TB	95°C	149°C	121°C	105°C	Ambient
1	5.25E-02 4.17E-02 5.98E-02 2.58E-02 7.07E-02	1.08E+00 6.09E-01 2.02E+01 3.37E-01 3.53E+01			
2	3.73E-03 3.43E-03 4.02E-03 2.84E-03 4.41E-03	5.71E-01 5.60E-01 6.10E-01 5.50E-01 1.26E+00	Sub 1: 2.41E-01 2.34E-01 2.48E-01 2.03E-01 2.76E-01 Sub 2: 1.59E-01 1.45E-01 2.00E-01 1.29E-01 3.31E-01 Overall: 1.60E-01 1.46E-01 2.11E-01 1.29E-01 3.31E-01	1.02E-01 9.74E-02 1.59E-01 8.50E-02 4.33E-01	2.94E-03 2.84E-03 3.14E-03 2.65E-03 3.33E-03
3	2.69E-03 2.02E-03 2.98E-03 2.02E-03 3.27E-03	5.97E-01 5.42E-01 8.36E-01 4.88E-01 1.66E+00	Sub 1: 2.52E-01 2.32E-01 2.59E-01 9.04E-02 2.71E-01 Sub 2: 2.59E-01 2.43E-01 2.90E-01 1.62E-01 6.02E-01 Overall: 2.53E-01 2.32E-01 2.65E-01 9.04E-02 6.02E-01	Sub 1: 1.45E-01 1.33E-01 1.61E-01 1.31E-01 1.86E-01 Sub 2: 1.02E-01 9.64E-02 1.21E-01 9.36E-02 3.44E-01 Overall: 1.02E-01 9.64E-02 1.21E-01 9.36E-02 3.44E-01	2.21E-03 1.54E-03 2.21E-03 1.44E-03 2.31E-03

TABLE A1-6c

Five-Number Summaries of Leakage Current A, Phase II Terminal Blocks (mA)

	Ambient	Peak 1 175°C	95°C	Peak 2 175°C	161°C
TB 4	1.92E-04 1.92E-04 2.88E-04 1.92E-04 2.88E-04	1.42E+00 4.09E-02 2.17E+00 9.23E-03 6.84E+00	1.99E-02 1.76E-02 2.50E-02 4.13E-03 2.71E-02	Sub 1: 7.05E+00 6.64E+00 7.22E+00 2.63E+00 1.17E+01 Sub 2: 4.69E+00 4.38E+00 4.85E+00 4.27E+00 1.13E+01 Overall: 7.14E+00 5.88E+00 7.48E+00 2.63E+00 1.17E+01	3.56E+00 3.44E+00 3.69E+00 2.74E+00 3.69E+00
TB 5	3.88E-04 2.91E-04 3.88E-04 2.91E-04 3.88E-04	5.18E-01 1.56E-01 6.03E-01 7.81E-02 3.65E+00	2.14E-03 1.75E-03 2.33E-03 1.26E-03 2.82E-03	Sub 1: 4.37E-01 3.80E-01 7.96E-01 3.05E-01 3.28E+01 Sub 2: 2.73E-01 2.58E-01 3.09E-01 2.38E-01 8.08E-01 Overall: 4.26E-01 3.31E-01 6.12E-01 2.38E-01 3.28E+01	2.77E-01 1.96E-01 2.41E-01 1.40E-01 2.41E-01
TB 6	2.88E-04 2.88E-04 2.88E-04 1.92E-04 2.88E-04	6.59E-01 3.50E-01 8.94E-01 4.73E-02 2.15E+00	3.27E-03 3.17E-03 3.65E-03 2.50E-03 5.96E-03	Sub 1: 9.62E+01 8.11E+00 1.29E+02 2.18E+00 1.57E+02 Sub 2: 9.44E+00 7.74E+00 1.11E+01 7.32E+00 7.64E+01 Overall: 2.45E+01 1.12E+01 1.25E+02 2.18E+00 1.57E+02	1.18E+01 9.69E-00 1.41E+01 6.42E+00 1.41E+01

TABLE A1-6d

Five-Number Summaries of Leakage Current A, Phase II Terminal Blocks
(mA)

	95°C	149°C	121°C	105°C	Ambient
TB 4	1.24E-01 1.06E-01 1.26E-01 8.52E-02 1.30E-01	4.46E+00 3.52E+00 6.95E+00 3.14E+00 1.41E+01	Sub 1: 2.85E+00 2.54E+00 3.47E+00 2.10E+00 4.11E+00 Sub 2: 1.37E+00 1.19E+00 1.76E+00 9.75E-01 3.93E+00 Overall: 1.48E+00 1.19E+00 1.89E+00 9.75E-01 4.11E+00	Sub 1: 4.78E-01 3.89E-01 7.89E-01 3.75E-01 1.17E+00 Sub 2: 7.44E-01 6.83E-01 8.88E-01 6.42E-01 1.95E+00 Overall: 6.73E-01 5.74E-01 6.96E-01 3.75E-01 1.95E+00	1.82E-01 1.81E-01 1.85E-01 1.80E-01 1.87E-01
TB 5	1.36E-03 1.26E-03 1.36E-03 1.07E-03 1.55E-03	6.42E-01 5.29E-01 1.00E+00 4.96E-01 3.08E+00	Sub 1: 1.13E+00 1.03E+00 1.42E+00 5.27E-01 1.63E+00 Sub 2: 1.72E+00 1.54E+00 1.83E+00 1.29E+00 2.09E+00 Sub 3: 2.96E-01 2.35E-01 7.89E-01 1.95E-01 1.76E+00 Overall: 3.07E-01 2.37E-01 8.25E-01 1.95E-01 2.09E+00	Sub 1: 2.79E-01 2.74E-01 3.73E-01 2.66E-01 8.17E-01 Sub 2: 2.67E-01 2.20E-01 2.96E-01 1.64E-01 1.06E+00 Overall: 2.66E-01 2.20E-01 2.87E-01 1.64E-01 1.06E+00	1.27E-02 1.24E-02 1.32E-02 1.21E-02 1.33E-02
TB 6	1.41E+00 1.12E+00 1.44E+00 5.53E-01 1.59E+00	5.33E+01 [illegible].84E+01 1.39E+02 1.43E+01 3.16E+02	Sub 1: 6.87E+01 4.63E+01 1.44E+02 2.47E+01 1.66E+02 Sub 2: 1.68E+01 1.61E+01 1.91E+01 7.83E+00 2.75E+01 Sub 3: 3.80E+00 3.33E+00 4.10E+00 2.64E+00 3.08E+01 Overall: 3.84E+00 3.36E+00 4.33E+00 2.64E+00 1.66E+02	4.65E+00 4.12E+00 5.26E+00 3.50E+00 7.08E+01	8.79E-01 8.74E-01 9.40E-01 3.18E-01 9.63E-01

TABLE A1-6e

Five-Number Summaries of Leakage Current A, Phase II Terminal Blocks
(mA)

TB	Ambient	Peak 1 175°C	95°C	Peak 2 175°C	161°C
7	1.96E-05 1.96E-05 1.96E-05 1.76E-05 2.15E-05	1.74E-01 1.57E-01 1.94E-01 1.26E-01 7.88E-01	9.74E-03 7.90E-03 1.18E-02 3.13E-05 2.01E-02	Sub 1: 4.35E-01 4.01E-01 4.71E-01 3.30E-01 1.01E+00 Sub 2: 6.58E-01 6.35E-01 6.95E-01 6.12E-01 9.21E-01 Overall: 6.42E-01 6.07E-01 6.55E-01 3.30E-01 1.01E+00	8.34E-01 6.11E-01 9.36E-01 4.74E-01 1.13E+00
8	1.97E-05 1.77E-05 1.97E-05 1.57E-05 2.16E-05	2.70E-01 2.04E-01 3.14E-01 5.27E-02 8.79E+00	2.65E-03 2.03E-03 3.58E-03 2.75E-05 1.71E-02	Sub 1: 2.24E+00 1.78E+00 2.29E+00 9.82E-01 4.25E+00 Sub 2: 7.56E-01 6.26E-01 1.11E+00 5.98E-01 2.94E+00 Overall: 2.12E+00 1.00E+00 2.28E+00 5.98E-01 4.25E+00	3.09E-01 2.97E-01 3.24E-01 2.29E-01 3.39E-01
9	1.96E-05 1.17E-05 2.15E-05 9.78E-06 2.15E-05	1.77E-01 9.94E-02 7.14E-01 3.96E-02 1.25E+00	1.64E-03 1.37E-03 2.12E-03 2.43E-04 2.33E-03	Sub 1: 1.02E+00 7.74E-01 1.15E+00 2.70E-01 2.46E+00 Sub 2: 1.20E+00 1.10E+00 1.23E+00 1.06E+00 1.36E+00 Overall: 1.22E+00 1.18E+00 1.24E+00 2.70E-01 2.46E+00	7.17E-01 5.45E-01 8.44E-01 5.37E-01 9.07E-01

TABLE A1-6f

Five-Number Summaries of Leakage Current A, Phase II Terminal Blocks
(mA)

TB	95°C	149°C	121°C	105°C	Ambient
7	6.61E-02 4.86E-03 9.34E-02 5.18E-04 9.34E-02	4.00E-01 3.01E-01 6.35E-01 2.22E-01 8.65E-01	Sub 1: 6.25E-01 4.76E-01 9.28E-01 2.90E-01 1.33E+00 Sub 2: 1.84E-01 9.60E-02 3.00E-01 4.16E-02 1.03E+00 Overall: 2.12E-01 1.08E-01 3.42E-01 4.16E-02 1.33E+00	Sub 1: 4.86E-01 4.13E-01 5.03E-01 1.69E-01 5.46E-01 Sub 2: 1.48E-01 1.16E-01 2.42E-01 8.39E-02 5.26E-01 Sub 3: 8.50E-02 5.74E-02 8.50E-02 5.74E-02 8.50E-02 Overall: 1.44E-01 1.15E-01 2.37E-01 5.74E-02 5.46E-01	6.63E-04 6.55E-04 6.65E-04 6.38E-04 6.67E-04
8	1.29E-03 1.08E-03 2.37E-03 3.68E-04 2.37E-03	8.13E-01 6.63E-01 9.35E-01 4.96E-01 1.03E+00	Sub 1: 2.43E+00 1.80E+00 3.36E+00 7.38E-01 7.56E+00 Sub 2: 1.55E-01 9.44E-02 1.94E-01 8.17E-02 1.26E+00 Overall: 1.63E-01 9.65E-02 2.22E-01 8.17E-02 7.56E+00	Sub 1: 1.12E-01 1.12E-01 3.23E-01 8.89E-02 3.23E-02 Sub 2: 4.20E-02 4.12E-02 4.57E-02 4.06E-02 5.89E-02 Sub 3: 2.54E-02 2.49E-02 2.95E-02 2.28E-02 7.82E-02 Sub 4: 1.67E-01 8.43E-02 1.67E-01 8.43E-02 1.67E-01 Overall: 2.58E-02 2.50E-02 3.09E-02 2.28E-02 3.23E-01	7.65E-04 7.57E-04 7.86E-04 7.51E-04 7.96E-04
9	3.78E-03 3.71E-03 8.90E-03 3.06E-03 8.90E-03	1.15E+00 8.65E-01 1.39E+00 7.80E-01 1.66E+00	Sub 1: 1.42E+00 1.30E+00 1.72E+00 3.70E-01 2.63E+00 Sub 2: 5.70E-01 4.64E-01 1.27E+00 3.45E-01 3.41E+00 Overall: 5.70E-01 4.64E-01 1.16E+00 3.45E-01 3.41E+00	Sub 1: 6.09E-01 5.61E-01 6.93E-01 5.18E-01 8.10E-01 Sub 2: 2.91E-01 2.73E-01 3.07E-01 [illegible]-01 5.30E-01 Sub 3: 1.34E+00 1.02E+00 1.34E+00 1.02E+00 1.34E+00 Overall: 2.92E-01 2.75E-01 3.11E-01 2.39E-01 1.34E+00	2.08E-03 2.02E-03 2.16E-03 2.00E-03 2.21E-03

TABLE A1-6g

Five-Number Summaries of Leakage Current A, Phase II Terminal Blocks (mA)

	Ambient	Peak 1 175°C	95°C	Peak 2 175°C	161°C
TB 10	2.16E-05 2.16E-05 2.16E-05 1.96E-05 2.16E-05	1.87E-01 4.31E-02 6.55E-01 2.67E-02 1.65E+00	1.08E-03 1.02E-03 1.50E-03 3.99E-04 1.59E-03	Sub 1: 8.51E-01 7.78E-01 9.54E-01 1.81E-01 2.28E+00 365 - 589 Sub 2: 7.21E-01 7.06E-01 7.69E-01 6.68E-01 9.86E-01 Overall: 8.59E-01 7.42E-01 9.36E-01 1.81E-01 2.28E+00	4.33E-01 3.93E-01 4.37E-01 3.62E-01 4.37E-01
TB 11	1.89E-03 6.48E-04 2.28E-03 6.42E-04 2.68E-03	3.35E-01 3.14E-02 1.63E+00 1.33E-02 3.75E+00	1.56E-03 1.36E-03 2.72E-03 1.92E-04 3.90E-03	Sub 1: 1.97E+00 1.81E+00 2.15E+00 6.43E-01 4.95E+00 Sub 2: 1.64E+00 1.56[illegible]00 1.83E+00 1.4[illegible]00 2.25E+00 Overall: 2.01E+00 1.75E+00 2.13E+00 6.43E-01 4.95E+00	8.01E-01 6.47E-01 8.16E-01 4.98E-01 8.92E-01
TB 12	1.[illegible]5E-05 1.76E-05 1.95E-05 1.56E-05 1.95E-05	2.39E-01 1.82E-01 5.13E-01 6.02E-02 1.87E+00	1.48E-01 1.12E-01 2.11E-01 1.12E-03 2.39E-01	Sub 1: 7.93E+00 7.58E+00 8.09E+00 5.82E+00 1.25E+01 Sub 2: 7.72E+00 7.08E+00 8.49E+00 6.27E+00 1.24E+01 Overall: 8.26E+00 7.79E+00 8.48E+00 5.82E+00 1.25E+01	2.34E+00 2.30E+00 2.38E+00 2.09E+00 2.44E+00

TABLE A1-6h

Five-Number Summaries of Leakage Current A, Phase II Terminal Blocks
(mA)

	95°C	149°C	121°C	105°C	Ambient
TB 10	2.04E-03 1.57E-03 2.19E-03 7.74E-04 2.19E-03	6.24E-01 5.12E-01 9.14E-01 4.68E-01 1.10E+00	Sub 1: 1.46E-01 1.34E-01 2.55E-01 7.63E-03 5.02E-01 Sub 2: 1.97E-01 1.78E-01 2.20E-01 1.45E-02 3.41E-01 Overall: 1.34E-01 1.12E-01 1.78E-01 7.63E-03 5.02E-01	Sub 1: 4.16E-01 4.12E-01 4.35E-01 4.09E-01 5.21E-01 Sub 2: 1.31E-01 1.18E-01 1.40E-01 1.09E-01 2.35E-01 Sub 3: 2.89E-01 2.01E-01 2.89E-01 2.01E-01 2.89E-01 Overall: 1.32E-01 1.20E-01 1.42E-01 1.09E-01 5.21E-01	9.72E-04 9.53E-04 1.02E-03 9.45E-04 1.05E-03
TB 11	1.77E-03 1.37E-03 9.37E-03 3.96E-04 9.37E-03	1.46E+00 1.35E+00 1.82E+00 4.73E-01 2.07E+00	Sub 1: 1.18E+00 1.09E+00 1.29E+00 3.83E-01 1.92E+00 Sub 2: 5.14E-01 3.21E-01 5.70E-01 2.11E-01 1.38E+00 Overall: 5.43E-01 3.26E-01 6.01E-01 2.11E-01 1.92E+00	Sub 1: 1.61E-01 1.56E-01 1.72E-01 1.46E-01 1.20E+00 Sub 2: 1.08E+00 9.15E-01 1.08E+00 9.15E-01 1.08E+00 Overall: 1.63E-01 1.56E-01 1.76E-01 1.46E-01 1.20E+00	3.73E-03 3.68E-03 3.91E-03 3.57E-03 4.02E-03
TB 12	5.12E-01 4.74E-02 5.85E-02 2.01E-02 5.85E-02	1.92E+01 1.88E+01 1.93E+01 4.58E+00 1.94E+01	Sub 1: 1.81E+01 1.80E+01 1.82E+01 1.76E+01 1.90E+01 Sub 2: 1.04E+01 3.30E+00 1.13E+01 2.23E+00 1.24E+01 Overall: 1.07E+01 3.46E+00 1.17E+01 2.23E+00 1.90E+01	Sub 1: 4.20E+00 3.66E+00 5.74E+00 3.60E+00 7.25E+00 Sub 2: 1.53E+00 1.51E+00 1.56E+00 1.39E+00 1.59E+00 Overall: 1.53E+00 1.51E+00 1.56E+00 1.39E+00 7.25E+00	5.30E-02 5.28E-02 5.33E-02 5.11E-02 5.38E-02

TABLE A1-7a

Five-Number Summaries of Leakage Current B, Phase II Terminal Blocks
(mA)

TB	Ambient	Peak 1 175°C	95°C	Peak 2 175°C	161°C
TB				Sub 1:	
1	2.91E-04	2.33E-01	1.76E-02	4.45E+00	8.12E-01
	2.91E-04 2.91E-04	1.54E-01 2.77E-01	1.08E-02 2.83E-02	4.27E+00 4.60E+00	7.24E-01 9.83E-01
	1.94E-04 2.91E-04	7.18E-03 4.49E+01	8.74E-04 3.43E-02	3.31E+00 6.83E+01	6.28E-01 9.83E-01
				Sub 2:	
				2.57E+00	
				1.79E+00 3.77E+00	
				1.73E+00 2.00E+01	
				Overall:	
				5.21E+00	
				4.22E+00 5.79E+00	
				1.73E+00 6.83E+01	
TB				Sub 1:	
2	2.91E-04	9.18E-01	2.33E-03	1.25E+00	6.80E-01
	2.91E-04 3.88E-04	5.40E-01 1.32E+00	2.14E-03 2.72E-03	1.17E+00 1.39E+00	6.35E-01 7.08E-01
	1.94E-04 3.88E-04	6.81E-02 3.10E+00	6.80E-04 2.91E-03	6.90E-01 4.99E+00	4.88E-01 7.08E-01
				Sub 2:	
				9.21E-01	
				8.97E-01 9.83E-01	
				8.97E-01 1.68E+00	
				Overall:	
				1.25E+00	
				1.09E+00 1.39E+00	
				6.90E-01 4.99E+00	
TB				Sub 1:	
3	2.91E-04	6.54E-01	3.88E-03	8.93E-01	5.55E-01
	2.91E-04 2.91E-04	2.38E-01 8.20E-01	3.11E-03 5.05E-03	8.81E-01 9.85E-01	5.25E-01 5.75E-01
	1.94E-04 2.91E-04	4.00E-02 2.06E+00	1.46E-03 6.21E-03	1.88E-01 2.97E+00	3.43E-01 5.75E-01
				Sub 2:	
				7.73E-01	
				7.27E-01 8.21E-01	
				7.08E-01 1.15E+00	
				Overall:	
				9.40E-01	
				8.60E-01 1.00E+00	
				1.88E-01 2.97E+00	

TABLE A1-7b

Five-Number Summaries of Leakage Current B, Phase II Terminal Blocks
(mA)

	95°C	149°C	121°C	105°C	Ambient
TB 1	5.29E-01 4.59E-01 6.67E-01 1.31E-01 8.43E-01	3.68E+01 1.26E+01 1.14E+02 1.78E+00 1.71E+02			
TB 2	4.17E-03 3.30E-03 4.37E-03 3.11E-03 5.05E-03	7.35E-01 7.19E-01 8.01E-01 6.55E-01 1.88E+00	Sub 1: 2.76E-01 2.68E-01 2.81E-01 2.26E-01 3.16E-01 Sub 2: 2.08E-01 1.95E-01 2.27E-01 1.78E-01 4.66E-01 Overall: 2.11E-01 1.95E-01 2.37E-01 1.78E-01 4.66E-01	1.17E-01 1.11E-01 1.69E-01 1.03E-01 5.70E-01	3.98E-03 3.59E-03 3.98E-03 1.50E-03 4.08E-03
TB 3	5.73E-03 4.17E-03 7.57E-03 3.50E-03 8.83E-03	8.12E-01 6.54E-01 1.05E+00 5.58E-01 1.66E+00	Sub 1: 2.36E-01 2.32E-01 2.40E-01 1.35E-01 2.67E-01 Sub 2: 1.54E-01 1.31E-01 2.04E-01 9.96E-02 5.37E-01 Overall: 1.58E-01 1.33E-01 2.10E-01 9.96E-02 5.37E-01	Sub 1: 2.10E-01 1.94E-01 2.33E-01 1.90E-01 2.67E-01 Sub 2: 1.30E-01 1.22E-01 1.63E-01 1.11E-01 5.19E-01 Overall: 1.30E-01 1.22E-01 1.63E-01 1.11E-01 5.19E-01	2.52E-03 1.46E-03 2.62E-03 1.36E-03 2.72E-03

TABLE A1-7c

Five-Number Summaries of Leakage Current B, Phase II Terminal Blocks
(mA)

	Ambient	Peak 1 175°C	95°C	Peak 2 175°C	161°C
TB 4	2.91E-04 1.94E-04 2.91E-04 9.71E-05 2.91E-04	5.89E-01 9.56E-02 1.62E+00 4.11E-02 3.69E+00	7.09E-03 5.83E-03 1.02E-02 2.72E-03 1.21E-02	Sub 1: 1.43E+00 1.24E+00 1.71E+00 5.72E-01 5.88E+00 Sub 2: 1.03E+00 9.82E-01 1.10E+00 8.28E-01 1.84E+00 Overall: 1.41E+00 1.15E+00 1.69E+00 5.72E-01 5.88E+00	7.20E-01 7.13E-01 7.40E-01 5.63E-01 7.40E-01
TB 5	3.88E-04 3.88E-04 3.88E-04 2.91E-04 3.88E-04	5.06E-01 4.33E-01 9.12E-01 5.57E-02 4.00E+01	4.40E-01 3.95E-01 4.71E-01 3.64E-01 4.77E-01	Sub 1: 3.80E+00 3.26E+00 8.46E+00 2.82E+00 1.11E+02 Sub 2: 2.62E+00 2.48E+00 2.77E+00 2.34E+00 7.28E+00 Overall: 3.43E+00 2.96E+00 5.52E+00 2.34E+00 1.11E+02	2.62E+00 2.50E+00 2.94E+00 1.48E+00 2.94E+00
TB 6	3.88E-04 2.91E-04 3.88E-04 2.91E-04 3.88E-04	1.25E+00 9.67E-02 2.13E+00 9.22E-03 1.36E+01	2.80E-02 2.52E-02 2.41E-01 1.83E-02 1.47E+00	Sub 1: 1.91E+02 1.60E+02 2.09E+02 1.45E+01 2.55E+02 Sub 2: 3.52E+01 2.79E+01 3.98E+01 2.66E+01 2.11E+02 Overall: 1.68E+02 4.38E+01 1.99E+02 1.45E+01 2.55E+02	6.14E+01 6.10E+01 1.00E+02 2.56E+01 1.00E+02

TABLE A1-7d

Five-Number Summaries of Leakage Current B, Phase II Terminal Blocks
(mA)

	95°C	149°C	121°C	105°C	Ambient
TB 4	8.54E-03 5.44E-03 9.32E-03 3.20E-03 9.32E-03	9.46E-01 6.46E-01 1.29E+00 5.58E-01 1.98E+00	Sub 1: 4.11E-01 3.85E-01 4.26E-01 3.49E-01 6.22E-01 Sub 2: 2.42E-01 2.19E-01 2.69E-01 1.99E-01 8.37E-01 Overall: 2.46E-01 2.21E-01 2.77E-01 1.99E-01 8.37E-01	Sub 1: 3.93E-01 3.15E-01 6.33E-01 3.03E-01 9.09E-01 Sub 2: 1.33E-01 1.27E-01 1.50E-01 1.20E-01 5.23E-01 Overall: 1.33E-01 1.27E-01 1.51E-01 1.20E-01 9.09E-01	2.43E-03 2.33E-03 2.43E-03 2.33E-03 2.62E-03
TB 5	2.00E-01 1.30E-01 2.23E-01 4.89E-02 3.50E-01	2.08E+00 1.96E+00 2.59E+00 1.88E+00 8.65E+00	Sub 1: 1.62E+00 1.33E+00 4.08E+00 8.17E-01 5.53E+00 Sub 2: 7.78E+00 5.82E+00 9.99E+00 4.54E+00 1.14E+01 Sub 3: 9.03E-01 7.12E-01 1.20E+00 4.93E-01 3.15E+00 Overall: 9.33E-01 7.23E-01 1.26E+00 4.93E-01 1.14E+01	Sub 1: 8.19E-01 7.92E-01 1.03E+00 7.60E-01 1.89E+00 Sub 2: 4.06E-01 3.56E-01 4.87E-01 3.25E-01 1.95E+00 Overall: 4.06E-01 3.56E-01 4.87E-01 3.25E-01 1.95E+00	1.83E-02 1.75E-02 1.86E-02 1.73E-02 1.87E-02
TB 6	4.06E+00 2.31E+00 5.21E+00 1.65E+00 7.79E+00	1.88E+02 3.88E+01 2.74E+02 2.63E+01 3.49E+02	Sub 1: 2.76E+02 2.68E+02 3.37E+02 2.25E+02 4.64E+02 Sub 2: 1.53E+02 1.24E+02 1.93E+02 3.29E+01 2.36E+02 Sub 3: 7.50E+00 5.48E+00 9.29E+00 4.30E+00 4.25E+02 Overall: 7.70E+00 5.57E+00 9.77E+00 4.30E+00 4.64E+02	6.17E+00 5.32E+00 7.52E+00 3.92E+00 6.37E+02	1.20E+00 1.19E+00 1.35E+00 1.39E-01 1.36E+00

TABLE A1-7e

Five-Number Summaries of Leakage Current B, Phase II Terminal Blocks
(mA)

TB	Ambient	Peak 1 175°C	95°C	Peak 2 175°C	161°C
7	7.88E-06 5.91E-06 7.88E-06 3.94E-06 7.88E-06	1.88E-01 1.50E-01 2.22E-01 1.03E-01 7.86E-01	1.27E-03 9.68E-04 1.70E-03 5.91E-06 4.72E-03	Sub 1: 8.00E-01 7.67E-01 8.20E-01 6.72E-01 1.60E+00 Sub 2: 1.08E+00 9.98E-01 1.22E+00 9.49E-01 1.61E+00 Overall: 1.02E+00 9.16E-01 1.05E+00 6.72E-01 1.61E+00	9.59E-01 6.99E-01 9.89E-01 6.65E-01 1.77E+00
8	7.84E-06 5.88E-06 7.84E-06 1.96E-06 7.84E-06	1.60E-01 1.26E-01 3.01E-01 5.23E-02 4.36E+00	4.01E-03 2.93E-03 5.90E-03 7.84E-06 3.61E-02	Sub 1: 2.10E+00 2.06E+00 2.12E+00 1.84E+00 3.89E+00 Sub 2: 2.13E+00 1.66E+00 2.76E+00 1.56E+00 5.27E+00 Overall: 2.20E+00 2.10E+00 2.23E+00 1.56E+00 5.27E+00	6.63E-01 6.40E-01 8.27E-01 5.87E-01 9.12E-01
9	7.81E-06 5.86E-06 7.81E-06 3.91E-06 7.81E-06	2.06E-01 1.44E-01 6.31E-01 4.01E-02 1.41E+00	7.50E-04 6.74E-04 1.02E-03 1.76E-04 1.11E-03	Sub 1: 9.21E-01 6.99E-01 1.06E+00 2.81E-01 1.95E+00 Sub 2: 1.18E+00 1.11E+00 1.28E+00 1.06E+00 1.37E+00 Overall: 1.21E+00 1.14E+00 1.24E+00 2.81E-01 1.95E+00	5.12E-01 4.11E-01 5.32E-01 3.82E-01 5.38E-01

TABLE A1-7f

Five-Number Summaries of Leakage Current B, Phase II Terminal Blocks
(mA)

TB	95°C	149°C	121°C	105°C	Ambient
TB 7	2.53E-02 2.09E-02 6.48E-02 7.54E-03 6.48E-02	4.69E-01 4.11E-01 7.66E-01 3.84E-01 1.41E+00	Sub 1: 1.82E-01 6.95E-02 4.14E-01 2.97E-02 1.25E+00 Sub 2: 5.52E-02 3.60E-02 1.04E-01 1.24E-02 3.34E-01 Overall: 4.29E-02 3.60E-02 5.87E-02 1.24E-02 1.25E+00	Sub 1: 1.35E-02 1.15E-02 1.55E-02 1.05E-02 1.99E-02 Sub 2: 1.14E-02 8.37E-03 2.14E-02 6.12E-03 1.72E-01 Sub 3: 1.01E-02 7.64E-03 1.01E-02 7.64E-03 1.01E-02 Overall: 1.05E-02 8.37E-03 1.15E-02 6.12E-03 1.72E-01	1.64E-03 1.63E-03 1.68E-03 1.60E-03 1.69E-03
TB 8	4.08E-03 2.36E-03 5.09E-03 9.29E-04 5.09E-03	2.79E+00 1.47E+00 3.19E+00 9.38E-01 3.64E+00	Sub 1: 4.75E+00 3.96E+00 5.91E+00 1.59E+00 6.92E+00 Sub 2: 4.49E-01 3.95E-01 5.20E-01 3.12E-01 2.29E+00 Overall: 4.65E-01 4.12E-01 5.97E-01 3.12E-01 6.92E+00	Sub 1: 8.36E-01 8.36E+01 2.55E+00 6.16E-01 2.55E+00 Sub 2: 1.06E-01 1.04E-01 1.16E-01 1.01E-01 2.25E-01 Sub 3: 7.41E-02 3.94E-02 1.05E-01 3.60E-02 1.59E-01 Sub 4: 7.92E-02 6.26E-02 7.92E-02 6.26E-02 7.92E-02 Overall: 7.49E-02 4.04E-02 1.01E-01 3.60E-02 2.55E+00	3.03E-03 2.99E-03 3.06E-03 2.93E-03 3.09E-03
TB 9	1.81E-03 1.72E-03 2.13E-03 1.40E-03 2.13E-03	8.60E-01 7.83E-01 1.43E+00 7.22E-01 1.54E+00	Sub 1: 6.83E-01 5.12E-01 7.58E-01 1.84E-01 1.18E+00 Sub 2: 3.69E-01 3.16E-01 6.55E-01 5.26E-02 1.31E+00 Overall: 3.34E-01 3.06E-01 3.72E-01 5.26E-02 1.31E+00	Sub 1: 4.55E-01 4.19E-01 5.27E-01 3.87E-01 6.55E-01 Sub 2: 1.84E-01 1.76E-01 1.90E-01 1.53E-01 3.85E-01 Sub 3: 9.64E-01 7.85E-01 9.64E-01 7.85E-01 9.64E-01 Overall: 1.84E-01 1.76E-01 1.91E-01 1.53E-01 9.64E-01	2.29E-03 2.24E-03 2.39E-03 2.22E-03 2.42E-03

TABLE A1-7g

Five-Number Summaries of Leakage Current B, Phase II Terminal Blocks
(mA)

	Ambient	Peak 1 175°C	95°C	Peak 2 175°C	161°C
TB 10	9.83E-06 7.87E-06 9.83E-06 7.87E-06 9.83E-06	1.96E-01 5.67E-02 5.69E-01 2.36E-02 1.32E+00	1.04E-03 8.10E-04 1.56E-03 4.44E-04 1.82E-03	Sub 1: 7.80E-01 6.42E-01 8.53E-01 1.85E-01 1.96E+00 Sub 2: 6.90E-01 6.74E-01 7.11E-01 5.60E-01 9.01E-01 Overall: 7.92E-01 6.93E-01 8.69E-01 1.85E-01 1.96E+00	4.03E-01 3.61E-01 4.26E-01 3.26E-01 4.28E-01
TB 11	NO B PATH FOR TERMINAL BLOCK 11				
TB 12	7.87E-06 5.90E-06 7.87E-06 5.90E-06 7.87E-06	2.68E-01 9.79E-02 3.97E-01 7.74E-02 1.39E+00	3.17E-01 2.62E-01 4.31E-01 1.05E-02 4.86E-01	Sub 1: 6.53E+00 3.83E+00 7.73E+00 3.20E+00 1.02E+01 Sub 2: 2.19E+00 1.78E+00 2.67E+00 1.71E+00 3.66E+00 Overall: 3.83E+00 2.64E+00 6.83E+00 1.71E+00 1.02E+01	1.14E+00 1.06E+00 1.30E+00 8.80E-01 1.31E+00

TABLE A1-7h

Five-Number Summaries of Leakage Current B, Phase II Terminal Blocks
(mA)

	95°C	149°C	121°C	105°C	Ambient
TB 10	1.96E-03 1.86E-03 2.24E-03 5.03E-04 2.24E-03	5.73E-01 4.43E-01 1.05E+00 3.99E-01 1.26E+00	Sub 1: 1.35E-01 1.26E-01 2.13E-01 2.81E-02 4.66E-01 Sub 2: 1.59E-01 1.41E-01 1.77E-01 4.41E-02 2.16E-01 Overall: 1.25E-01 1.03E-01 1.41E-01 2.81E-02 4.66E-01	Sub 1: 2.66E-01 2.62E-01 2.81E-01 2.58E-01 3.26E-01 Sub 2: 6.99E-02 6.58E-02 7.81E-02 6.17E-02 1.07E-01 Sub 3: 2.47E-01 1.70E-01 2.47E-01 1.70E-01 2.47E-01 Overall: 7.32E-02 6.64E-02 7.92E-02 6.17E-02 3.26E-01	6.43E-04 6.27E-04 6.63E-04 6.16E-04 6.75E-04
TB 11	NO B PATH FOR TERMINAL BLOCK 11				
TB 12	4.80E-03 4.61E-03 1.37E-02 1.83E-03 1.37E-02	1.26E+00 1.11E+00 2.05E+00 9.22E-01 3.30E+00	Sub 1: 4.76E-01 4.65E-01 4.97E-01 1.55E-01 5.42E-01 Sub 2: 5.84E-01 5.59E-01 6.35E-01 5.13E-01 9.49E-01 Overall: 4.76E-01 4.43E-01 5.36E-01 1.55E-01 9.49E-01	Sub 1: 7.36E-01 6.90E-01 8.42E-01 6.82E-01 1.12E+00 Sub 2: 4.33E-01 4.19E-01 4.47E-01 4.00E-01 4.79E-01 Overall: 4.33E-01 4.19E-01 4.47E-01 4.00E-01 1.12E+00	3.19E-02 3.19E-02 3.22E-02 3.18E-02 3.29E-02

TABLE A1-8a

Five-Number Summaries of Leakage Current G, Phase II Terminal Blocks
(mA)

	Ambient	Peak 1 175°C	95°C	Peak 2 175°C	161°C
TB 1	3.88E-04 2.91E-04 3.88E-04 2.91E-04 3.88E-04	2.33E-01 1.84E-01 2.52E-01 1.46E-01 2.16E+02	2.15E-02 1.60E-02 3.76E-02 2.62E-03 4.66E-02	Sub 1: 6.29E+00 5.46E+00 7.03E+00 2.11E+00 5.50E+01 Sub 2: 1.55E+00 1.30E+00 1.94E+00 1.29E+00 9.98E+00 Overall: 6.01E+00 3.41E+00 7.03E+00 1.29E+00 5.50E+01	8.81E-01 8.69E-01 9.22E-01 5.98E-01 9.22E-01
TB 2	2.91E-04 2.91E-04 3.88E-04 1.94E-04 3.88E-04	9.17E-02 5.09E-02 1.42E-01 2.91E-03 1.75E+00	4.85E-03 4.66E-03 5.34E-03 1.94E-03 5.63E-03	Sub 1: 7.97E-01 7.18E-01 8.27E-01 7.09E-03 3.50E+00 Sub 2: 1.56E+00 1.07E+00 1.65E+00 9.48E-01 1.95E+00 Overall: 1.18E+00 8.37E-01 1.44E+00 7.09E-03 3.50E+00	1.21E+00 1.07E+00 1.28E+00 9.09E-01 1.28E+00
TB 3	2.91E-04 1.94E-04 2.91E-04 1.94E-04 2.91E-04	5.99E-01 2.87E-01 6.99E-01 1.74E-01 2.29E+00	1.46E-03 1.36E-03 1.94E-03 1.94E-04 1.94E-03	Sub 1: 1.65E+00 1.62E+00 1.70E+00 5.28E-01 4.13E+00 Sub 2: 1.62E+00 1.59E+00 1.64E+00 1.56E+00 2.28E+00 Overall: 1.72E+00 1.63E+00 1.77E+00 5.28E-01 4.13E+00	6.72E-01 6.52E-01 7.59E-01 5.15E-01 7.59E-01

TABLE A1-8b

Five-Number Summaries of Leakage Current G, Phase II Terminal Blocks
(mA)

	95°C	149°C	121°C	105°C	Ambient
TB 1	1.12E-01 5.92E-02 1.17E-01 1.05E-02 1.21E-01	1.33E+01 3.29E+00 5.35E+01 1.21E+00 8.97E+01			
TB 2	9.07E-02 8.21E-02 9.33E-02 6.53E-02 9.41E-02	1.56E+00 1.41E+00 1.65E+00 1.11E+00 1.69E+00	Sub 1: 2.43E+00 2.18E+00 3.02E+00 1.69E+00 3.74E+00 Sub 2: 8.20E-01 6.94E-01 1.08E+00 5.03E-01 2.48E+00 Overall: 9.19E-01 7.00E-01 1.20E+00 5.03E-01 3.74E+00	4.92E-01 4.45E-01 5.90E-01 3.72E-01 9.59E-01	1.95E-01 1.94E-01 1.97E-01 1.93E-01 2.00E-01
TB 3	2.02E-02 1.28E-02 2.23E-02 9.42E-03 2.47E-02	1.37E+00 1.15E+00 1.76E+00 1.03E+00 2.50E+00	Sub 1: 6.20E-01 5.97E-01 6.29E-01 5.23E-01 7.08E-01 Sub 2: 5.73E-01 5.52E-01 6.02E-01 4.19E-01 9.21E-01 Overall: 5.75E-01 5.54E-01 6.00E-01 4.19E-01 9.21E-01	Sub 1: 4.61E-01 4.27E-01 5.06E-01 4.24E-01 5.70E-01 Sub 2: 3.65E-01 3.53E-01 3.87E-01 3.32E-01 8.84E-01 Overall: 3.65E-01 3.53E-01 3.87E-01 3.32E-01 8.84E-01	1.42E-02 1.24E-02 1.42E-02 1.23E-02 1.43E-02

TABLE A1-8c

Five-Number Summaries of Leakage Current G, Phase II Terminal Blocks
(mA)

	Ambient	Peak 1 175°C	95°C	Peak 2 175°C	161°C
TB 4	1.94E-04 9.71E-05 1.94E-04 9.71E-05 1.94E-04	4.94E-01 1.09E-01 8.84E-01 4.56E-02 1.66E+00	3.98E-03 3.30E-03 4.37E-03 6.80E-04 5.73E-03	Sub 1: 1.65E+00 1.58E+00 1.68E+00 8.18E-01 2.79E+00 Sub 2: 1.24E+00 1.20E+00 1.35E+00 1.15E+00 2.69E+00 Overall: 1.68E+00 1.43E+00 1.71E+00 8.18E-01 2.79E+00	8.74E-01 8.64E-01 9.19E-01 8.46E-01 9.19E-01
TB 5	1.92E-04 1.92E-04 2.88E-04 1.92E-04 2.88E-04	2.64E+00 9.56E-01 3.90E+00 3.30E-01 1.59E+01	1.23E-02 1.19E-02 1.42E-02 9.90E-03 1.53E-02	Sub 1: 1.83E+01 1.67E+01 1.88E+01 1.23E+01 2.77E+01 Sub 2: 1.81E+01 1.78E+01 1.84E+01 1.76E+01 2.08E+01 Overall: 1.88E+01 1.84E+01 1.91E+01 1.23E+01 2.77E+01	7.12E+01 6.66E+01 8.07E+01 5.84E+01 8.07E+01
TB 6	2.91E-04 2.91E-04 3.88E-04 2.91E-04 3.88E-04	2.17E+00 3.50E-01 4.40E+00 1.86E-01 4.20E+01	3.01E-01 1.21E-01 1.93E+00 9.35E-02 4.92E+00	Sub 1: 1.78E+02 1.46E+02 1.86E+02 4.80E+01 2.16E+02 Sub 2: 4.74E+01 4.16E+01 5.73E+01 3.79E+01 1.73E+02 Overall: 1.59E+02 6.90E+01 1.85E+02 3.79E+01 2.16E+02	6.68E+01 6.09E+01 8.51E+01 5.50E+01 8.51E+01

TABLE A1-8d

Five-Number Summaries of Leakage Current G, Phase II Terminal Blocks
(mA)

	95°C	149°C	121°C	105°C	Ambient
TB 4	2.42E-02 1.97E-02 2.52E-02 1.37E-02 2.57E-02	1.09E+00 7.17E-01 1.62E+00 6.03E-01 2.71E+00	Sub 1: 4.34E-01 4.04E-01 4.80E-01 3.76E-01 6.18E-01 Sub 2: 2.56E-01 2.23E-01 2.83E-01 1.92E-01 6.74E-01 Overall: 2.58E-01 2.27E-01 3.01E-01 1.92E-01 6.74E-01	Sub 1: 2.13E-01 1.76E-01 3.39E-01 1.72E-01 5.02E-01 Sub 2: 1.19E-01 1.14E-01 1.29E-01 1.05E-01 3.09E-01 Overall: 1.19E-01 1.14E-01 1.30E-01 1.05E-01 5.02E-01	1.65E-03 1.55E-03 1.75E-03 1.55E-03 1.75E-03
TB 5	9.05E-01 6.63E-01 9.52E-01 4.65E-01 1.13E+00	7.84E+01 3.40E+01 8.98E+01 2.42E+01 1.04E+02	Sub 1: 8.78E+01 7.87E+01 9.62E+01 6.99E+01 1.15E+02 Sub 2: 1.04E+02 9.59E+01 1.10E+02 3.56E+01 1.14E+02 Sub 3: 6.01E+00 5.77E+00 6.77E+00 5.08E+00 1.72E+01 Overall: 6.05E+00 5.79E+00 7.25E+00 5.08E+00 1.15E+02	Sub 1: 3.77E+00 3.72E+00 4.05E+00 3.65E+00 5.47E+00 Sub 2: 4.69E+00 4.47E+00 5.06E+00 4.02E+00 9.26E+00 Overall: 4.44E+00 4.07E+00 4.63E+00 3.65E+00 9.26E+00	4.44E-01 4.29E-01 4.84E-01 3.84E-01 5.19E-01
TB 6	3.12E+00 2.39E+00 4.46E+00 1.86E+00 9.37E+00	1.22E+02 5.24E+01 2.10E+02 4.34E+01 2.90E+02	Sub 1: 2.97E+02 2.92E+02 3.34E+02 1.61E+02 4.93E+02 Sub 2: 1.67E+02 1.47E+02 2.10E+02 4.39E+01 2.66E+02 Sub 3: 6.44E+00 5.64E+00 8.56E+00 4.25E+00 9.09E+01 Overall: 6.56E+00 5.76E+00 9.54E+00 4.25E+00 4.93E+02	7.26E+00 6.49E+00 7.59E+00 5.67E+00 1.57E+02	8.66E-01 8.25E-01 8.86E-01 6.83E-02 1.70E+00

TABLE A1-8e

Five-Number Summaries of Leakage Current G, Phase II Terminal Blocks
(mA)

TB	Ambient	Peak 1 175°C	95°C	Peak 2 175°C	161°C
7	5.87E-06 3.91E-06 5.87E-06 3.91E-06 1.37E-05	7.42E-01 1.23E-01 8.70E-01 4.52E-02 2.98E+00	4.64E-02 4.01E-02 5.31E-02 2.45E-03 5.62E-02	Sub 1: 2.26E+00 2.22E+00 2.26E+00 2.01E+00 3.81E+00 Sub 2: 2.91E+00 2.76E+00 3.02E+00 2.49E+00 4.43E+00 Overall: 2.47E+00 2.33E+00 2.51E+00 2.01E+00 4.43E+00	1.83E+00 1.74E+00 1.90E+00 1.49E+00 2.19E+00
8	3.92E-06 1.96E-06 3.92E-06 1.96E-06 7.84E-06	1.13E-01 7.86E-02 2.53E-01 7.19E-02 9.79E+00	1.09E-03 9.86E-04 1.89E-03 3.92E-06 1.52E-02	Sub 1: 2.40E+00 2.29E+00 2.57E+00 2.04E+00 5.56E+00 Sub 2: 1.74E+00 1.33E+00 2.28E+00 1.24E+00 5.18E+00 Overall: 2.57E+00 2.07E+00 2.73E+00 1.24E+00 5.56E+00	9.86E-01 9.33E-01 9.90E-01 8.80E-01 1.01E+00
9	1.96E-06 1.96E-06 1.96E-06 1.96E-06 1.96E-06	1.78E-01 9.90E-02 4.40E-01 2.29E-02 7.75E-01	8.34E-04 6.97E-04 1.10E-03 9.20E-05 1.21E-03	Sub 1: 8.11E-01 6.18E-01 9.05E-01 1.97E-01 1.84E+00 Sub 2: 1.05E+00 1.00E+00 1.08E+00 9.60E-01 1.25E+00 Overall: 1.05E+00 1.01E+00 1.06E+00 1.97E-01 1.84E+00	4.55E-01 3.72E-01 4.73E-01 3.51E-01 4.73E-01

TABLE A1-8f

Five-Number Summaries of Leakage Current G, Phase II Terminal Blocks
(mA)

TB	95°C	149°C	121°C	105°C	Ambient
7	9.82E-02 9.47E-02 1.01E-01 6.88E-02 1.01E-01	2.52E+00 2.46E+00 2.57E+00 2.25E+00 2.75E+00	Sub 1: 3.03E+00 2.81E+00 3.32E+00 9.10E-01 4.39E+00 Sub 2: 1.19E+00 1.04E+00 1.74E+00 8.24E-01 3.45E+00 Overall: 1.22E+00 1.04E+00 1.81E+00 8.24E-01 4.39E+00	Sub 1: 2.84E-01 2.47E-01 3.20E-01 2.26E-01 4.89E-01 Sub 2: 6.82E-01 6.46E-01 7.41E-01 5.99E-01 1.51E+00 Sub 3: 1.14E+00 9.09E-01 1.14E+00 9.09E-01 1.14E+00 Overall: 3.20E-01 2.70E-01 6.11E-01 2.26E-01 1.51E+00	2.25E-01 2.23E-01 2.29E-01 2.22E-01 2.30E-01
8	2.26E-03 1.42E-03 2.66E-03 4.66E-04 2.66E-03	1.24E+00 9.87E-01 1.44E+01 8.83E-01 1.55E+00	Sub 1: 3.59E+00 2.75E+00 4.70E+00 1.35E+00 7.28E+00 Sub 2: 1.91E-01 1.47E-01 2.62E-01 1.27E-01 1.90E+00 Overall: 1.98E-01 1.50E-01 3.15E-01 1.27E-01 7.28E+00	Sub 1: 1.96E-01 1.96E-01 5.76E-01 1.63E-01 5.76E-01 Sub 2: 5.59E-02 5.44E-02 6.10E-02 5.40E-02 8.56E-02 Sub 3: 3.81E-02 3.20E-02 4.61E-02 3.02E-02 9.78E-02 Sub 4: 8.02E-02 5.38E-02 8.02E-02 5.38E-02 8.02E-02 Overall: 3.92E-02 3.21E-02 4.62E-02 3.02E-02 5.76E-01	9.80E-05 6.66E-05 1.12E-04 1.57E-05 1.33E-04
9	2.04E-03 2.01E-03 2.92E-03 1.25E-03 2.92E-03	7.66E-01 6.82E-01 1.01E+00 4.49E-01 1.06E+00	Sub 1: 3.01E-01 2.66E-01 3.57E-01 1.41E-01 3.99E-01 Sub 2: 2.89E-01 2.27E-01 3.83E-01 1.96E-01 6.43E-01 Overall: 2.36E-01 2.15E-01 2.56E-01 1.41E-01 6.43E-01	Sub 1: 2.99E-01 2.69E-01 3.50E-01 2.44E-01 4.28E-01 Sub 2: 1.13E-01 1.10E-01 1.15E-01 8.62E-02 2.19E-01 Sub 3: 6.79E-01 5.00E-01 6.79E-01 5.00E-01 6.79E-01 Overall: 1.13E-01 1.10E-01 1.16E-01 8.62E-02 6.79E-01	3.99E-04 3.93E-04 4.07E-04 3.87E-04 4.13E-04

TABLE A1-8g

Five-Number Summaries of Leakage Current G, Phase II Terminal Blocks
(mA)

TB	Ambient	Peak 1 175°C	95°C	Peak 2 175°C	161°C
10	3.92E-06	1.57E-01	4.28E-04	Sub 1:	2.68E-01
	1.96E-06 3.92E-06	6.75E-02 3.15E-01	4.22E-04 5.53E-04	5.05E-01	2.52E-01 2.70E-01
	1.96E-06 3.92E-06	2.85E-02 7.49E-01	9.22E-05 6.04E-04	4.64E-01 5.88E-01	2.34E-01 2.87E-01
				2.00E-01 1.62E+00	
				Sub 2:	
				4.71E-01	
				4.52E-01 4.84E-01	
				4.32E-01 6.92E-01	
				Overall:	
				5.20E-01	
				4.74E-01 5.97E-01	
				2.00E-01 1.62E+00	
11	7.86E-06	1.82E-01	2.28E-03	Sub 1:	7.36E-01
	5.90E-06 7.86E-06	7.78E-03 9.04E-01	2.06E-03 2.60E-03	1.53E+00	6.64E-01 7.89E-01
	5.90E-06 7.86E-06	7.66E-05 1.90E+00	6.09E-04 2.87E-03	1.37E+00 1.61E+00	5.70E-01 8.30E-01
				5.77E-01 3.35E+00	
				Sub 2:	
				1.36E+00	
				1.28E+00 1.46E+00	
				1.19E+00 2.02E+00	
				Overall:	
				1.59E+00	
				1.39E+00 1.68E+00	
				5.77E-01 3.35E+00	
12	3.94E-06	7.12E-01	8.60E-03	Sub 1:	2.07E+00
	2.22E-06 3.94E-06	5.14E-01 1.18E+00	8.30E-03 1.01E-02	3.82E+00	1.80E+00 2.18E+00
	1.97E-06 3.94E-06	2.09E-01 2.25E+00	3.02E-03 1.01E-02	3.51E+00 4.16E+00	1.67E+00 2.26E+00
				2.75E+00 6.27E+00	
				Sub 2:	
				4.59E+00	
				4.25E+00 4.82E+00	
				8.04E-01 5.31E+00	
				Overall:	
				4.73E+00	
				4.39E+00 4.78E+00	
				8.04E-01 6.27E+00	

TABLE A1-8h

Five-Number Summaries of Leakage Current G, Phase II Terminal Blocks
(mA)

	95°C	149°C	121°C	105°C	Ambient
TB 10	2.32E-03 2.23E-03 3.38E-03 5.88E-05 3.38E-03	3.96E-01 3.57E-01 5.71E-01 3.11E-01 6.91E-01	Sub 1: 2.16E-01 1.31E-01 2.78E-01 4.61E-04 7.67E-01 Sub 2: 7.82E-02 6.58E-02 9.01E-02 1.03E-02 2.87E-01 Overall: 6.53E-02 3.71E-02 7.80E-02 4.61E-04 7.67E-01	Sub 1: 2.04E-01 2.00E-01 2.18E-01 1.97E-01 2.60E-01 Sub 2: 4.89E-02 3.97E-02 5.39E-02 3.53E-02 9.42E-02 Sub 3: 2.61E-01 1.70E-01 2.61E-01 1.70E-01 2.61E-01 Overall: 5.06E-02 3.98E-02 5.73E-02 3.53E-02 2.61E-01	2.35E-05 1.37E-05 3.33E-05 5.88E-06 4.12E-05
TB 11	1.02E-02 4.33E-03 1.34E-02 3.05E-03 1.34E-02	1.40E+00 1.25E+00 1.53E+00 1.04E+00 1.91E+00	Sub 1: 7.65E-01 5.85E-01 8.29E-01 4.26E-03 1.24E+00 Sub 2: 5.53E-01 5.22E-01 5.75E-01 3.26E-01 6.49E-01 Overall: 5.04E-01 3.64E-01 5.41E-01 4.26E-03 1.24E+00	Sub 1: 3.79E-01 3.74E-01 3.98E-01 3.63E-01 1.50E+00 Sub 2: 1.12E+00 7.63E-01 1.12E+00 7.63E-01 1.12E+00 Overall: 3.81E-01 3.74E-01 3.99E-01 3.63E-01 1.50E+00	2.77E-02 2.35E-02 2.92E-02 1.90E-02 2.97E-02
TB 12	2.50E-02 2.00E-02 3.00E-02 1.35E-02 3.00E-02	5.07E+00 4.50E+00 5.49E+00 2.78E+00 5.60E+00	Sub 1: 1.61E+00 1.60E+00 1.63E+00 5.46E-01 1.69E+00 Sub 2: 1.53E+00 1.39E+00 1.72E+00 1.20E+00 2.17E+00 Overall: 1.50E+00 1.35E+00 1.57E+00 5.46E-01 2.17E+00	Sub 1: 2.32E+00 2.27E+00 2.39E+00 2.26E+00 2.56E+00 Sub 2: 1.51E+00 1.38E+00 1.91E+00 1.29E+00 2.15E+00 Overall: 1.51E+00 1.38E+00 1.91E+00 1.29E+00 2.56E+00	2.14E-02 2.12E-02 2.17E-02 2.10E-02 2.18E-02

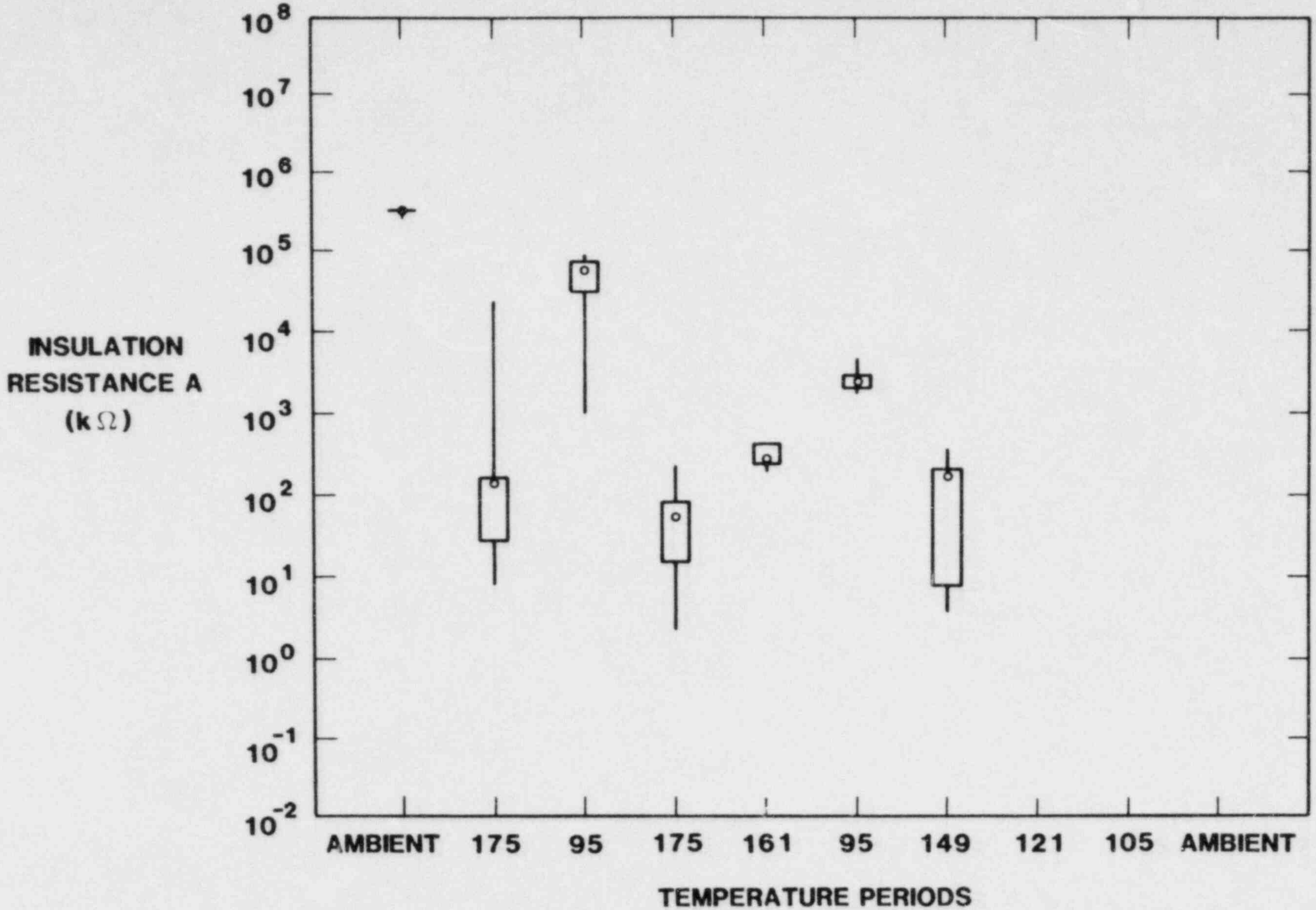

Figure A1-13

Box and Whisker Plot of Insulation Resistance A for TB 1, Phase II

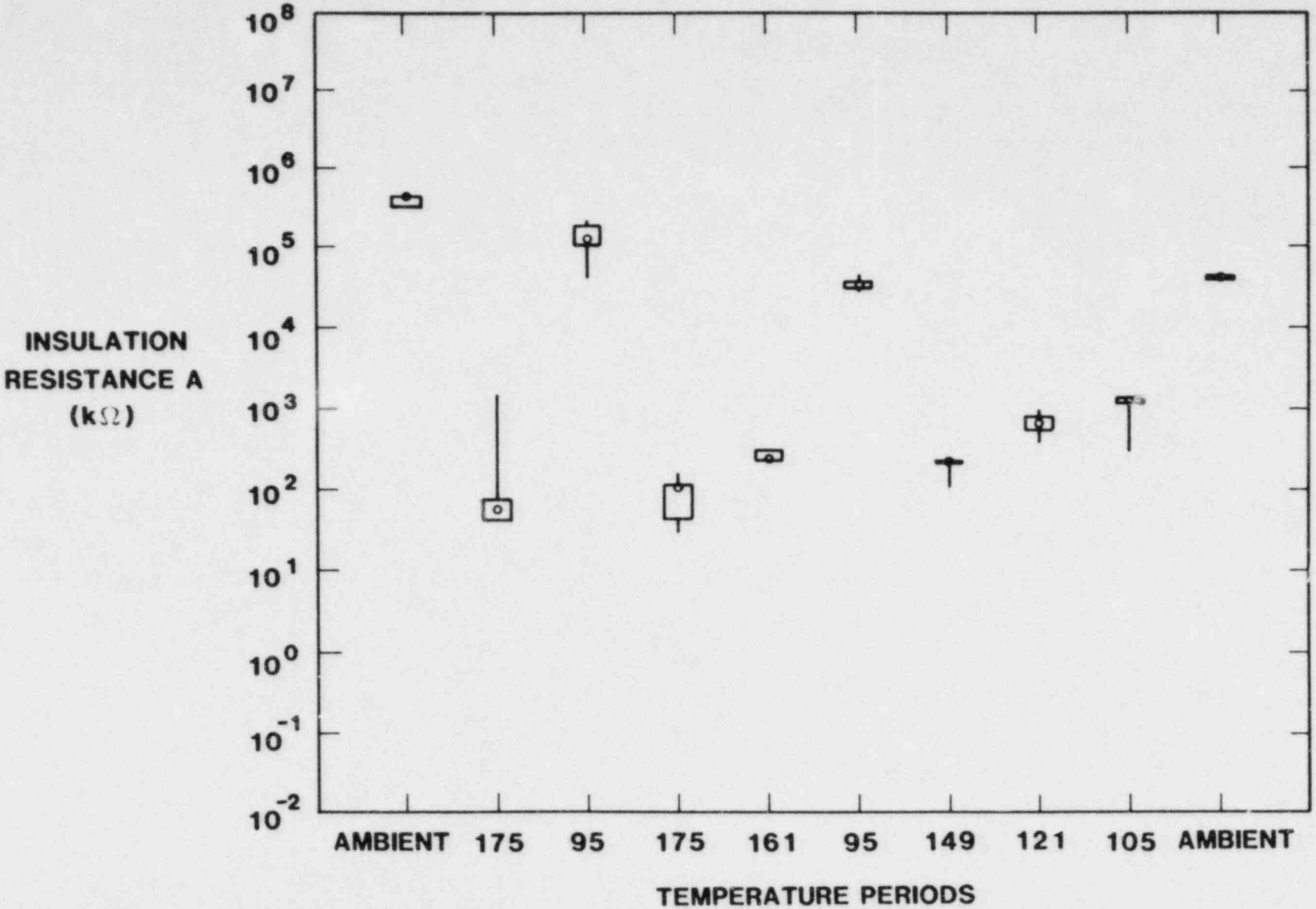

Figure A1-14

Box and Whisker Plot of Insulation Resistance A for TB 2, Phase II

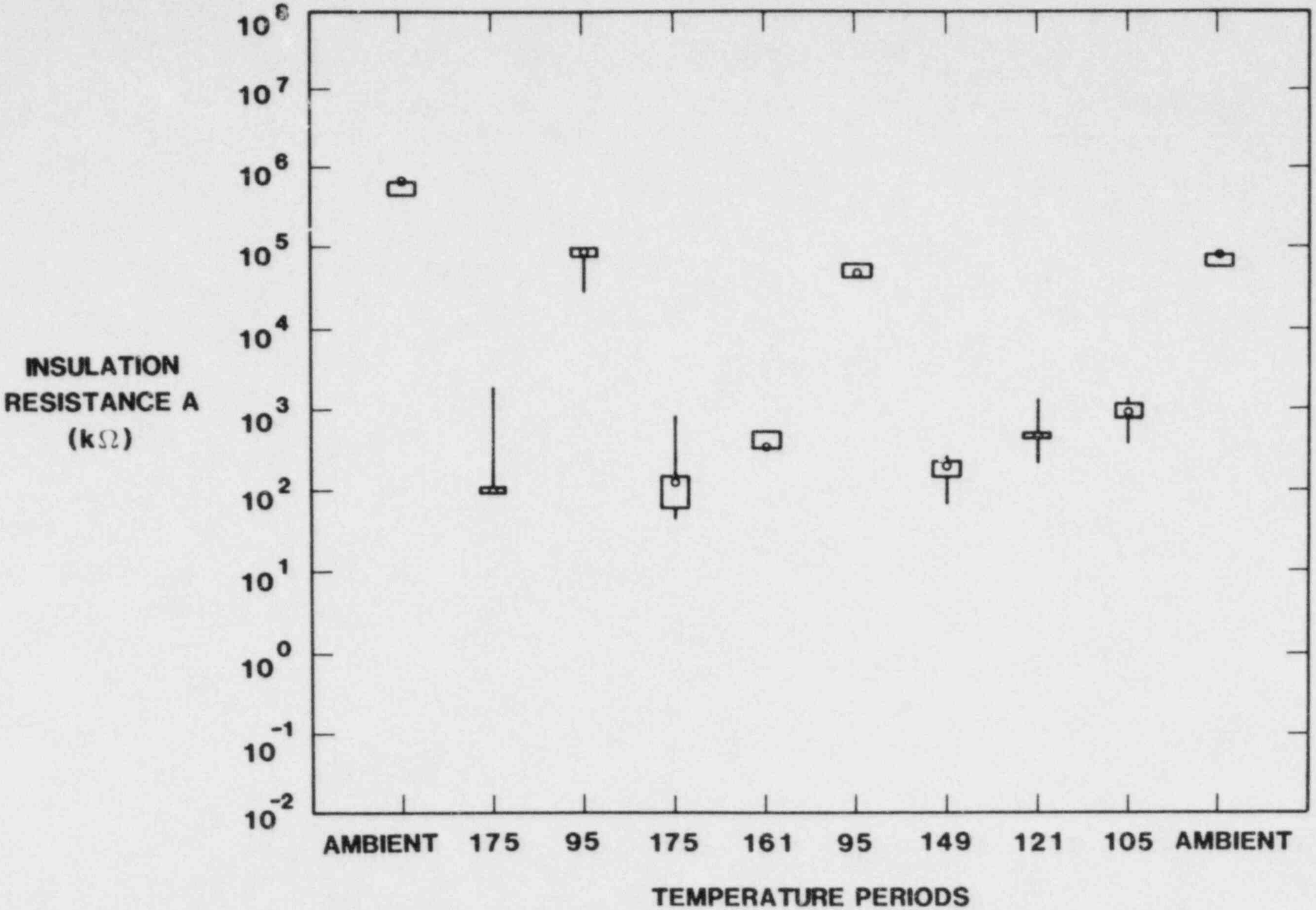

Figure A1-15

Box and Whisker Plot of Insulation Resistance A for TB 3, Phase II

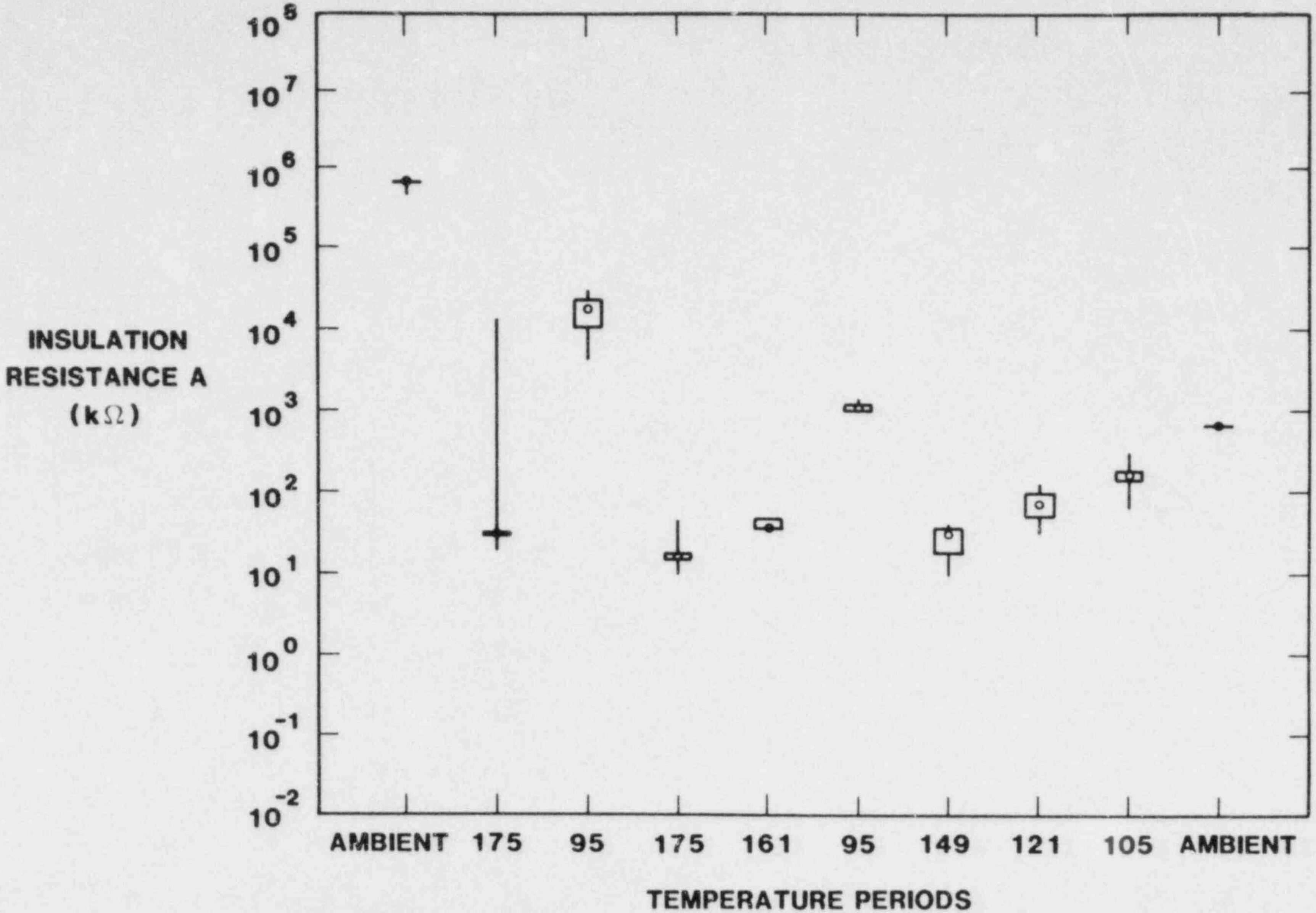

Figure A1-16

Box and Whisker Plot of Insulation Resistance A for TB 4, Phase II

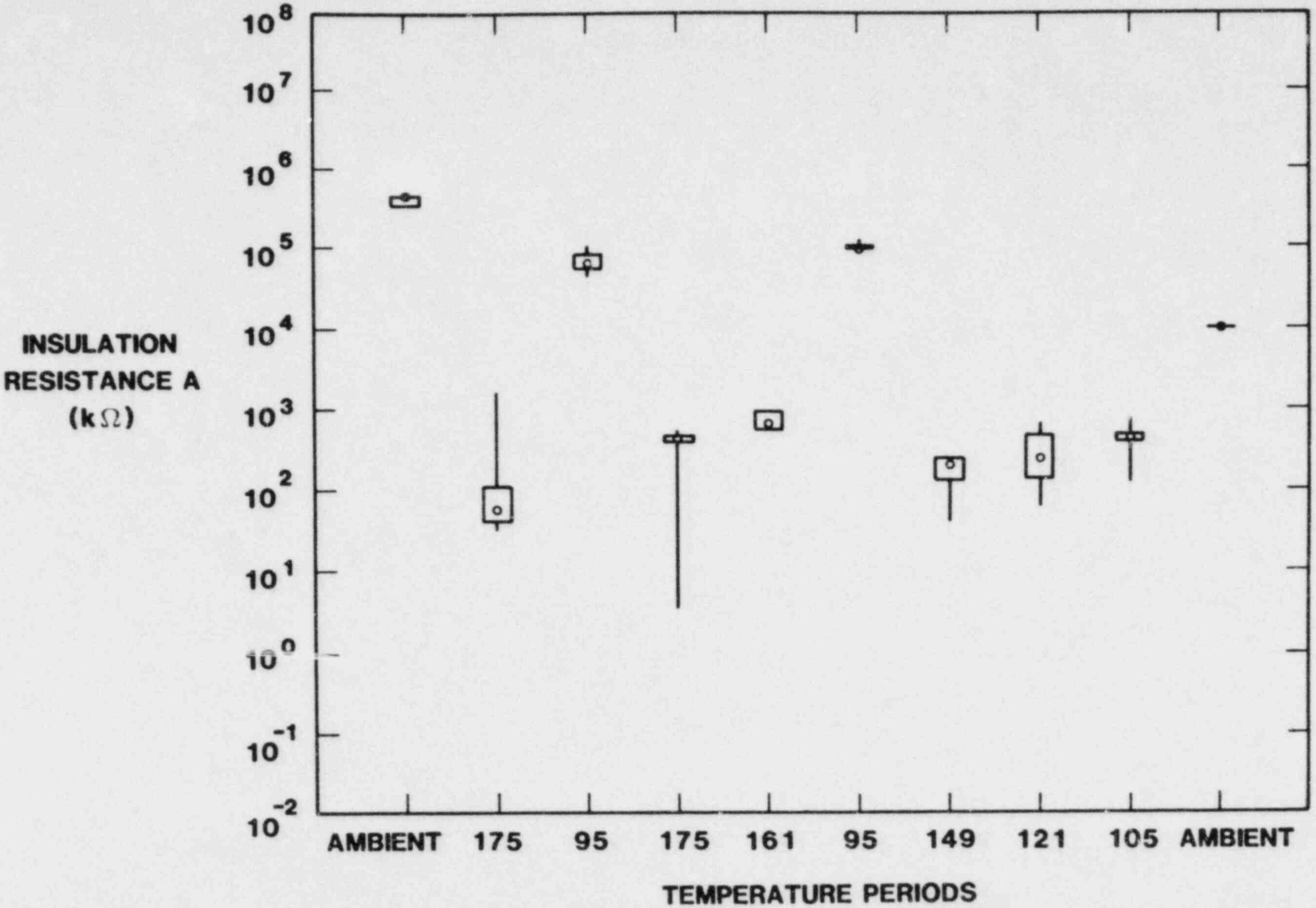

Figure A1-17

Box and Whisker Plot of Insulation Resistance A for TB 5, Phase II

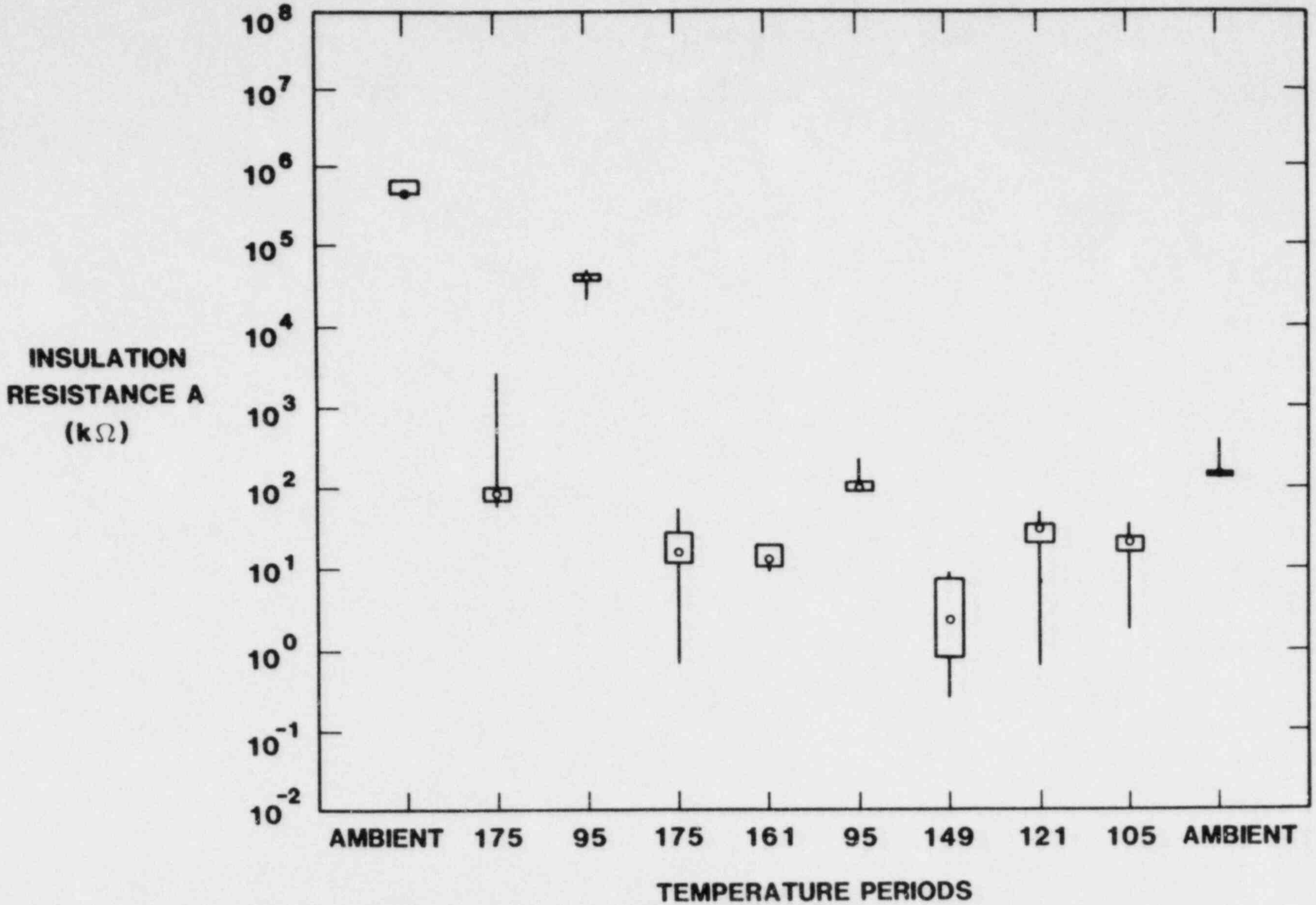

Figure A1-18

Box and Whisker Plot of Insulation Resistance A for TB 6, Phase II

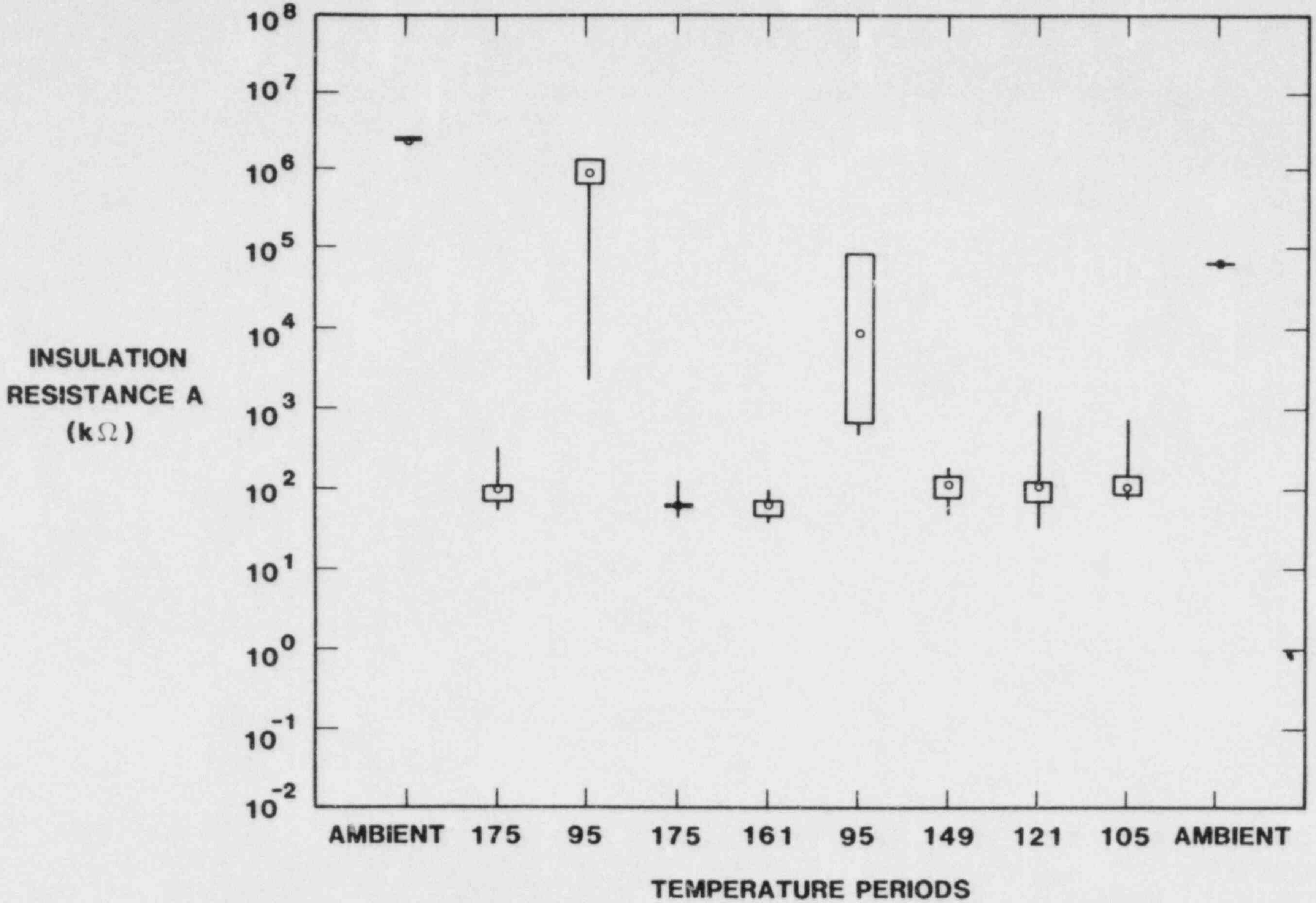

Figure A1-19

Box and Whisker Plot of Insulation Resistance A for TB 7, Phase II

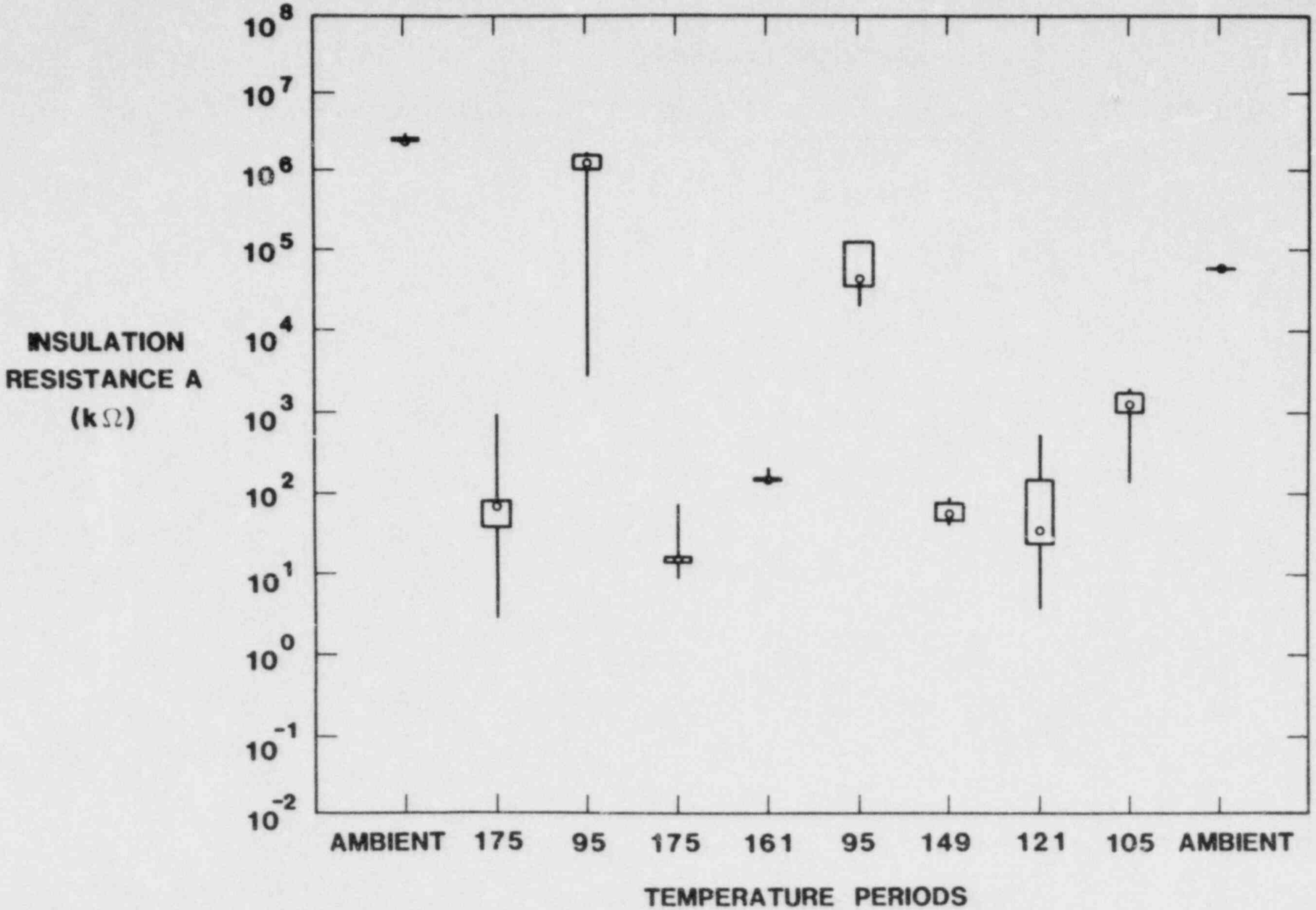

Figure A1-20

Box and Whisker Plot of Insulation Resistance A for TB 8, Phase II

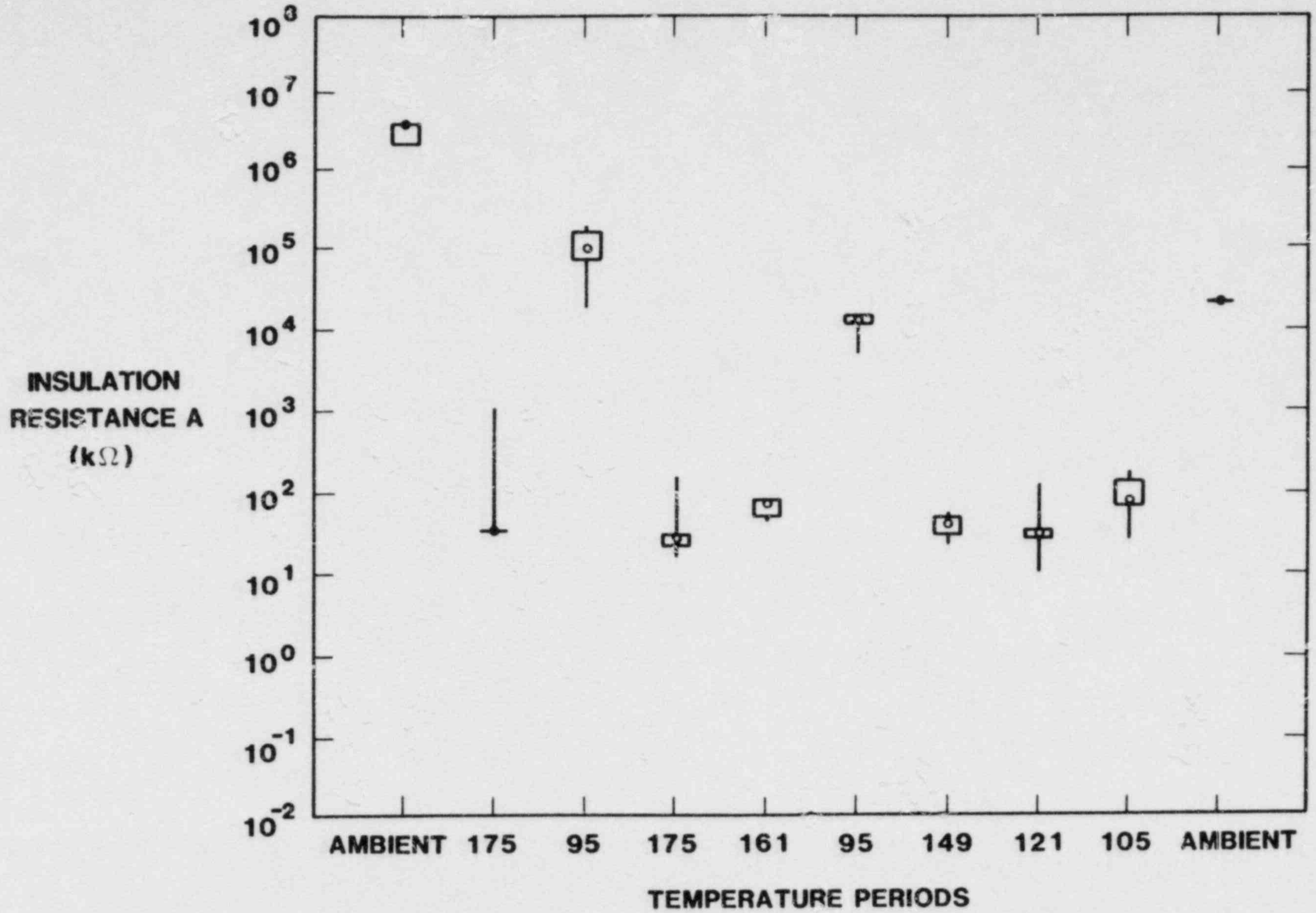

Figure A1-21

Box and Whisker Plot of Insulation Resistance A for TB 9, Phase II

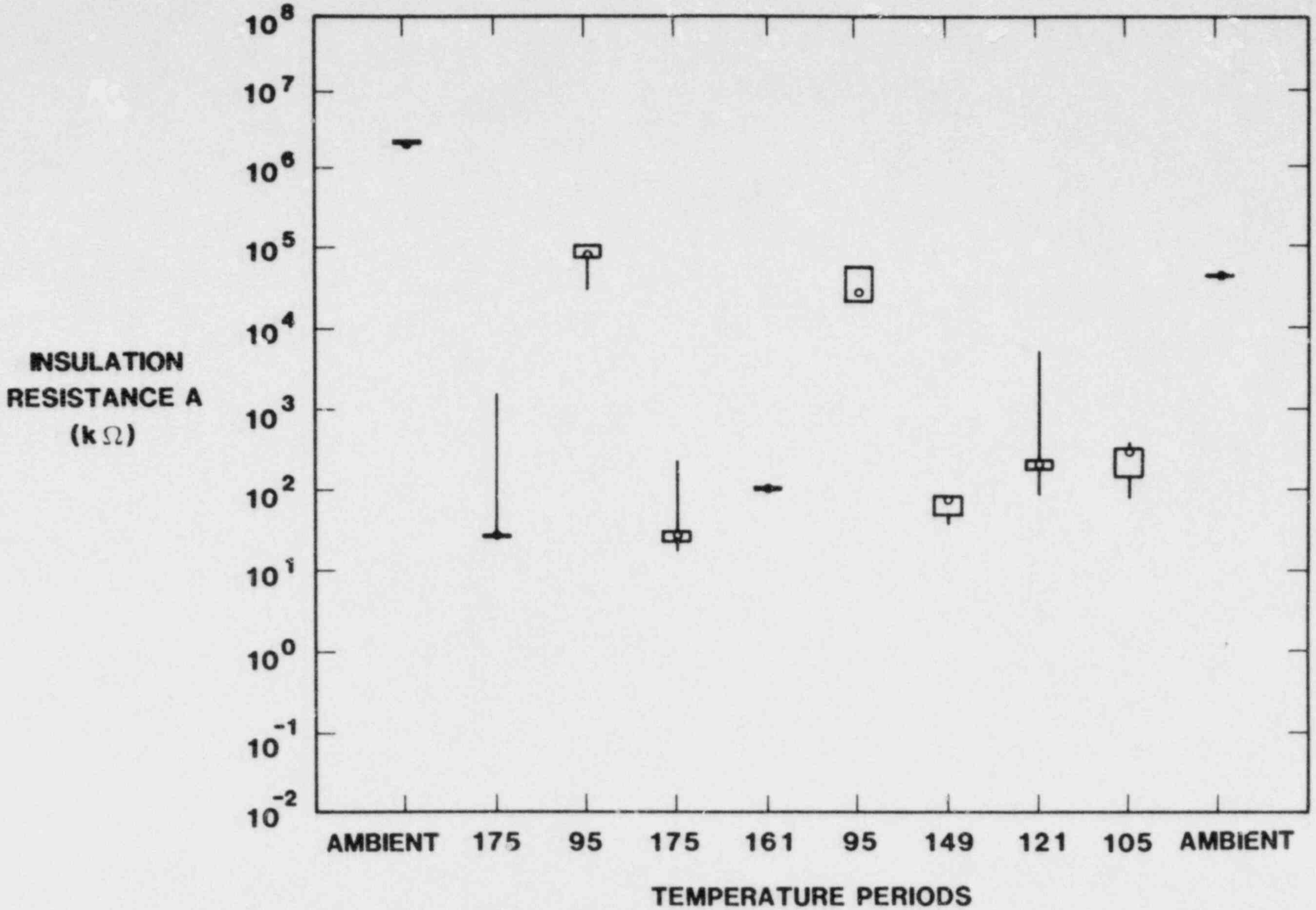

Figure A1-22

Box and Whisker Plot of Insulation Resistance A for TB 10, Phase II

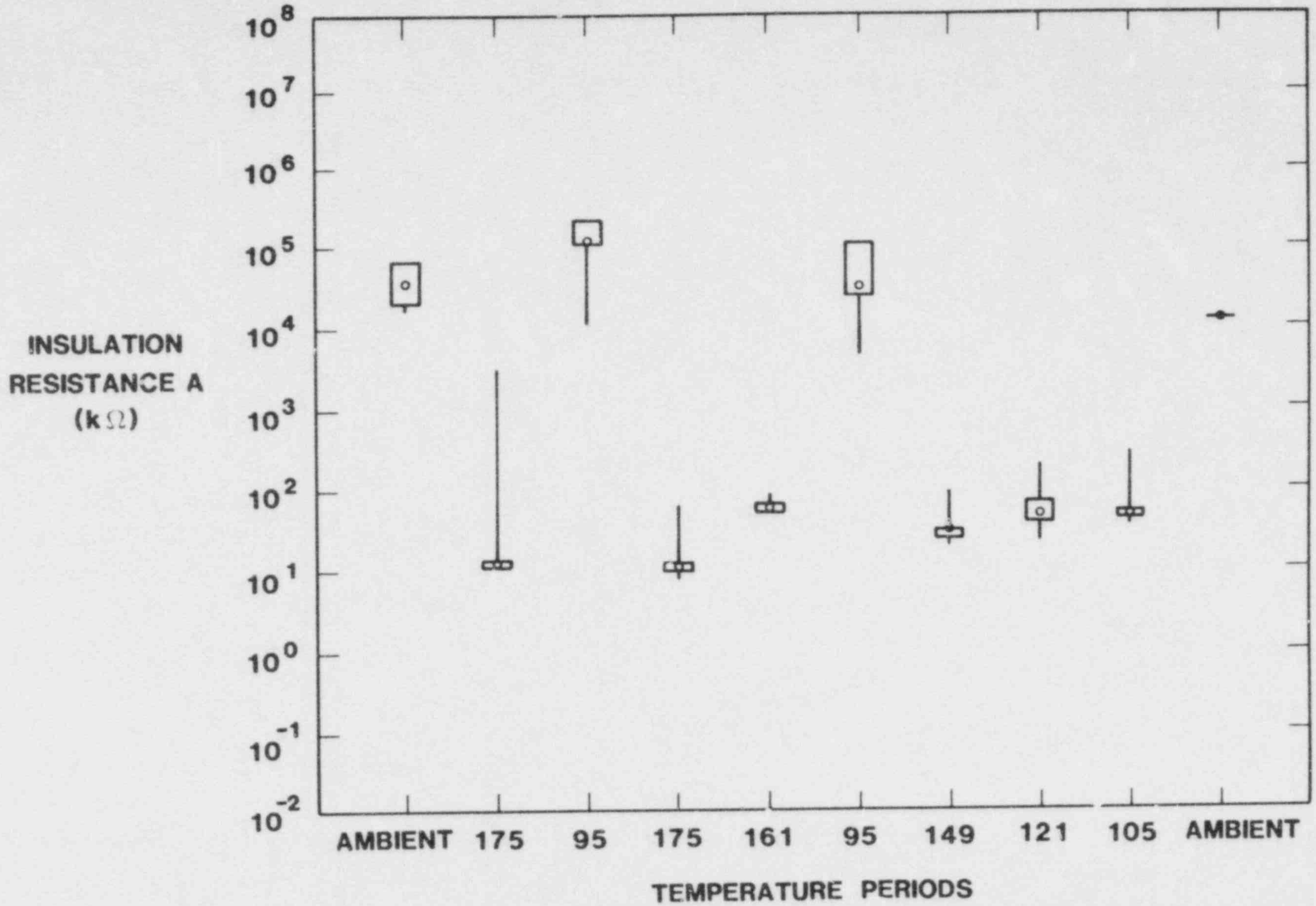

Figure A1-23

Box and Whisker Plot of Insulation Resistance A for TB 11, Phase II

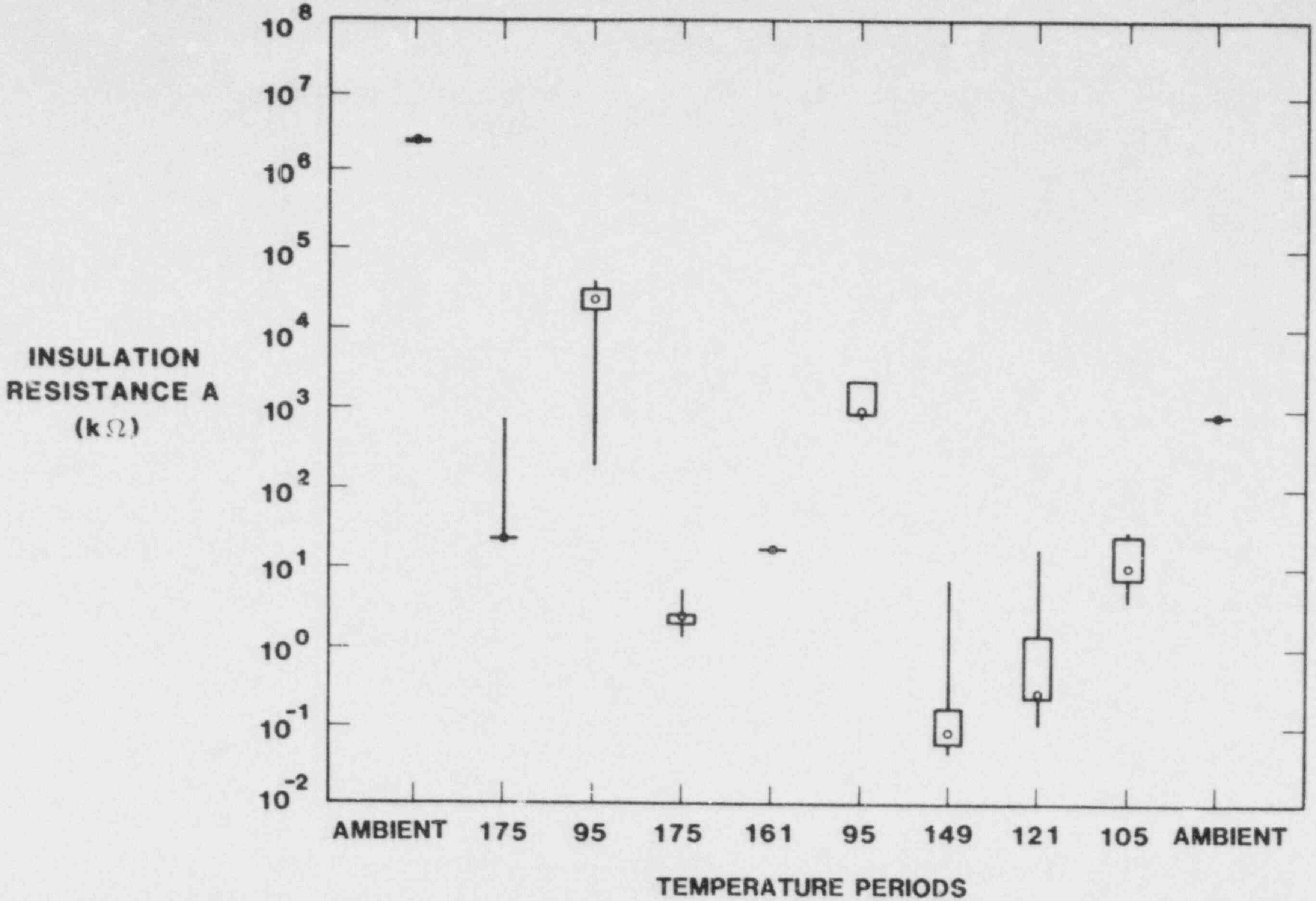

Figure A1-24

Box and Whisker Plot of Insulation Resistance A for TB 12, Phase II

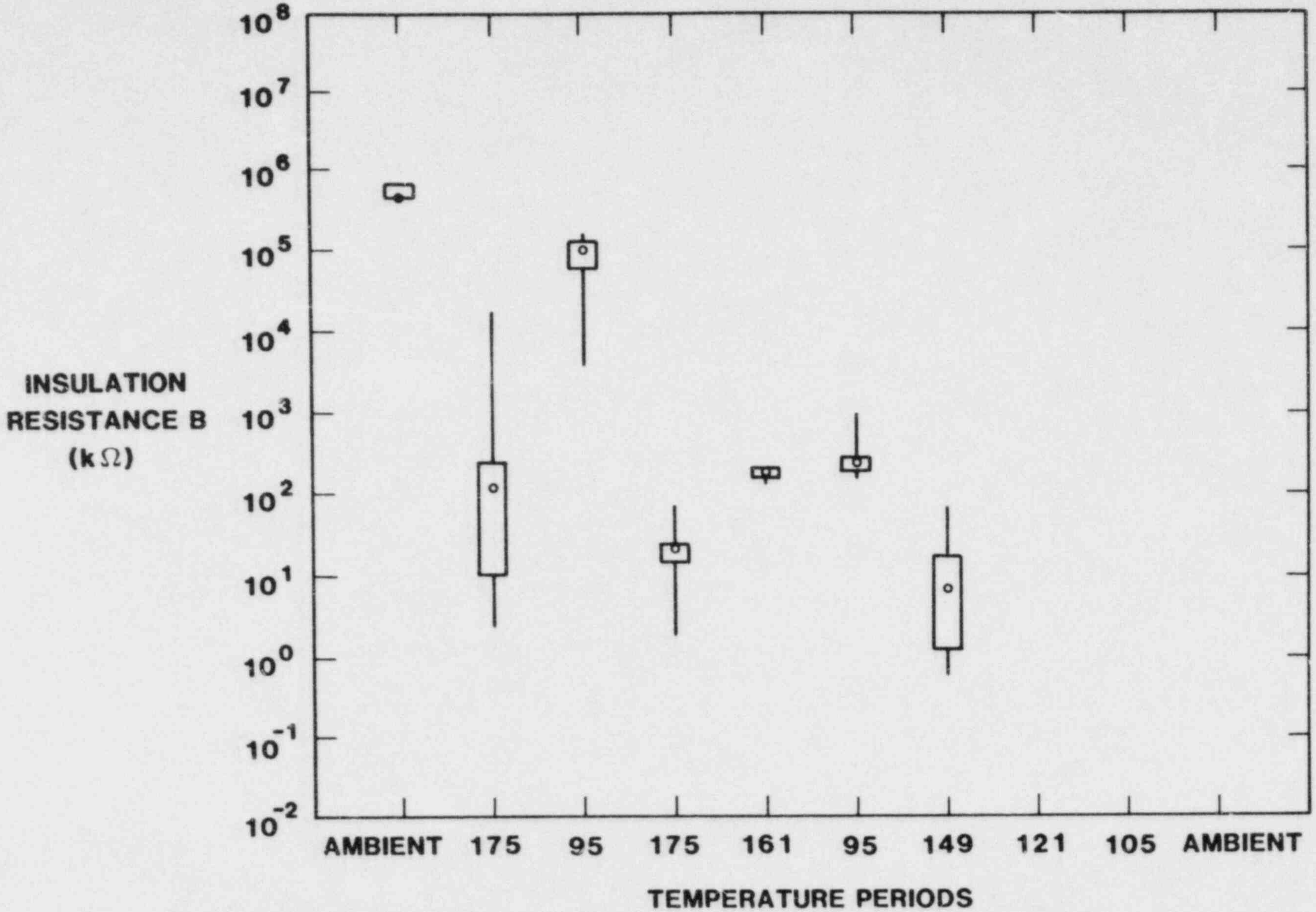

Figure A1-25

Box and Whisker Plot of Insulation Resistance B for TB 1, Phase II

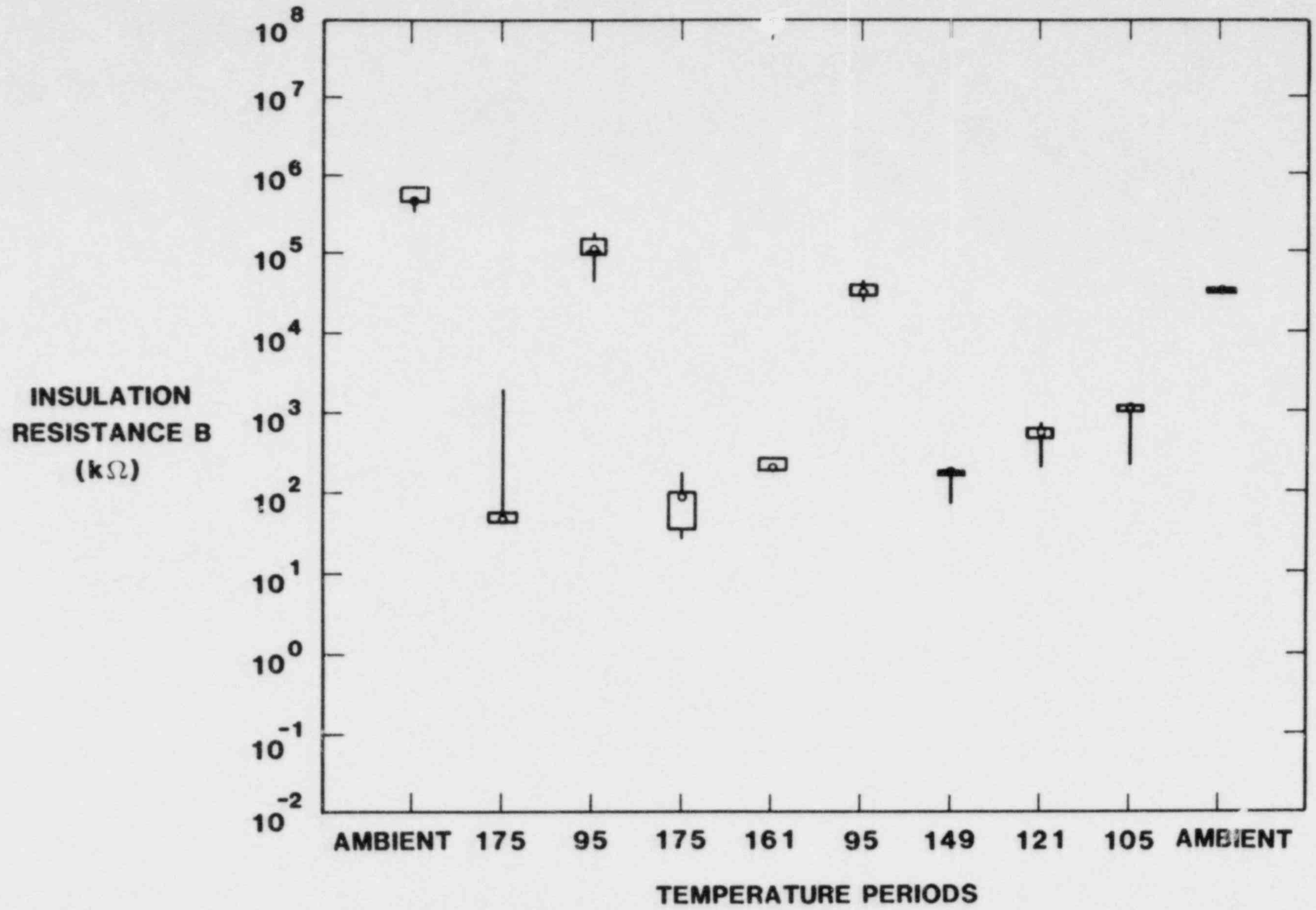

Figure A1-26

Box and Whisker Plot of Insulation Resistance B for TB 2, Phase II

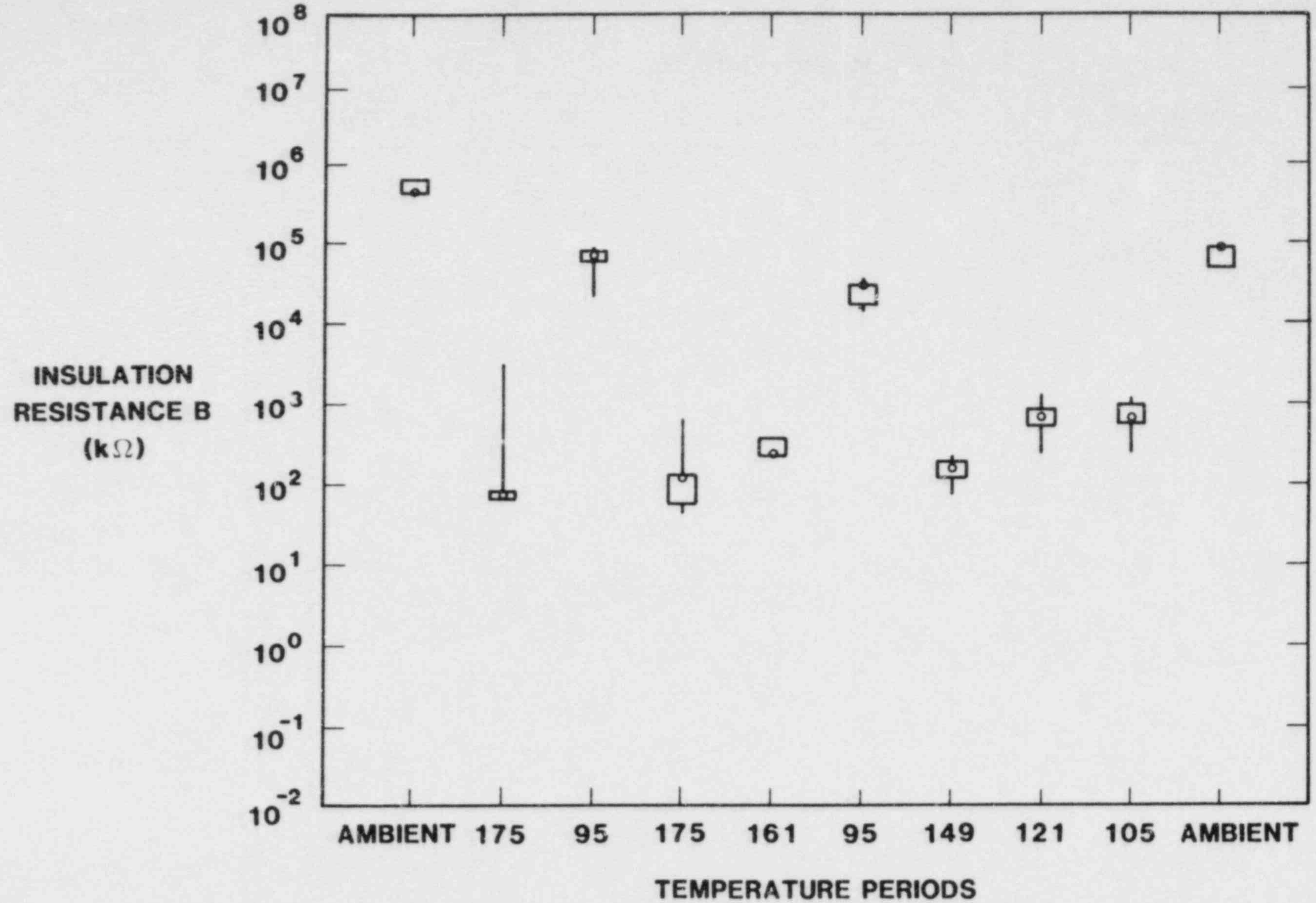

Figure A1-27

Box and Whisker Plot of Insulation Resistance B for TB 3, Phase II

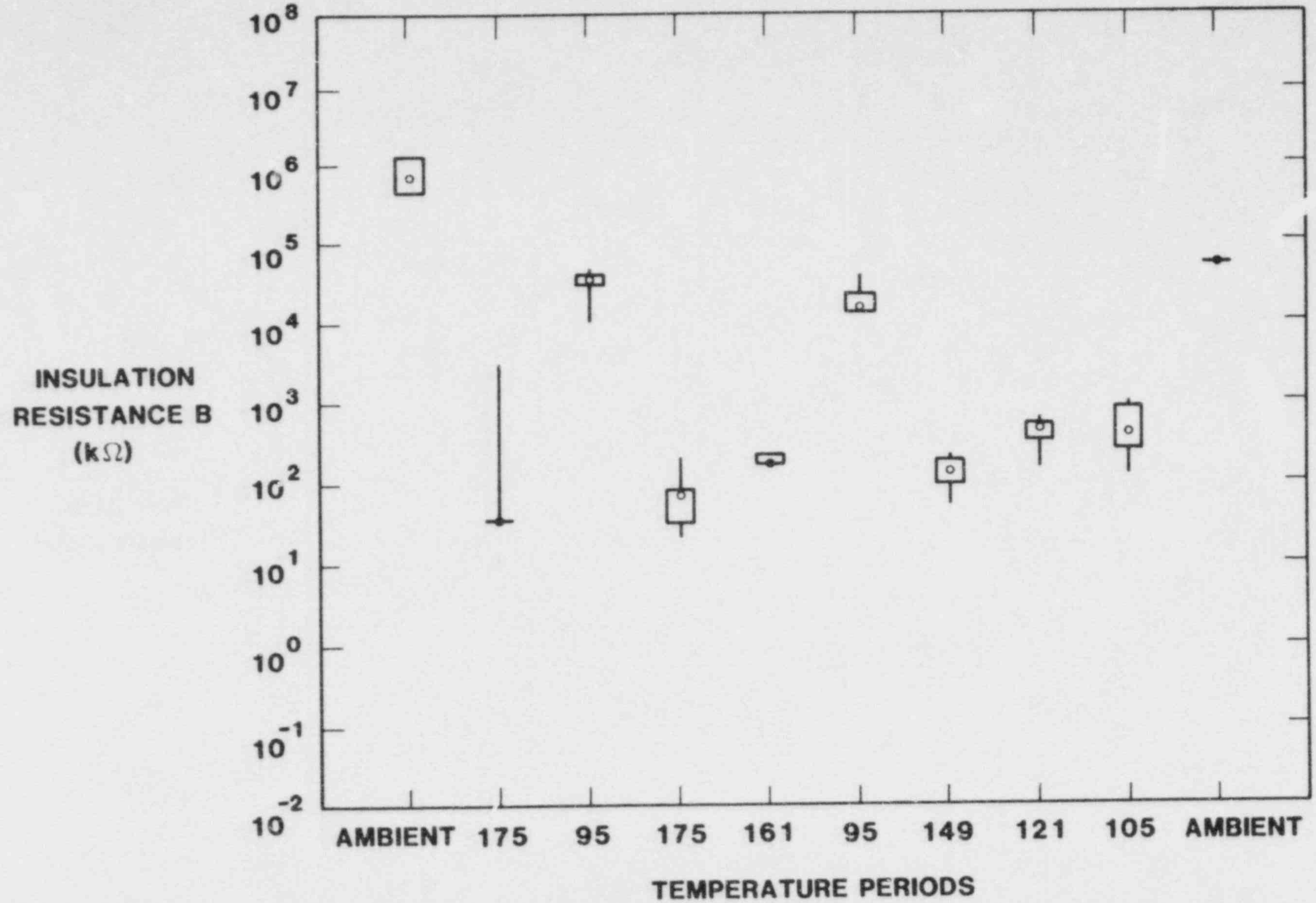

Figure A1-28

Box and Whisker Plot of Insulation Resistance B for TB 4, Phase II

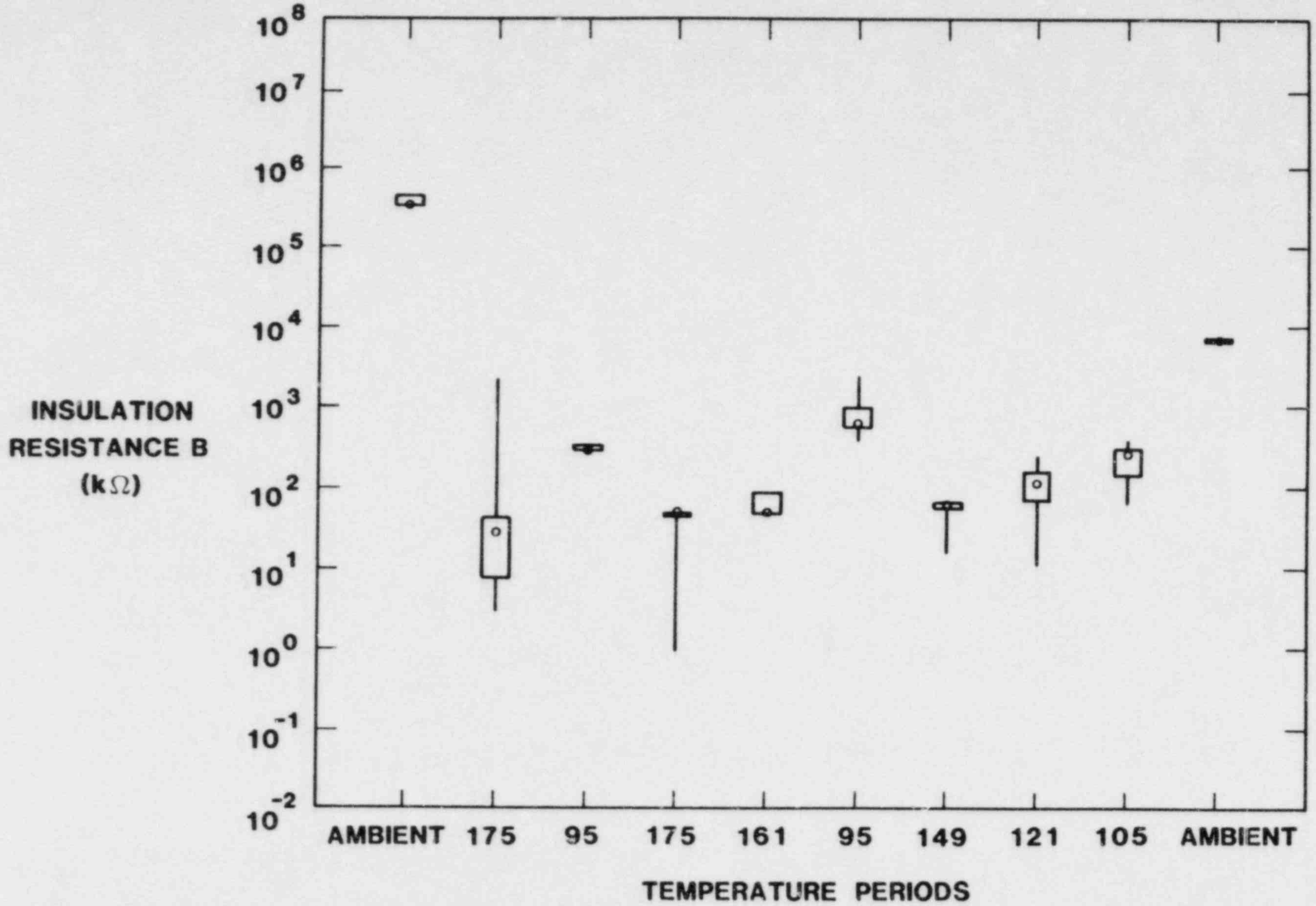

Figure A1-29

Box and Whisker Plot of Insulation Resistance B for TB 5, Phase II

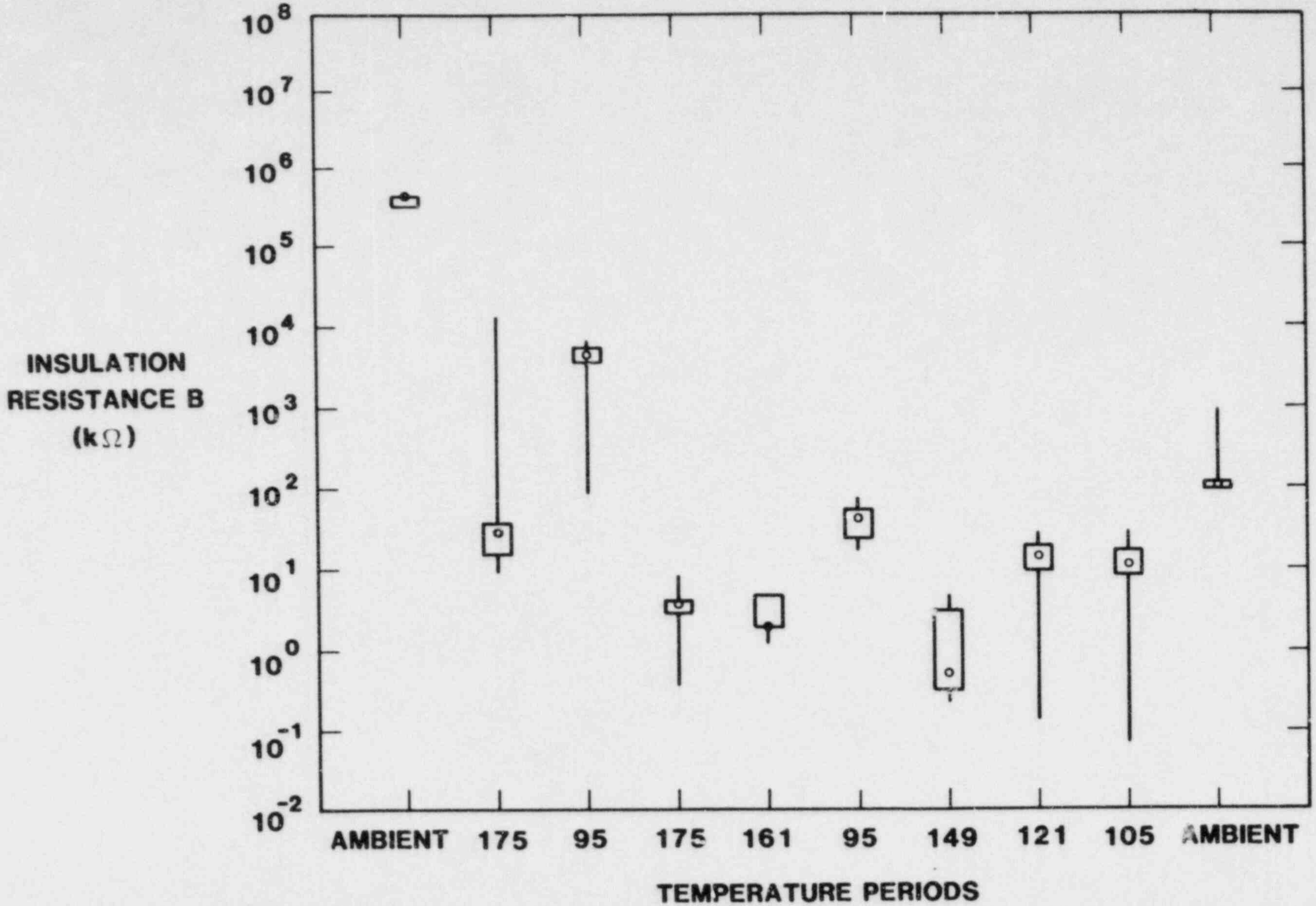

Figure A1-30

Box and Whisker Plot of Insulation Resistance B for TB 6, Phase II

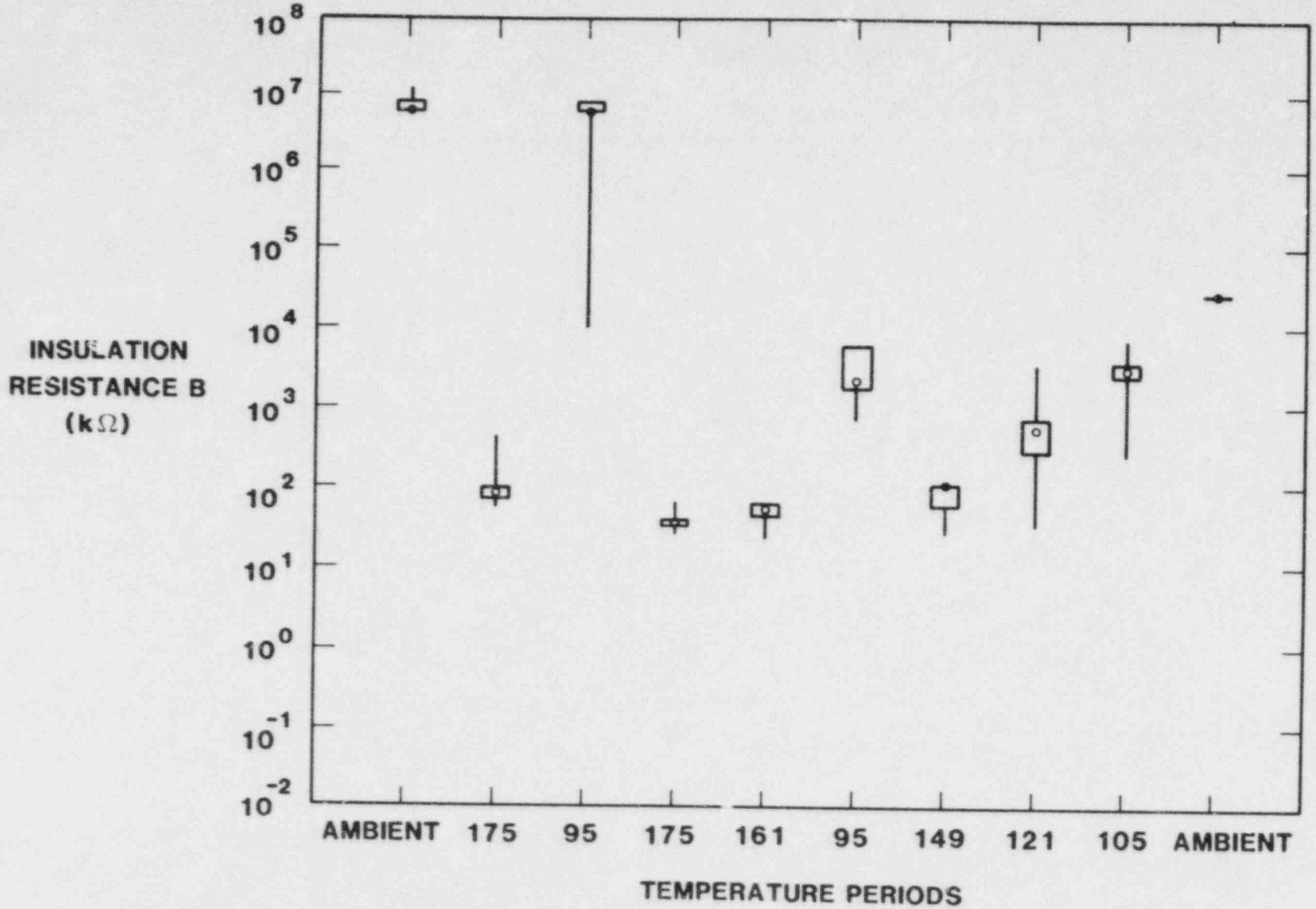

Figure A1-31

Box and Whisker Plot of Insulation Resistance B for TB 7, Phase II

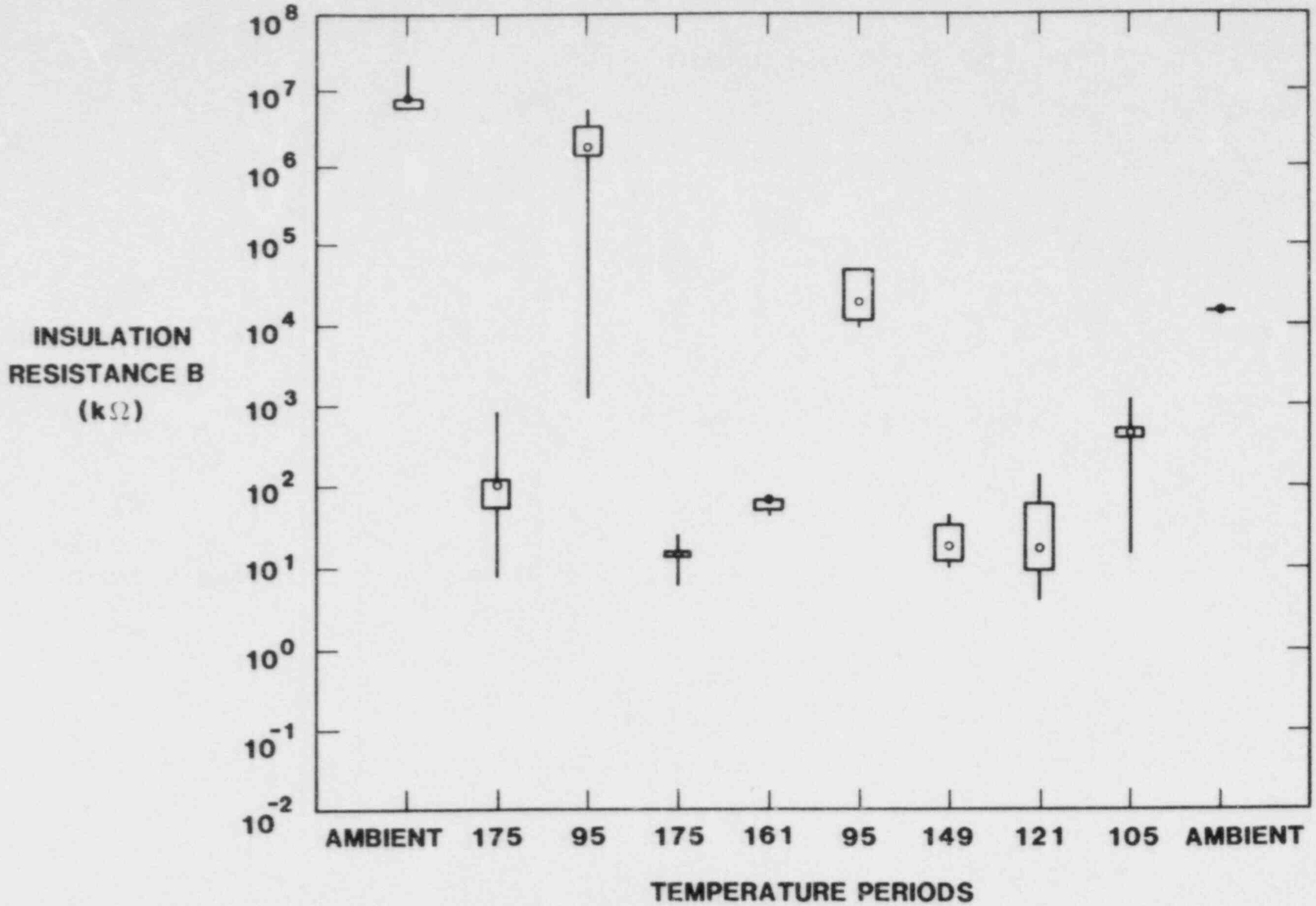

Figure A1-32

Box and Whisker Plot of Insulation Resistance B for TB 8, Phase II

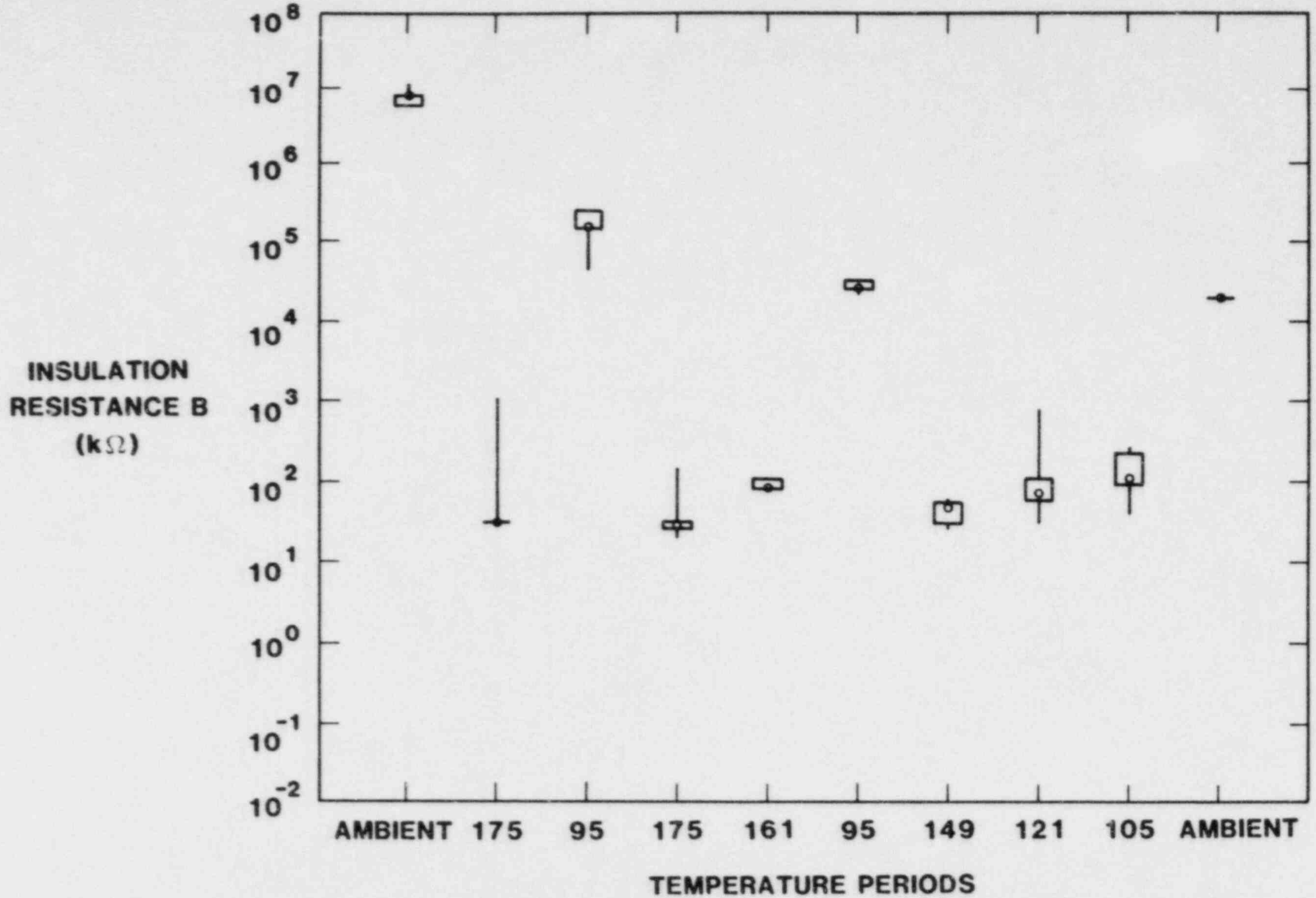

Figure A1-33

Box and Whisker Plot of Insulation Resistance B for TB 9, Phase II

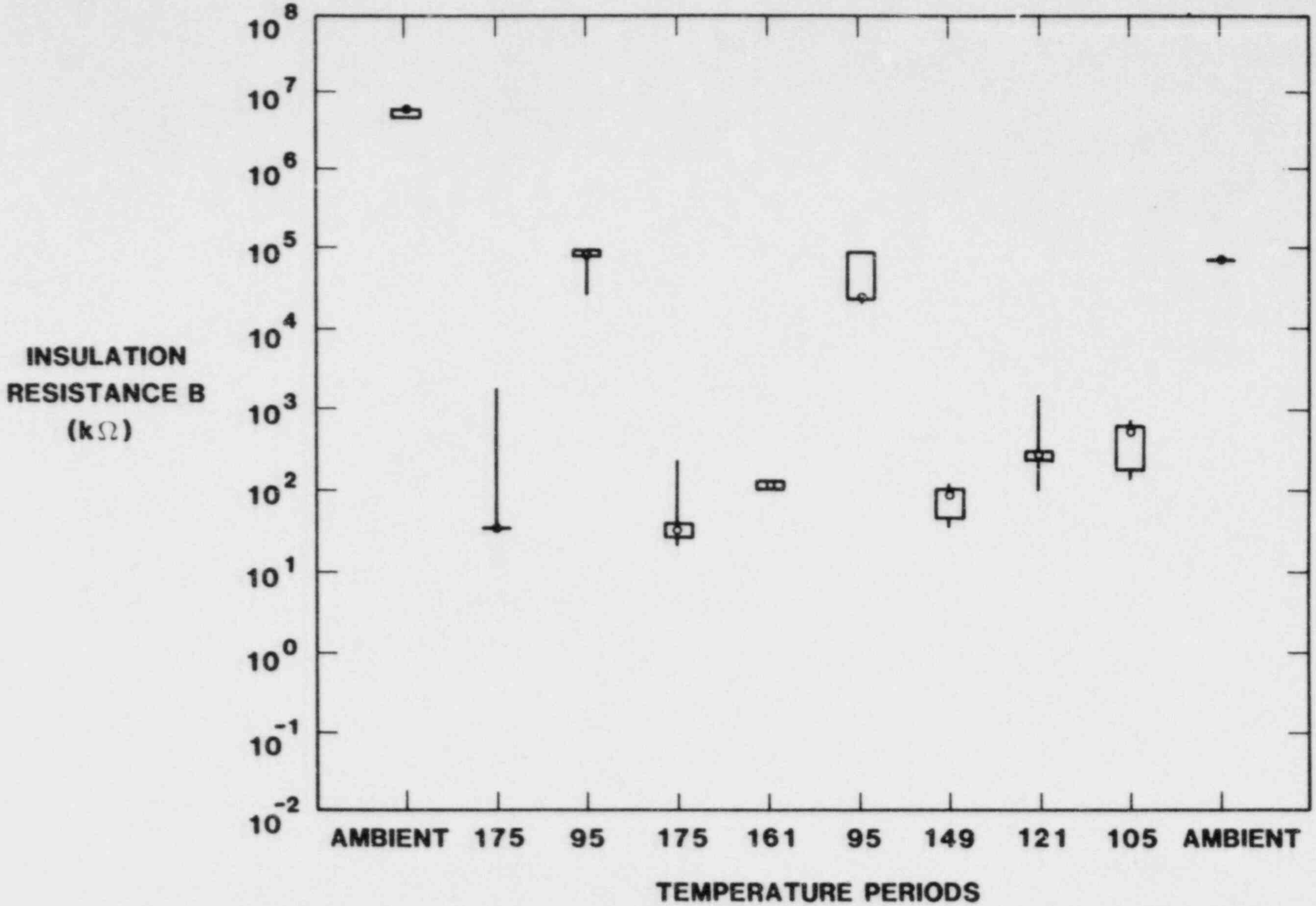

Figure A1-34

Box and Whisker Plot of Insulation Resistance B for TB 10, Phase II

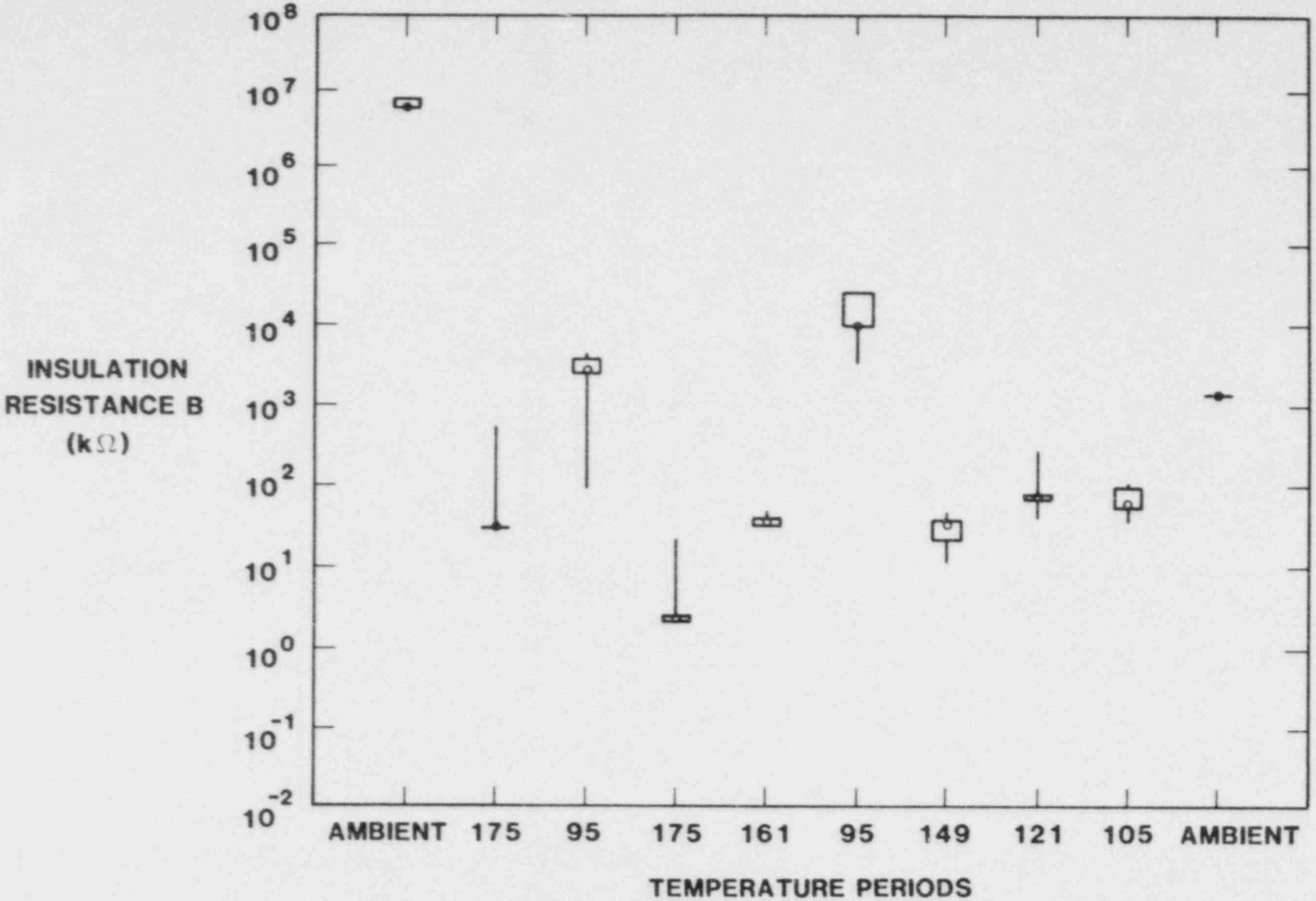

Figure A1-35

Box and Whisker Plot of Insulation Resistance B for TB 12, Phase II

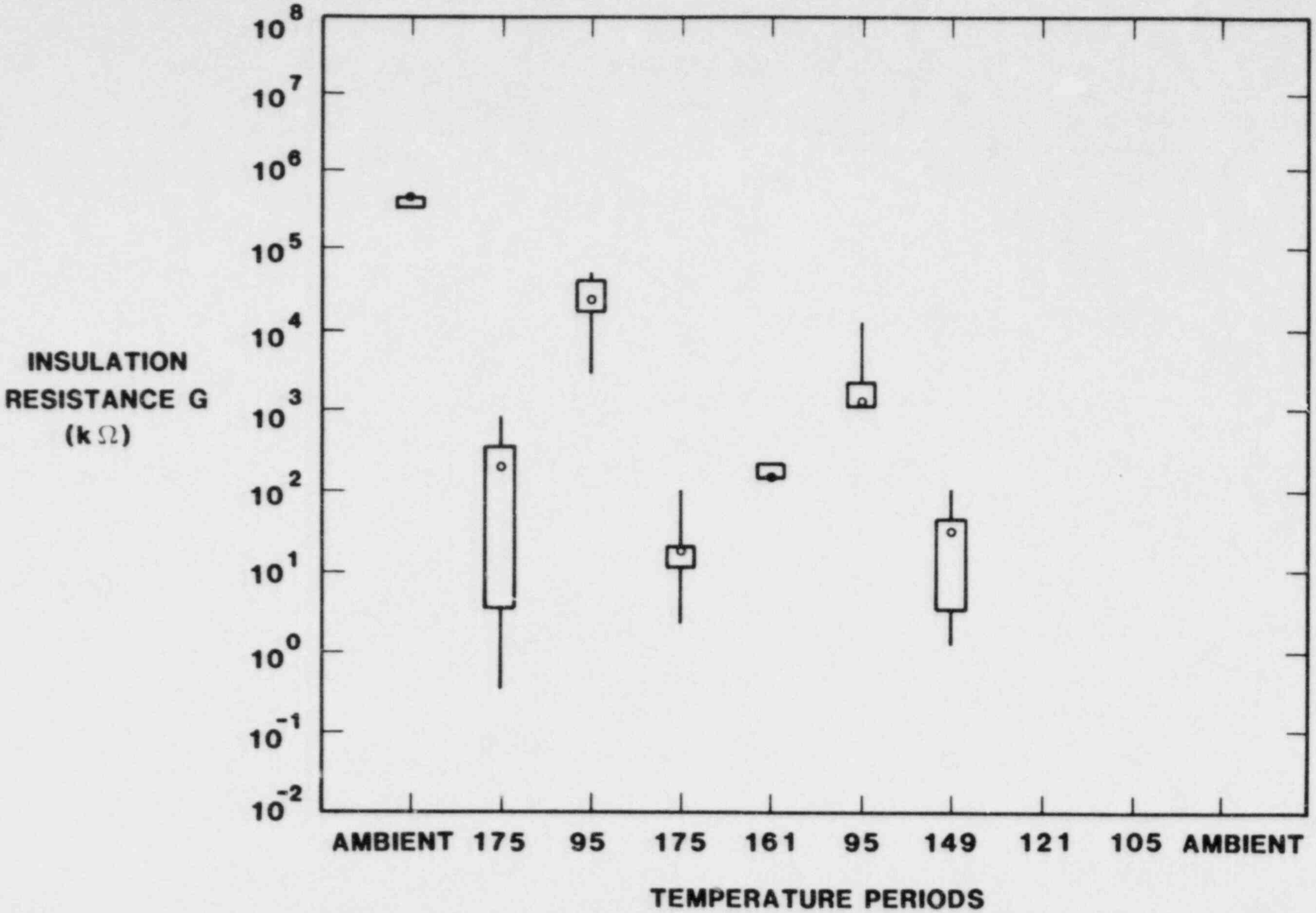

Figure A1-36

Box and Whisker Plot of Insulation Resistance G for TB 1, Phase II

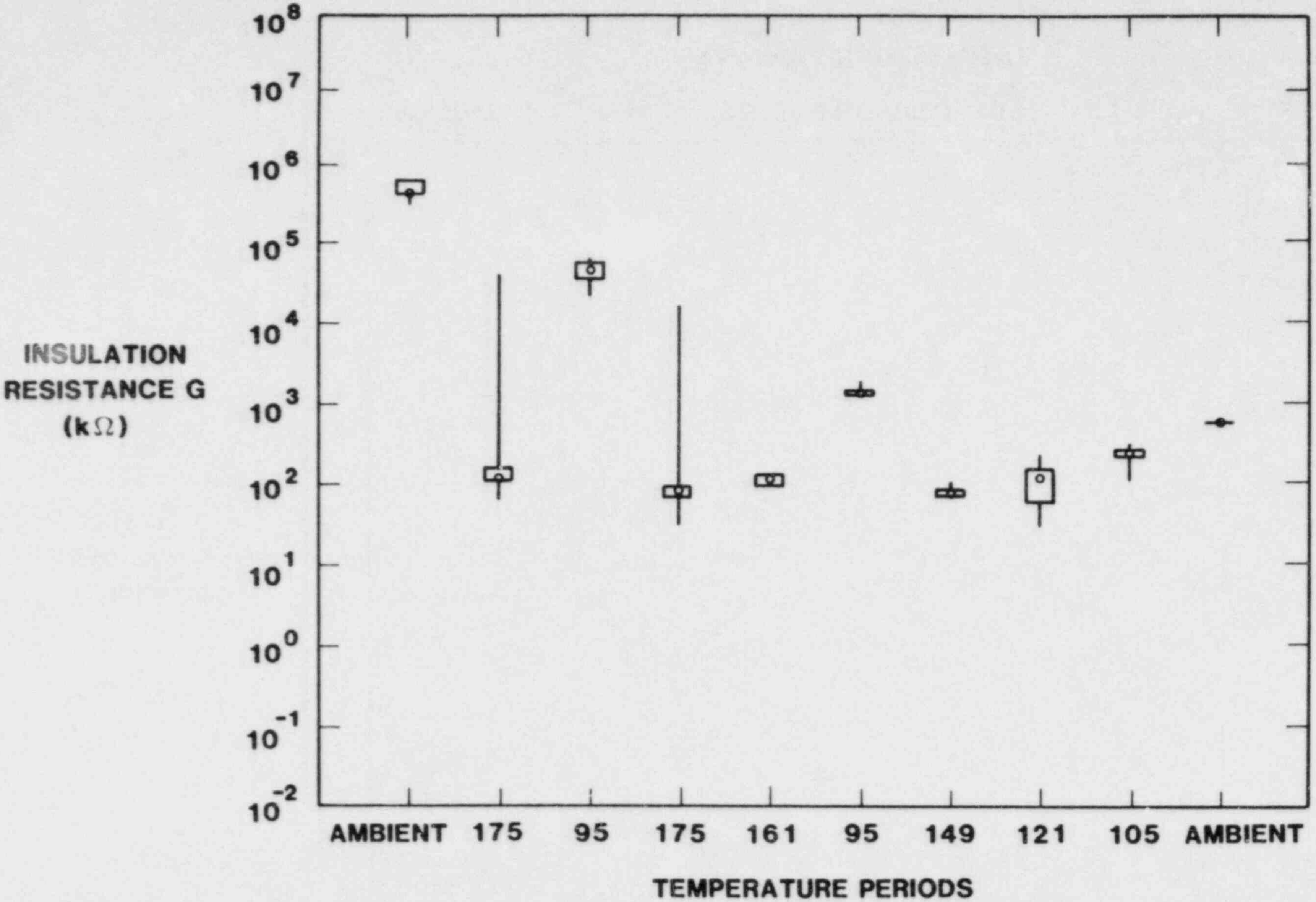

Figure A1-37

Box and Whisker Plot of Insulation Resistance G for TB 2, Phase II

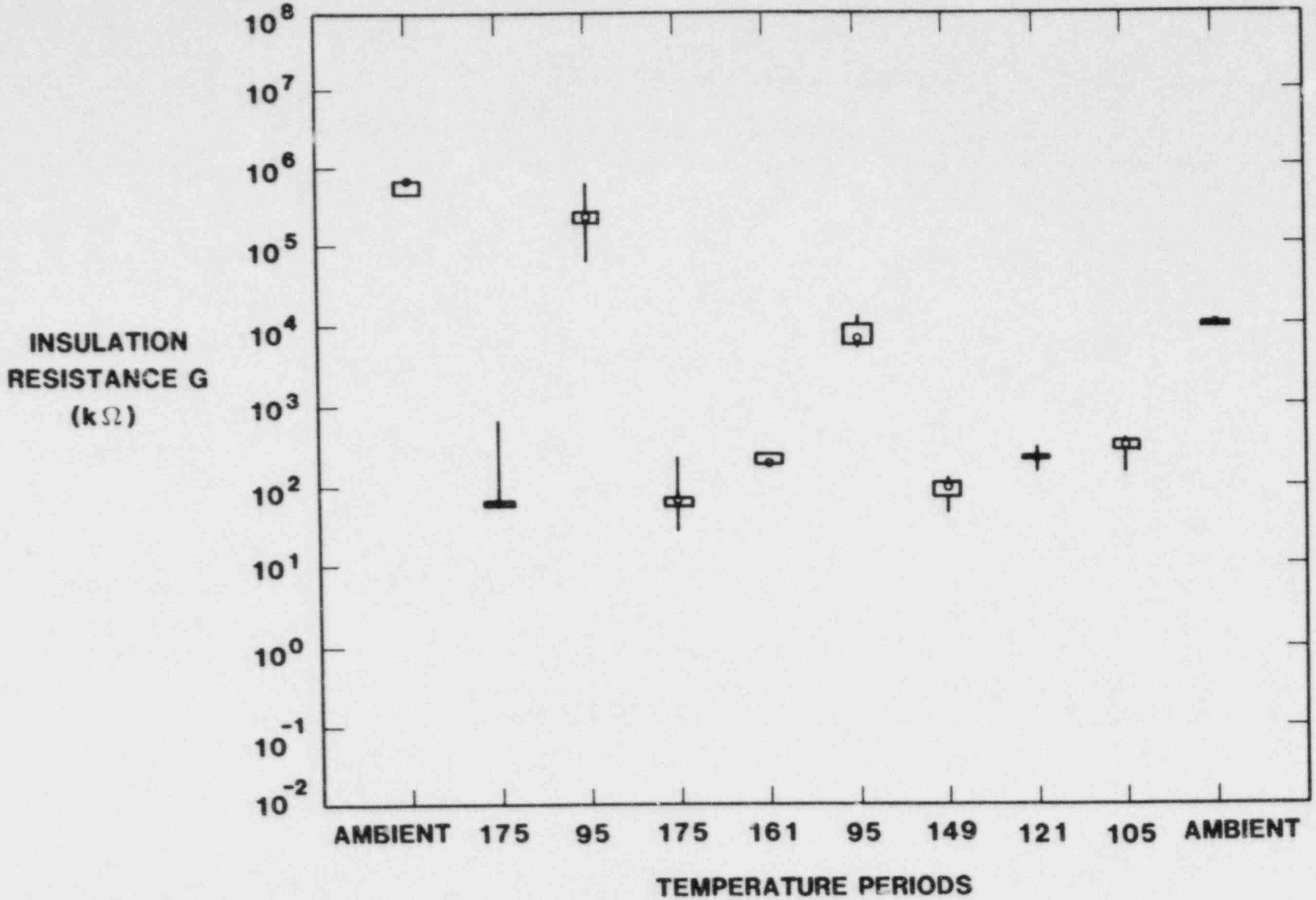

Figure A1-38

Box and Whisker Plot of Insulation Resistance G for TB 3, Phase II

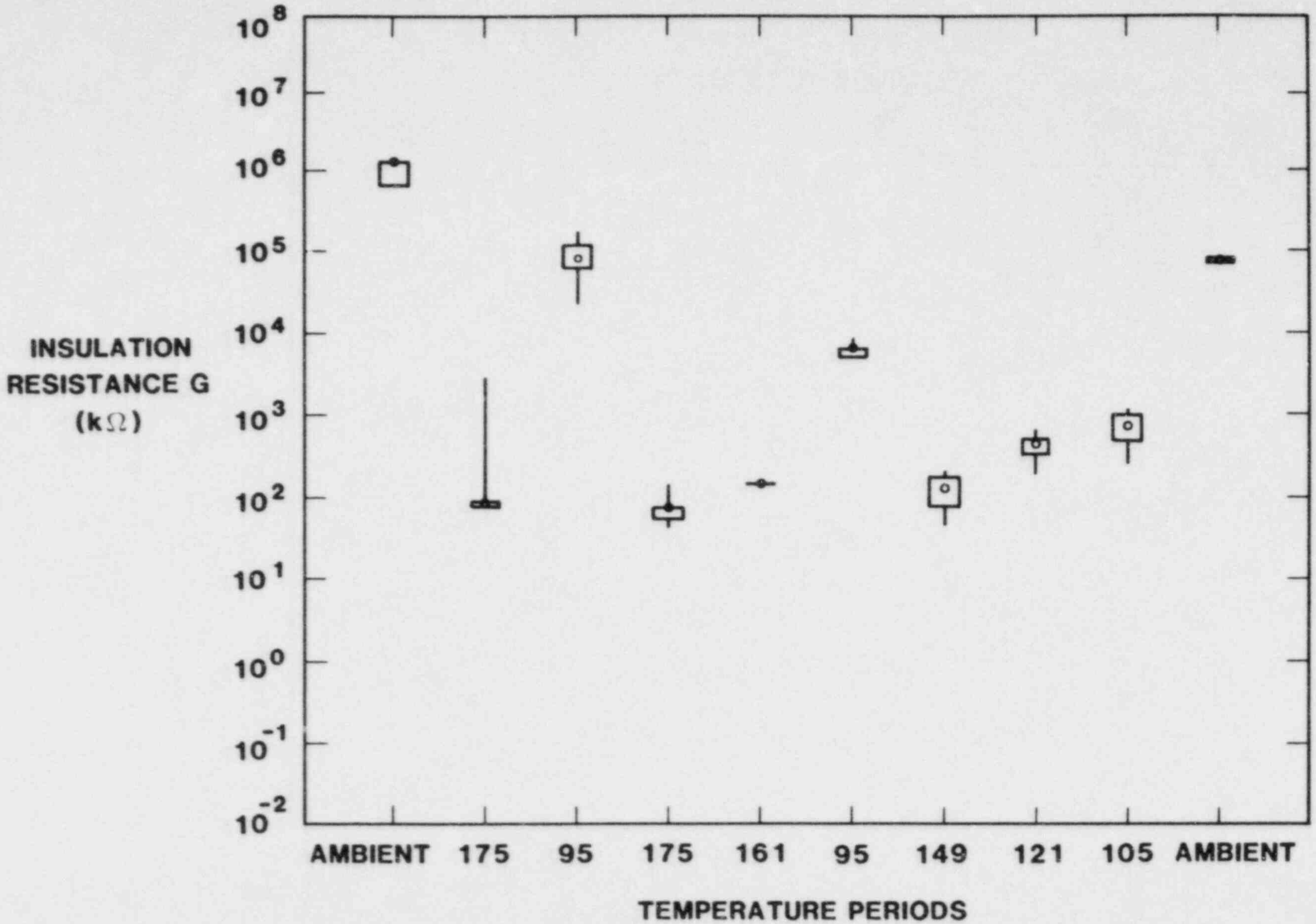

Figure A1-39

Box and Whisker Plot of Insulation Resistance G for TB 4, Phase II

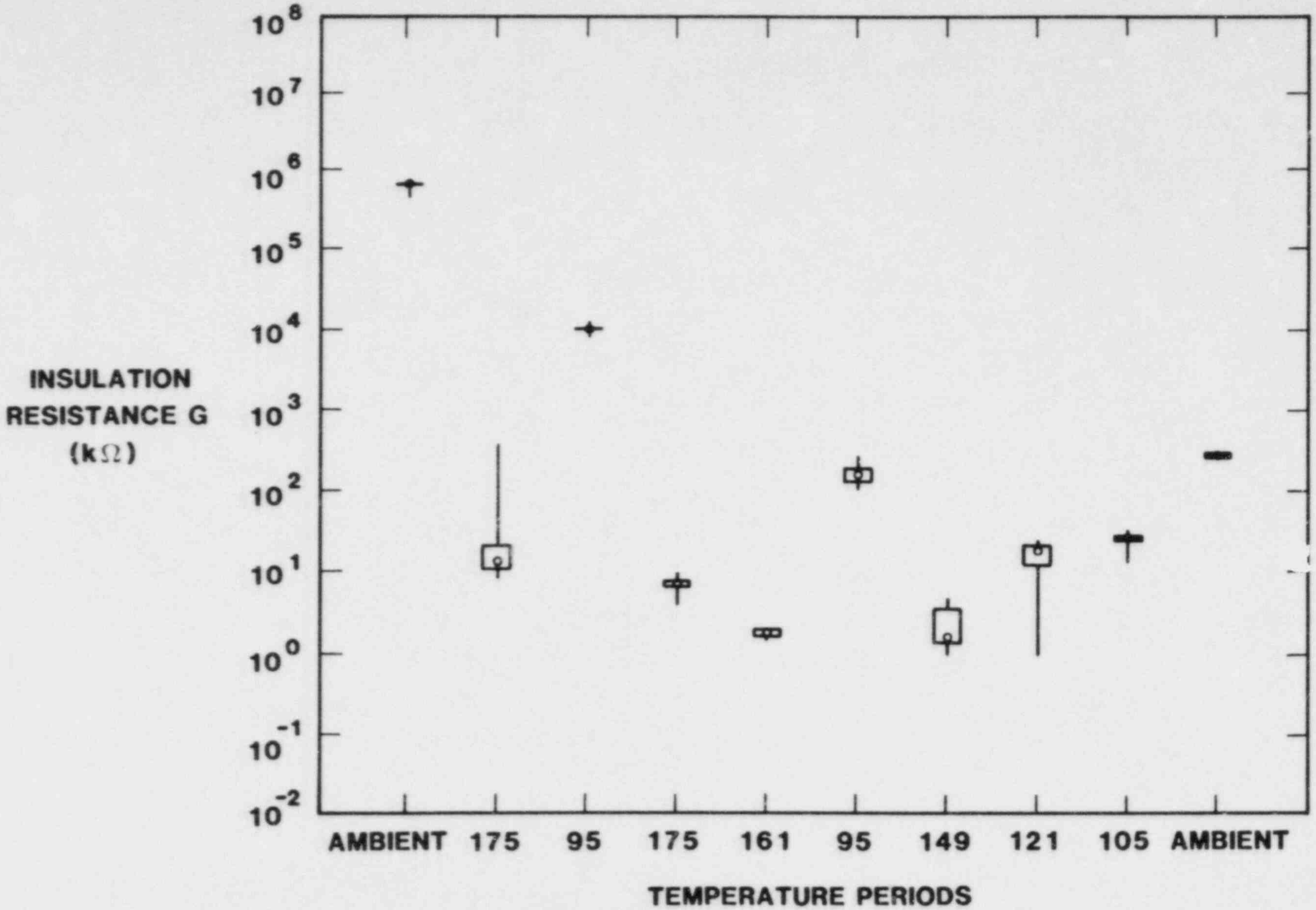

Figure A1-40

Box and Whisker Plot of Insulation Resistance G for TB 5, Phase II

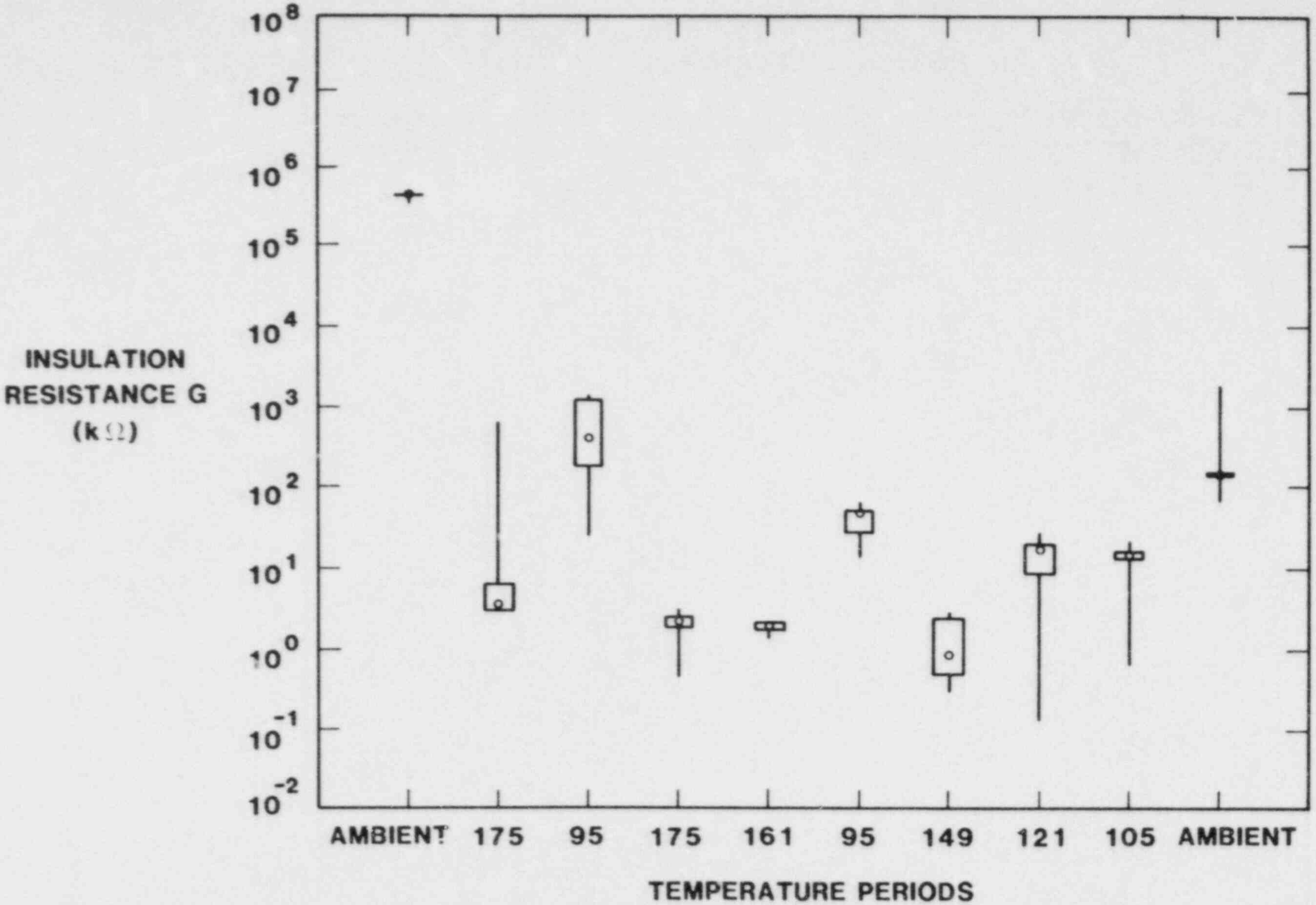

Figure A1-41

Box and Whisker Plot of Insulation Resistance G for TB 6, Phase II

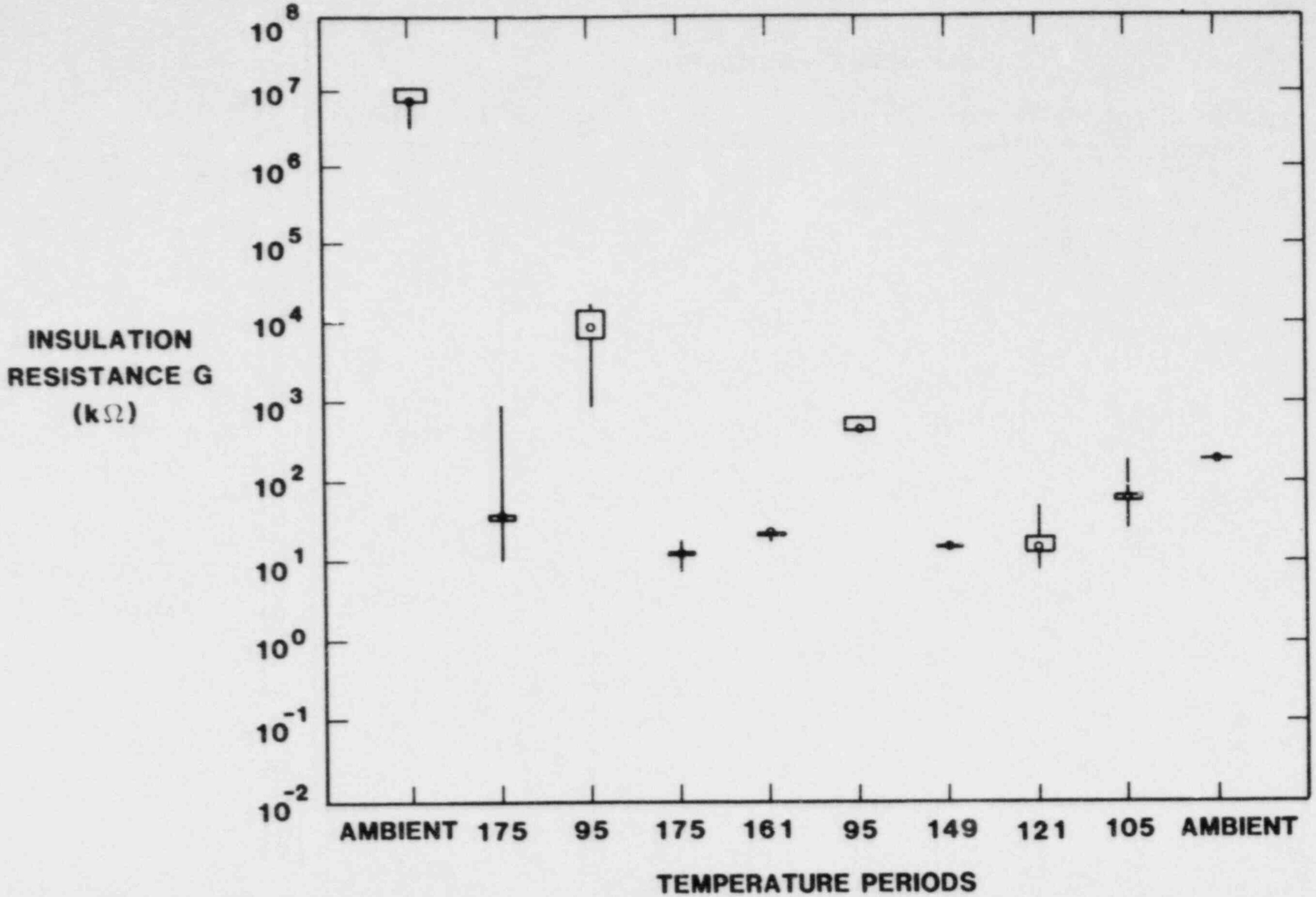

Figure A1-42

Box and Whisker Plot of Insulation Resistance G for TB 7, Phase II

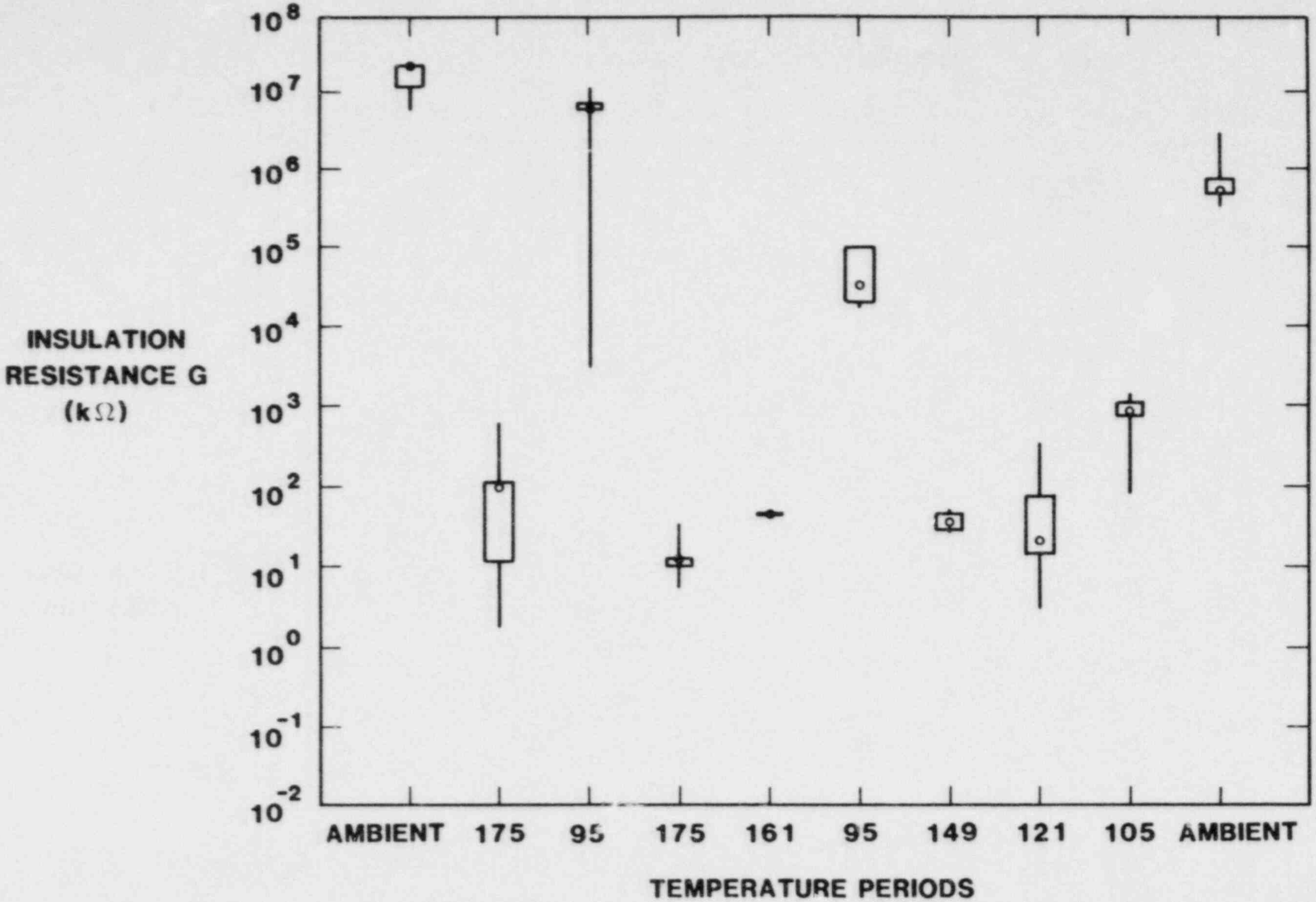

Figure A1-43

Box and Whisker Plot of Insulation Resistance G for TB 8, Phase II

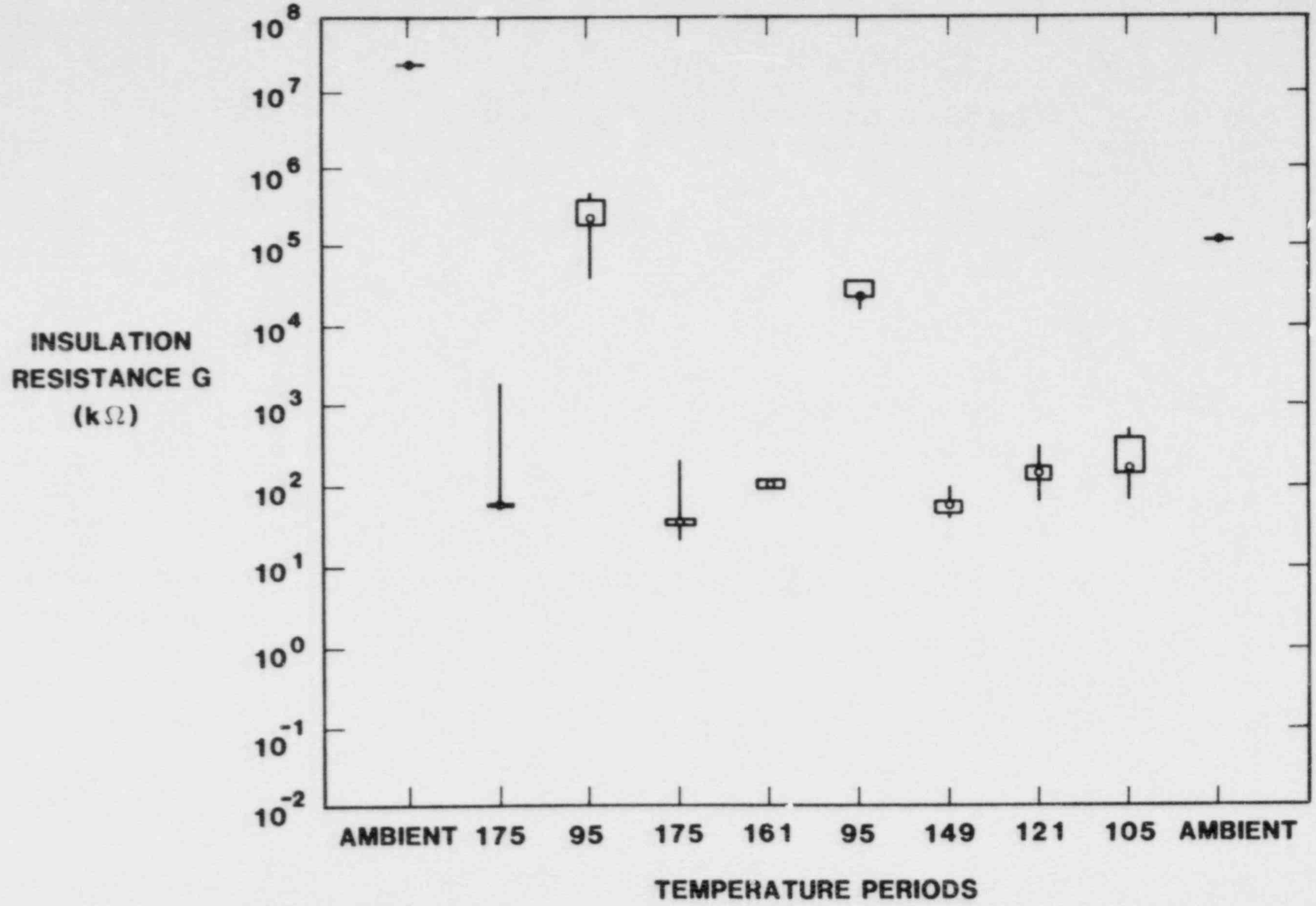

Figure A1-44

Box and Whisker Plot of Insulation Resistance G for TB 9, Phase II

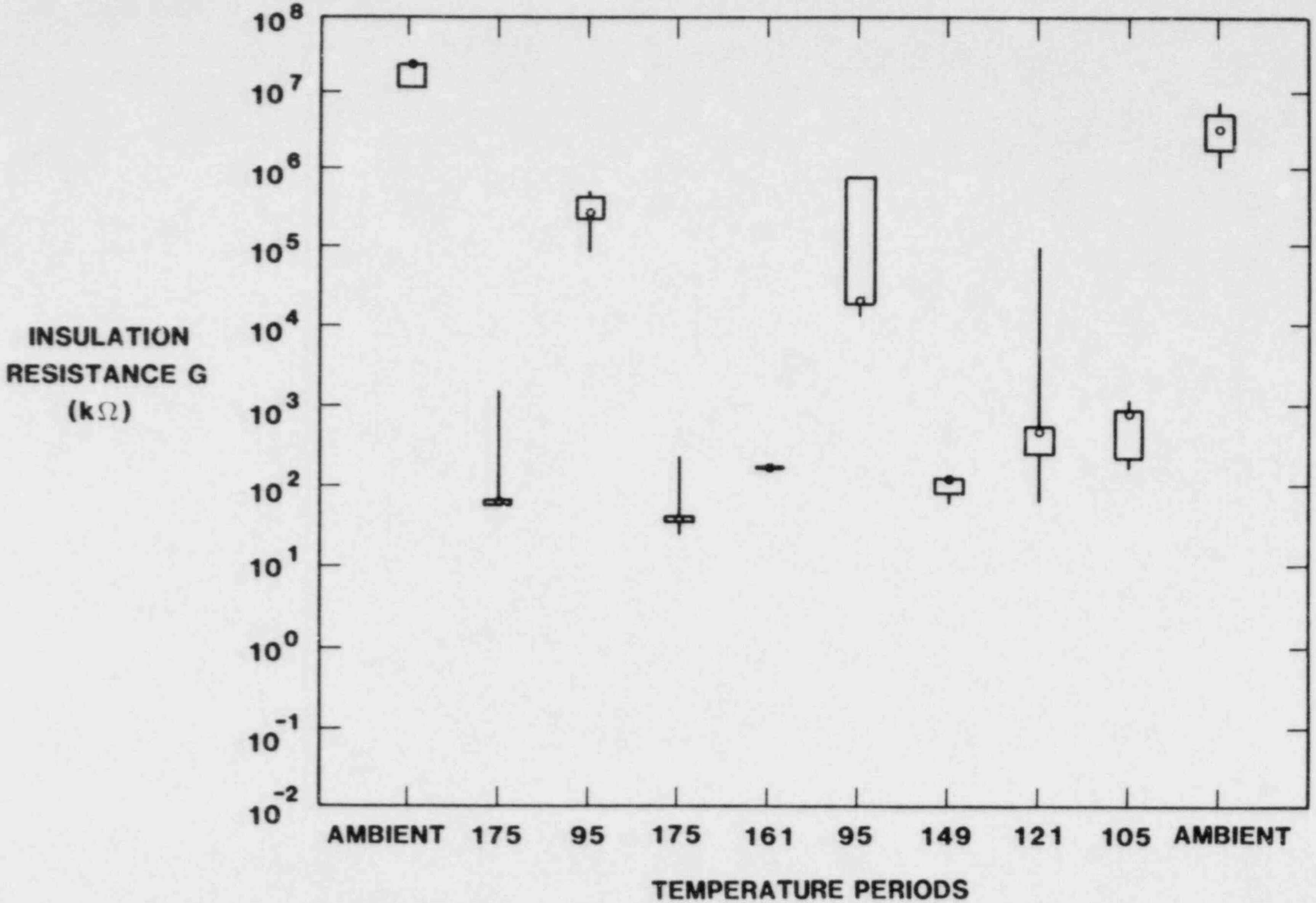

Figure A1-45

Box and Whisker Plot of Insulation Resistance G for TB 10, Phase II

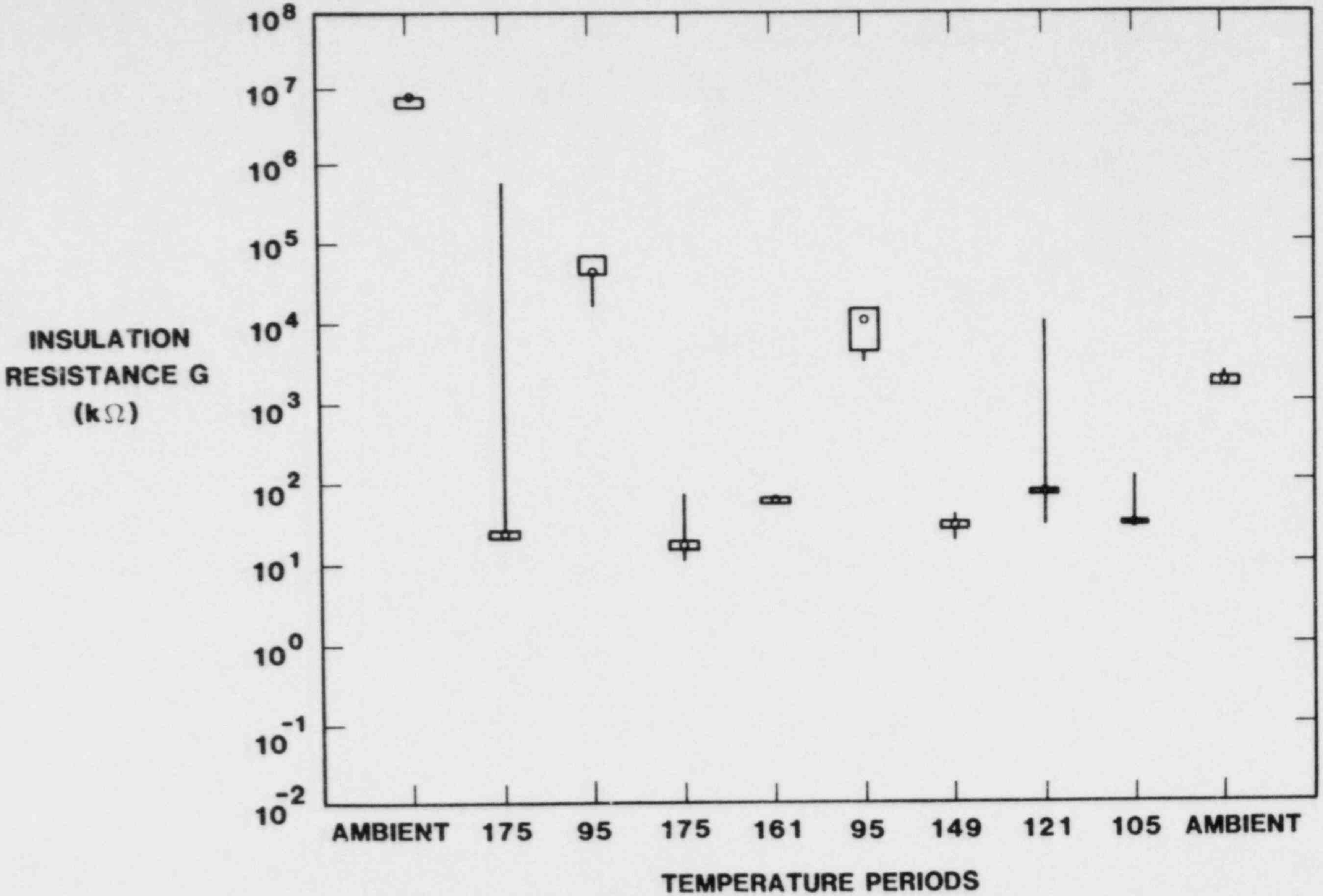

Figure A1-46

Box and Whisker Plot of Insulation Resistance G for TB 11, Phase II

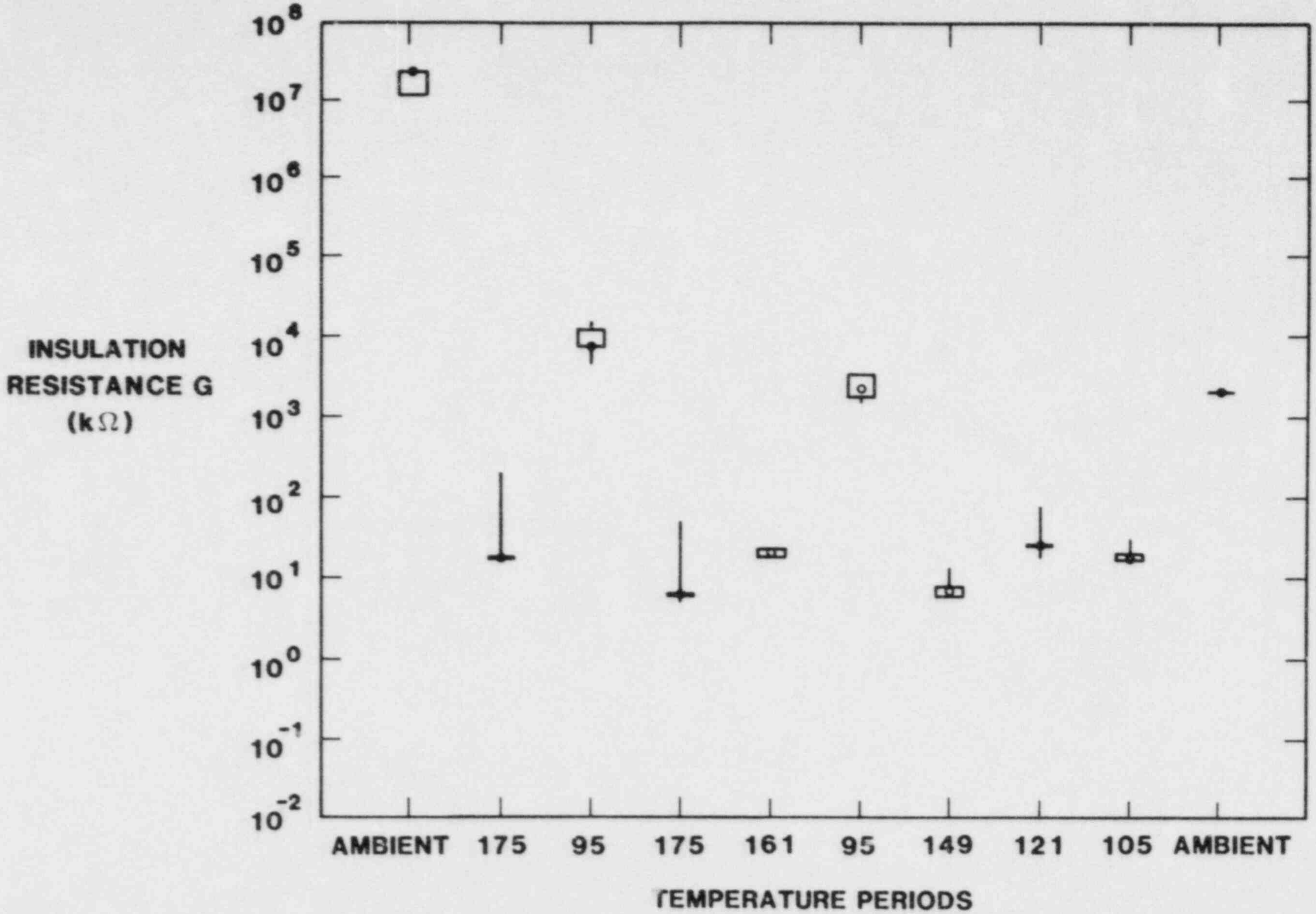

Figure A1-47

Box and Whisker Plot of Insulation Resistance G for TB 12, Phase II

APPENDIX 2
Discussion of Significant Anomalies

A2-1 Cable Extrusion

The one significant anomaly which may have affected some of the Phase II results was the extrusion of selected cables through the compression feedthrough used to pass the cables through the chamber boundary. This problem was not experienced in Phase I. All of the extrusion occurred during the first 175°C plateau of the environmental exposure. The problem was eliminated during the subsequent environmental exposure by retorquing the feedthrough compression nuts during the cooldown period between the first and second 175°C plateau. No attempt was made to reinsert the cables into the chamber and they were left in the extruded state for the remainder of the test. Table A2-1 summarizes by cable number the approximate amount of extrusion experienced by each cable. These measurements were made after the test during disassembly of the test set-up. The markers used to gauge the amount of extrusion were remnants of adhesive from tape wrapped on each cable during test assembly to mark the position of the rubber feedthrough stoppers. This tape was on the inside of the chamber boundary and slid along the cables as they extruded through the rubber stoppers. Some of the tape's adhesive actually extruded through the stoppers with the cable and acted as the gauge.

An unknown amount of tensile stress was introduced to the stranded conductors of the cables; however, we estimate that the force may have been as high as two or three kilograms-force.

When the test setup was disassembled, we noted that in some instances there was some visible tensioning of the cables. No effect from this tensioning was observed until the post-test IR measurements were made (See Appendix 3). At that time we found that the grounds of terminal blocks 2 and 7 were common with each other but not to the chamber and that the Leakage A path of terminal block 4 and the Power Out path of terminal block 6 were common with the chamber wall and hence to each other. The post-test inspection indicated what had occurred. In the case of terminal blocks 2 and 7, during assembly the ground wire from terminal block 7 had been looped close to the individual ground plate of terminal block 2. When cable 3 extruded 6.6 cm, the ground wire for terminal block 7 was pulled tight across the sharp corner of the ground plate for terminal block 2, and sometime thereafter experienced a creep shortout [17] to the terminal block 2 ground plate. This failure resulted in the grounds of terminal blocks 2 and 7 becoming common, though still isolated from the chamber.

In the case of terminal blocks 4 and 6, cables 10 and 20 extruded 7 and 7.9 cm, respectively. These cables entered their respective NEMA-4 enclosures in the bottom of the intertwined wire bundle. The extrusion process plus the weight of the overlying cables drew one conductor in each cable taught over the lower edge of the conduit bulkhead terminator causing each to experience a creep shortout [17] to the NEMA-4 enclosures. These failures made the Power Out of terminal block 6 and the Leakage A path of terminal block 4 common via the chamber.

Table A2-1

Summary of Distances That Cables Extruded From Test Chamber

Cable No.	Terminal Blocks and Connections	Approximate Amount Extruded (cm)
1	TB 7 Power In TB 8 Power In TB 1 Power In	6
2	TB 7 Power Out TB 7 Leakage A TB 7 Leakage B	7.6
3	TB 7 Ground TB 8 Ground TB 1 Ground	6.6
4	TB 8 Power Out TB 8 Leakage A TB 8 Leakage B	8.4
5	TB 1 Power Out TB 1 Leakage A TB 1 Leakage B	0
6	TB 2 Power In TB 3 Power In TB 4 Power In	0
7	TB 2 Power Out TB 2 Leakage A TB 2 Leakage B	7.3
8	TB 2 Ground TB 3 Ground TB 4 Ground	0
9	TB 3 Power Out TB 3 Leakage A TB 3 Leakage B	6
10	TB 4 Power Out TB 4 Leakage A TB 4 Leakage B	7
11	TB 9 Power In TB 9 Ground TB 10 Power In	0

Table A2-1
(continued)

Summary of Distances That Cables Extruded From Test Chamber

Cable No.	Terminal Blocks and Connections	Approximate Amount Extruded (cm)
12	TB 9 Power Out TB 9 Leakage A TB 9 Leakage B	0
13	TB 10 Power Out TB 10 Leakage A TB 10 Leakage B	10.8
14	TB 10 Ground TB 11 Low, Power Supply Side TB 11 High, Power Supply Side	8.2
15	TB 11 Low, Tmtr Side Side TB 11 High, Tmtr Side Side TB 11 Ground	0
16	TB 5 Power In TB 6 Power In TB 12 Power In	7.6
17	TB 12 Power Out TB 12 Leakage A TB 12 Leakage B	0
18	TB 5 Ground TB 6 Ground TB 12 Ground	0
19	TB 5 Power Out TB 5 Leakage A TB 5 Leakage B	0
20	TB 6 Power Out TB 6 Leakage A TB 6 Leakage B	7.9

The effect of these shorts on the data appeared to be minimal. We suspect that the time interval when the shorts probably occurred was during the first 175°C plateau or a short time thereafter. The two reasons for this belief are first, we observed the cables extruding during the first 175°C plateau, and second, 42 minutes after the beginning of the cooldown from the first 175°C plateau, we noted that the polarity of the readout for the terminal block 2 ground path had reversed. At that time we had no explanation for the reversal, but in retrospect it seems plausible that this change was evidence of the creep shortout between the grounds of terminal blocks 2 and 7. Figures A2-1 and A2-2 reproduce Figures 14 and 15 showing the Phase II circuits in total with modifications which account for the short circuits. The major changes are: (1) the low sides of all power supplies became connected via the load resistors in the respective branches of the circuits, (2) the system no longer truly floated from chamber ground, i.e., it was connected to the chamber via the load resistors in the shorted paths, and (3) alternate return paths for leakage paths 4A, 2G, and 7G existed which may have shunted some of the leakage currents around the measuring resistors for those paths. Apparently, the effect on the circuit performance was not too significant. A review of the leakage currents in the affected paths (i.e., 4A, 2G, 7G) showed no discernible change that could be correlated with the time interval when the short circuits are suspected of occurring. For this reason, we made no further adjustments to the data analysis procedure and reported the data as though the shortings did not occur.

If a more conservative approach is desired, the data from the 2G, 7G and 4A leakage paths can be ignored as invalid. The tying of the power supplies together and the failure to maintain a truly floating system did not affect the data in any of the other channels since their measurement resistors provide isolation between the terminal blocks and the short circuit points.

A2-2 Thermocouple Feedthrough Failure

As reported in Section 3.1, a thermocouple feedthrough failed at the 11 hour, 6 minute point of the Phase II test. This was 50 minutes after the 161°C plateau was attained. The failure was caused by the use of fiber washers in the feedthroughs around the thermocouple wires rather than metal washers. The duration of the cooldown caused by the failure of the washer was 1 hour and 50 minutes. By the time the failed washer and all other fiber washers had been replaced, the environmental exposure profile had progressed to the 149°C plateau, and so when the chamber was repressurized it was returned to 149°C. During the cooldown and repair, the chemical spray which was on was terminated and was not reinitiated until the chamber temperature was stable at 149°C. The reheating process was accomplished over a 10-minute period. All terminal blocks remained powered during the repair.

The only possible detrimental effect of the unanticipated cooldown could have been the rapid cooling of the blocks and the losing of some data at 161°C and 149°C. The primary effect of the unanticipated cooldown was positive, since it afforded an opportunity to analyze data from a second cold period in the environmental exposure profile, and confirm the behavior of the blocks. In fact, Figure 40 which illustrates the leakage behavior of the transmitter circuit both with and without steam present is for the unanticipated cooldown period.

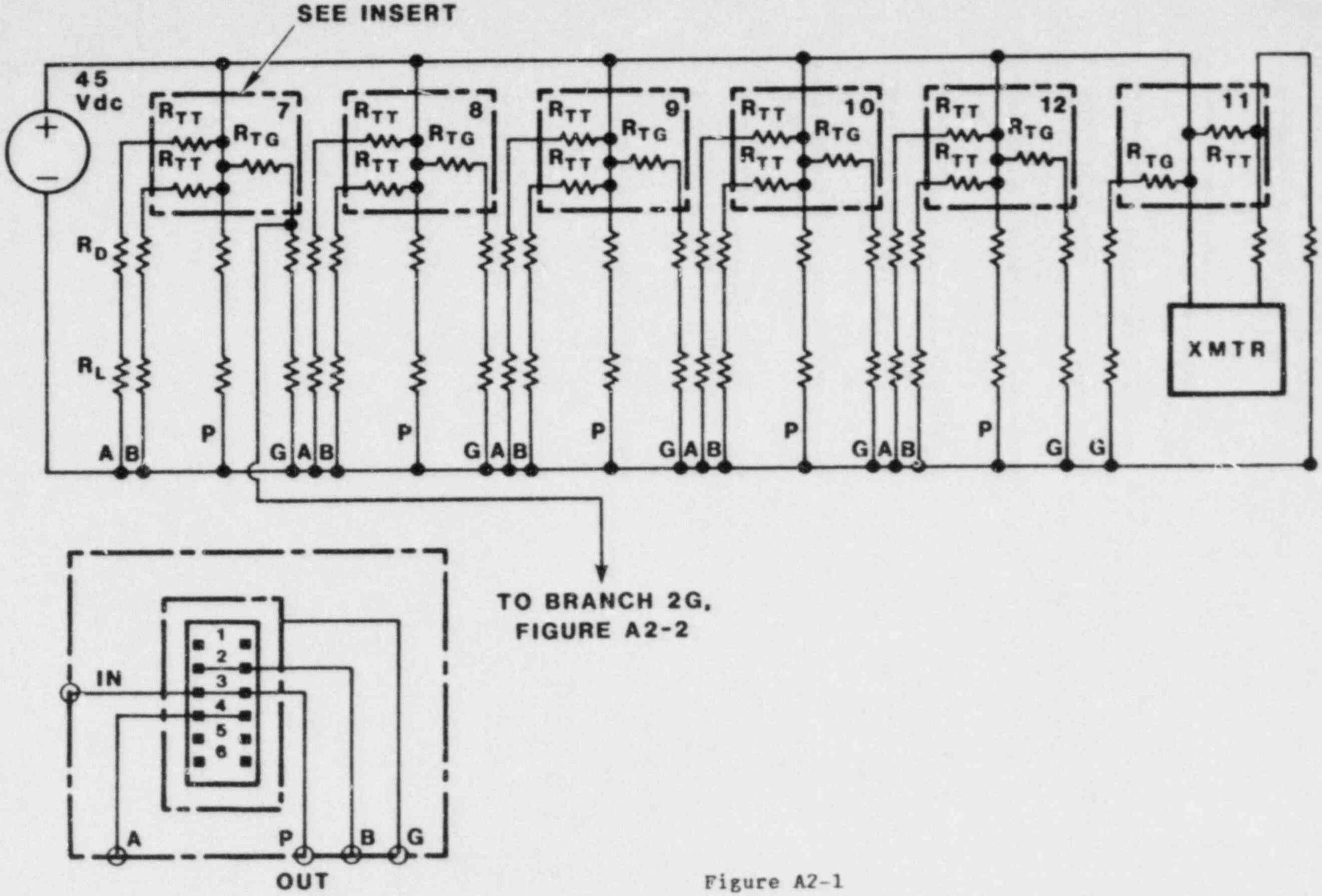

Figure A2-1

Detailed Circuit Schematic for Phase II 45 Vdc Terminal Blocks With Circuit Modifications Resulting from Creep Shortout of Branches 2G, 7G, 4A, and 6P

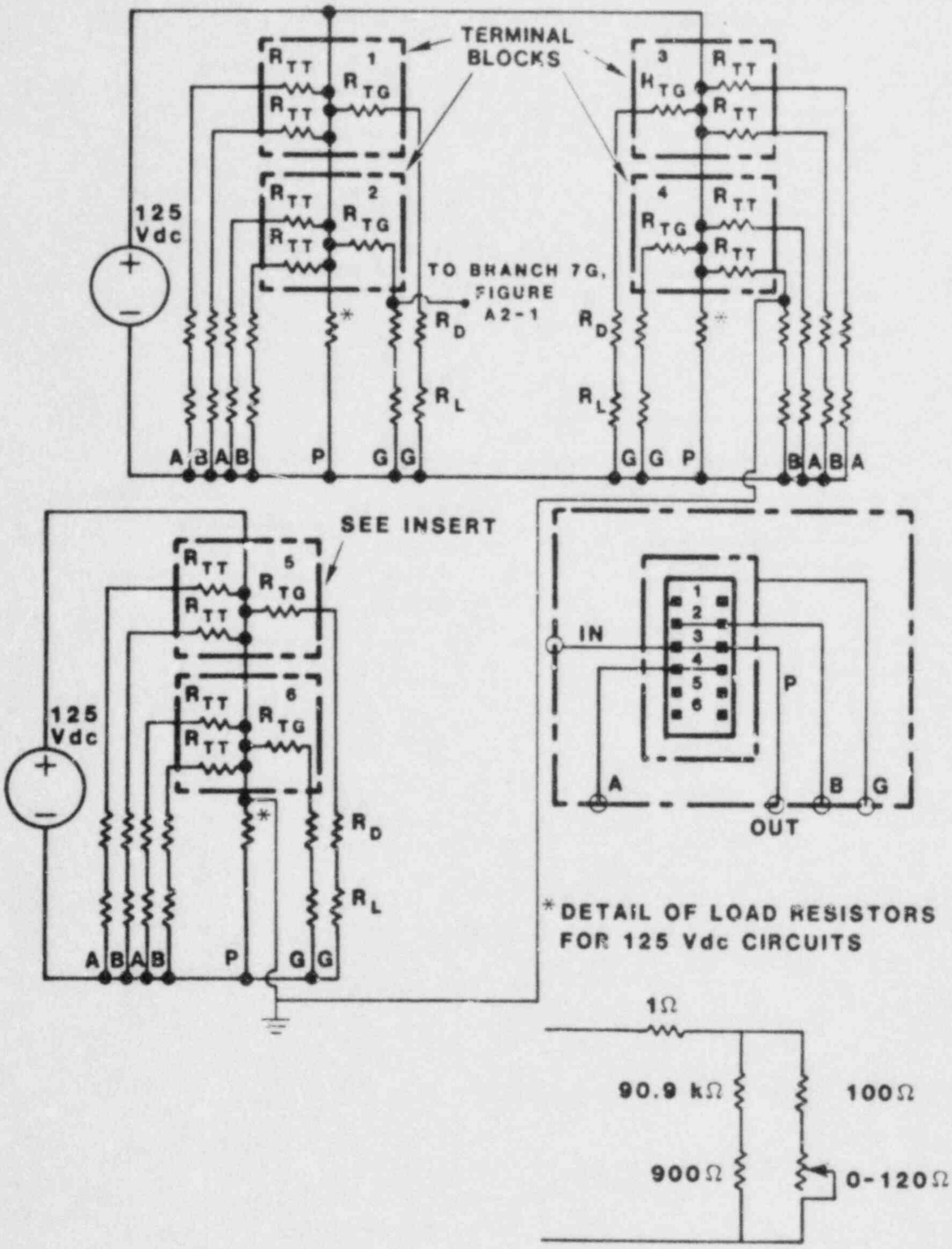

Figure A2-2

Detailed Circuit Schematic for Phase II 125 Vdc Terminal Blocks
With Circuit Modifications Resulting from Creep
Shortout of Branches 2G, 7G, 4A, and 6P

APPENDIX 3
Post-Test Megohmmeter Measurements

Near the end of the 105°C plateau and at various times subsequent to the conclusion of the steam exposure, the connections to each terminal block were measured with a megohmmeter*. This was accomplished from outside the chamber through the cables used in the experiment. The purpose was to monitor the terminal block resistance while they were drying out and to verify the integrity of the cables. Tables A3-1 through A3-12 summarize the results of these measurements. At each measurement three pieces of information were recorded for each wire combination: (1) insulation resistance (IR), (2) the voltage at which the IR measurement was made (V), and (3) the galvanic potential being generated internal to the system between the wire pair (EMF). The IR measurements were made at either the voltage used to power the terminal blocks during the test (i.e., 125 Vdc or 45 Vdc), or, if these voltages were too large, at the highest possible voltage attainable to keep the measurement on scale. Resistance values are reported in ohms and voltage values in volts. For comparison purposes, a spot check of the IR values between conductors in the same cable gave results from 7×10^6 ohms to 2.3×10^{12} ohms.

During these measurements the shorting problems discussed in Appendix 2 were discovered. The megohmmeter IR measurements generally follow the IR measurements recorded during the test. For the 105°C measurements we see values on the order of 10^4 to 10^5 ohms, while at the post-test ambient temperatures we see values on the order of 10^6 to 10^7 ohms. Note also that after removal of the terminal blocks the IR values of the open cables returns to 10^6 to 10^{12} ohms. The 10^6 values are for measurements made soon after the test when moisture is probably still present, while the 10^{12} values are for measurements made during test disassembly after the terminal blocks had air dried for 14 days.

The galvanic action that was observed is not surprising. Within the terminal block assembly there are many dissimilar metals in close contact so that the addition of an electrolyte makes possible oxidation-reduction reactions. Further, the chemical analysis identified the presence of CdS which is a potentially participant in galvanic reactions. The identification of such galvanic action may be significant to the analysis of terminal block effects in low voltage, low impedance circuits such as RTD circuits.

In general, these megohm measurements validate the real time IR measurements and indicate that in this test the terminal blocks and not the cables were the source of low insulation resistance.

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*Biddle Megohmmeter Model RM170 S/N 578, Property No. R14343, Calibration Period August 19, 1982 - February 19, 1983.

Table A3-1
Terminal Block 1 Megohm Measurements

		Elapsed Time: 120 Hrs T = 106°C 5 to 6 psig	Elapsed Time: 140 Hrs T = 24°C 0 psig	Elapsed Time: 266 Hrs T = 17°C 0 psig	Elapsed Time: 309 Hrs T = 22°C 0 psig	Elapsed Time: 621 Hrs TB Removed, Cables Only
Power Out to Ground Wire	IR (ohms)	4.35 K	11.75 K	23.0 K	3.85 K	9875 K
	V (Vdc)	10	25	50	10	125
	EMF (Vdc)	0.38	0.442	0.270	0.051	
Power Out to Leakage A	IR (ohms)	550	1.1 K	1.2 K	600	375 K
	V (Vdc)	1	1	1	1	125
	EMF (Vdc)	0.2	0.0081	0.002	0.0066	
Power Out to Leakage B	IR (ohms)	2.85 K	9.25 K	16.5 K	4.1 K	17000 K
	V (Vdc)	5	5	50	10	125
	EMF (Vdc)	0.34	0.0498	0.0875	0.0019	
Power Out to Chamber	IR (ohms)	137.5 K	310 K	1062 K	175 K	1875 M
	V (Vdc)	125	125	125	125	125
	EMF (Vdc)	0.45	0.649	0.538	0.0746	
Ground Wire to Chamber	IR (ohms)	147 K	300 K	1062 K	175 K	2000 M
	V (Vdc)	125	125	125	125	125
	EMF (Vdc)	0.076	0.217	0.296	0.213	
Leakage A to Chamber	IR (ohms)	149 K	320 K	1062 K	178 K	2000 M
	V (Vdc)	125	125	125	125	125
	EMF (Vdc)	0.26	0.641	0.534	0.688	
Leakage B to Chamber	IR (ohms)	152.5 K	328 K	1087 K	183 K	2000 M
	V (Vdc)	125	125	125	125	125
	EMF (Vdc)	0.12	0.600	0.457	0.735	

Table A3-2
Terminal Block 2 Megohm Measurements

		Elapsed Time: 120 Hrs T = 106°C 5 to 6 psig	Elapsed Time: 140 Hrs T = 24°C 0 psig	Elapsed Time: 266 Hrs T = 17°C 0 psig	Elapsed Time: 309 Hrs T = 22°C 0 psig	Elapsed Time: 621 Hrs TB Removed, Cables Only
Power Out to Ground Wire	IR (ohms)	50 K	35000 K	16000 K	47.5 M	850 M
	V (Vdc)	125	125	125	125	125
	EMF (Vdc)	0.377	0.2[illegible]5	0.103	0.235	
Power Out to Leakage A	IR (ohms)	54 K	35000 K	19375 K	50 M	66 M
	V (Vdc)	125	125	125	125	125
	EMF (Vdc)	0.35	0.211	0.007	0.235	
Power Out to Leakage B	IR (ohms)	57.5 K	25000 K	15625 K	41 M	59 M
	V (Vdc)	125	125	125	125	125
	EMF (Vdc)	0.33	0.208	0.009	0.223	
Power Out to Chamber	IR (ohms)	54 K	28150 K	9750 K	28175 K	3750 M
	V (Vdc)	125	125	125	125	125
	EMF (Vdc)	0.45	0.281	0.167	0.227	
Ground Wire to Chamber	IR (ohms)	22.5 K	91 K	237 K	938 K	2125 M
	V (Vdc)	25	125	125	125	125
	EMF (Vdc)	0.07	0.198	0.145	0.111	
Leakage A to Chamber	IR (ohms)	30 K 31.5 K	26 K	412 K	1325 K	3750 M
	V (Vdc)	25 90	125	125	125	125
	EMF (Vdc)	0.0098	0.427	0.349	0.0986	
Leakage B to Chamber	IR (ohms)	29.5 K	163 K	337 K	1000 K	3625 M
	V (Vdc)	50	125	125	125	125
	EMF (Vdc)	0.115	0.448	0.387	0.145	

Table A3-3
Terminal Block 3 Megohm Measurements

		Elapsed Time: 120 Hrs T = 106°C 5 to 6 psig	Elapsed Time: 140 Hrs T = 24°C 0 psig	Elapsed Time: 266 Hrs T = 17°C 0 psig TB Removed, Cables Only	Elapsed Time: 309 Hrs T = 22°C 0 psig TB Removed, Cables Only	Elapsed Time: 621 Hrs TB Removed, Cables Only
Power Out to Ground Wire	IR (ohms)	41.8K	9500 K	1875 G	1[illegible]625 K	250000 G
	V (Vdc)	110	125	125	125	125
	EMF (Vdc)	0.463	0.565	0	-0.073	
Power Out to Leakage A	IR (ohms)	81 K	66250 K	875 G	4563 M	Open
	V (Vdc)	125	125	125	125	500
	EMF (Vdc)	0.315	0.454	0	-0.051	
Power Out to Leakage A	IR (ohms)	84 K	58750 K	1250 G	6875 K	Open
	V (Vdc)	125	125	125	125	500
	EMF (Vdc)	0.314	0.454	0	-0.051	
Power Out to Chamber	IR (ohms)	63 K	8125 K	69 G	475 K	1250 G
	V (Vdc)	125	125	125	125	125
	EMF (Vdc)	0.454	0.491	0	0.023	
Ground Wire to Chamber	IR (ohms)	33 K	41 K	30 G	788 K	813 G
	V (Vdc)	90	125	125	125	125
	EMF (Vdc)	-0.007	-0.047	0	0.0975	
Leakage A to Chamber	IR (ohms)	64 K	1825 K	37.5 G	52.5 M	625 G
	V (Vdc)	125	125	125	125	125
	EMF (Vdc)	0.141	0.0617	0	0.256	
Leakage B to Chamber	IR (ohms)	72.5 K	1575 K	1.375 G	2250 K	625 G
	V (Vdc)	125	125	125	125	125
	EMF (Vdc)	0.141	0.0935 (SEE NOTE)	0	0.0746	

NOTE: TB removed at 109 hrs elapsed time for chemical analysis. This measurement made before removal.

Table A3-4
Terminal Block 4 Megohm Measurements

		Elapsed Time: 120 Hrs T = 106°C 5 to 6 psig	Elapsed Time: 140 Hrs T = 24°C 0 psig	Elapsed Time: 266 Hrs T = 17°C 0 psig	Elapsed Time: 309 Hrs T = 22°C 0 psig	Elapsed Time: 621 Hrs TB Removed, Cables Only
Power Out to Ground Wire	IR (ohms)	64 K	74 M	18250 G	4625 K	6875 M
	V (Vdc)	125	125	125	125	125
	EMF (Vdc)	0.436	0.376	0.0198	1.016	
Power Out to Leakage A	IR (ohms)	63 K	54 M	81 K	231 K	32500 K
	V (Vdc)	125	125	125	125	125
	EMF (Vdc)	0.441	0.325	0.0155	1.018	
Power Out to Leakage A	IR (ohms)	75 K	55 M	17250 K	6875 K	194 M
	V (Vdc)	125	125	125	125	125
	EMF (Vdc)	0.546	0.288	0.014	1.029	
Power Out to Chamber	IR (ohms)	29 K	20625 K	5375 G	2188 K	56 M
	V (Vdc)	75	125	125	125	125
	EMF (Vdc)	0.44	0.285	0.0155	0.915	
Ground Wire to Chamber	IR (ohms)	11 K	161 K	275 K	96 K	325 M
	V (Vdc)	25	125	125	125	125
	EMF (Vdc)	0.005	0.047	0.0058	0.0127	
Leakage A to Chamber	IR (ohms)	<350	<350	<350	<350 (11 ohms, Fluke)	Short at Conduit Entrance to Box
	V (Vdc)	1	1	1	125	
	EMF (Vdc)	0	0	0	0	
Leakage B to Chamber	IR (ohms)	21 K	265 K	450 K	500 K	33750 K
	V (Vdc)	60	125	125	125	125
	EMF (Vdc)	-0.105	0.132	0.002	-0.00229	

Table A3-5
Terminal Block 5 Megohm Measurements

		Elapsed Time: 120 Hrs T = 106°C 5 to 6 psig	Elapsed Time: 140 Hrs T = 24°C 0 psig	Elapsed Time: 266 Hrs T = 17°C 0 psig TB Removed, Cables Only	Elapsed Time: 309 Hrs T = 22°C 0 psig TB Removed, Cables Only	Elapsed Time: 621 Hrs TB Removed, Cables Only
Power Out to Ground Wire	IR (ohms)	4.4 K	363 K	2250 G (erratic)	550 K	15000 G
	V (Vdc)	10	125	125	125	125
	EMF (Vdc)	0.227	0.689	0	0.113	
Power Out to Leakage A	IR (ohms)	11 K	1438 K	312 M	65 K	3125 G
	V (Vdc)	30	125	125	125	125
	EMF (Vdc)	0.241	0.795	0	0.587	
Power Out to Leakage A	IR (ohms)	8.25 K	839 K	1750 G	2.1 K	5625 G
	V (Vdc)	25	125	125	10	125
	EMF (Vdc)	0.315	0.690	0	0.294	
Power Out to Chamber	IR (ohms)	35 K	450 K	1725 K	125 K	750 G
	V (Vdc)	100	125	125	125	125
	EMF (Vdc)	-0.191	0.426	0.289	-0.351	
Ground Wire to Chamber	IR (ohms)	30 K	148 K	81 G	456 K	1000 G
	V (Vdc)	90	125	125	125	125
	EMF (Vdc)	-0.419	-0.106	0	-0.451	
Leakage A to Chamber	IR (ohms)	39 K	388 K	65 M	134 K	625 G
	V (Vdc)	100	125	125	125	125
	EMF (Vdc)	-0.435	-0.230	0.036	-0.917	
Leakage B to Chamber	IR (ohms)	37 K	275 K	91 G	119 K	750 G
	V (Vdc)	125	125	125	125	125
	EMF (Vdc)	-0.511	-0.119 (SEE NOTE)	0	-0.612	

NOTE: TB removed at 109 hrs elapsed time for chemical analysis. This measurement made before removal.

Table A3-6
Terminal Block 6 Megohm Measurements

		Elapsed Time: 120 Hrs T = 106°C 5 to 6 psig	Elapsed Time: 140 Hrs T = 24°C 0 psig	Elapsed Time: 266 Hrs T = 17°C 0 psig	Elapsed Time: 309 Hrs T = 22°C 0 psig	Elapsed Time: 621 Hrs TB Removed, Cables Only
Power Out to Ground Wire	IR (ohms)	Open	Short	1775 K	17500 K	225 M
	V (Vdc)	Shorted with reverse EMF?	125	125	125	125
	EMF (Vdc)	0.381	0.746	-0.122	0.659	
Power Out to Leakage A	IR (ohms)	Open	Short	3937 K	50000 K	388 M
	V (Vdc)			125	125	125
	EMF (Vdc)	0.615	0.750	0.0562	0.651	
Power Out to Leakage A	IR (ohms)	Open	Short	975 K	3.48 K	350 M
	V (Vdc)			125	(Fluke)	125
	EMF (Vdc)	0.271	0.672	-0.0997	0.664	
Power Out to Chamber	IR (ohms)	<350	Short	<350	<350 57	Short at Conduit Entrance to Box
	V (Vdc)	1	1	1	1 (Fluke)	
	EMF (Vdc)	-0.003	0.0011	0.058	-0.00002	
Ground Wire to Chamber	IR (ohms)	<350	84 K	5.4 K	8.75 K	23750 K
	V (Vdc)	1	10	10	25	125
	EMF (Vdc)	-0.383	-0.621	0.180	-0.637	
Leakage A to Chamber	IR (ohms)	<350	10 K	7 K	17.5 K	50 M
	V (Vdc)	1	10	10	25	125
	EMF (Vdc)	0.619	-0.608	0.0029	-0.626	
Leakage B to Chamber	IR (ohms)	<350	3.75 K	4 K 3.5 K	1.7 K	3500 K
	V (Vdc)	1	5	1 5	5	125
	EMF (Vdc)	-0.274	0.551	0.159	-0.652	

Table A3-7
Terminal Block 7 Megohm Measurements

		Elapsed Time: 120 Hrs T = 106°C 5 to 6 psig	Elapsed Time: 140 Hrs T = 24°C 0 psig	Elapsed Time: 266 Hrs T = 17°C 0 psig	Elapsed Time: 309 Hrs T = 22°C 0 psig	Elapsed Time: 621 Hrs TB Removed, Cables Only
Power Out to Ground Wire	IR (ohms)	270 K	405 K	1201 K	23 M	2205 G
	V (Vdc)	45	45	45	45	45
	EMF (Vdc)	0.647	0.251	0.258	0.057	
Power Out to Leakage A	IR (ohms)	540 K	16200 K	12600 K	162 M	2700 G
	V (Vdc)	45	45	45	45	45
	EMF (Vdc)	0.679	0.0841	0.023	0.024	
Power Out to Leakage A	IR (ohms)	2700 K	4275 K	4770 K	48 M	2025 G
	V (Vdc)	45	45	45	45	45
	EMF (Vdc)	0.585	0.125	0.108	0.035	
Power Out to Chamber	IR (ohms)	203 K	261 K	603 K	14400 K	225 G
	V (Vdc)	45	45	45	45	45
	EMF (Vdc)	0.718	0.429	0.399	0.092	
Ground Wire to Chamber	IR (ohms)	20 K	93 K	238 K	990 K	3150 M
	V (Vdc)	45	45	45	45	45
	EMF (Vdc)	0.072	0.198	0.146	0.112	
Leakage A to Chamber	IR (ohms)	135 K	3240 K	3375 K	1125 K	225 G
	V (Vdc)	45	45	45	45	45
	EMF (Vdc)	0.035	0.248	0.289	0.095	
Leakage B to Chamber	IR (ohms)	540 K	630 K	833 K	3600 K	248 G
	V (Vdc)	45	45	45	45	45
	EMF (Vdc)	0.098	0.291	0.247	0.133	

Table A3-8
Terminal Block 8 Megohm Measurements

		Elapsed Time: 120 Hrs T = 106°C 5 to 6 psig	Elapsed Time: 140 Hrs T = 24°C 0 psig	Elapsed Time: 266 Hrs T = 17°C 0 psig TB Removed, Cables Only	Elapsed Time: 309 Hrs T = 22°C 0 psig TB Removed, Cables Only	Elapsed Time: 621 Hrs TB Removed, Cables Only
Power Out to Ground Wire	IR (ohms)	675 K	18450 K	202 M	225 G	67500 G
	V (Vdc)	45	45	45	45	45
	EMF (Vdc)	0.813	0.339	0	0	
Power Out to Leakage A	IR (ohms)	810 K	22500 K	13050 M	99 K	45000 G
	V (Vdc)	45	45	45	45	45
	EMF (Vdc)	0.859	0.306	0	0.056	
Power Out to Leakage A	IR (ohms)	855 K	16650 K	3825 M	99 K	9000 G
	V (Vdc)	45	45	45	45	45
	EMF (Vdc)	0.919	0.296	0	0.071	
Power Out to Chamber	IR (ohms)	450 K	12150 K	63 G	1247 K	1125 G
	V (Vdc)	45	45	45	45	45
	EMF (Vdc)	0.567	0.289	0.0009	0.159	
Ground Wire to Chamber	IR (ohms)	22 K	378 K	1890 K	292 M	630 G
	V (Vdc)	45	45	45	45	45
	EMF (Vdc)	-0.247	-0.049	0.344	0.001	
Leakage A to Chamber	IR (ohms)	27 K	459 K	90 M	1305 K	2700 G
	V (Vdc)	45	45	45	45	45
	EMF (Vdc)	-0.292	0.0196	0.041	0.106	
Leakage B to Chamber	IR (ohms)	25 K	374 K	34 M	1305 K	810 G
	V (Vdc)	45	45	45	45	45
	EMF (Vdc)	-0.254	0.0442 (SEE NOTE)	0.104	0.094	

NOTE: TB removed at 109 hrs elapsed time for chemical analysis. This measurement made before removal.

Table A3-9
Terminal Block 9 Megohm Measurements

		Elapsed Time: 120 Hrs T = 106°C 5 to 6 psig	Elapsed Time: 140 Hrs T = 24°C 0 psig	Elapsed Time: 266 Hrs T = 17°C 0 psig	Elapsed Time: 309 Hrs T = 22°C 0 psig	Elapsed Time: 621 Hrs TB Removed, Cables Only
Power Out to Ground Wire	IR (ohms)	45 K	14400 K	3060 K	17 M	23 G
	V (Vdc)	45	45	45	45	45
	EMF (Vdc)	0.478	0.371	0.031	0.362	
Power Out to Leakage A	IR (ohms)	41 K	10665 K	2520 K	14850 K	122 M
	V (Vdc)	45	45	45	45	45
	EMF (Vdc)	0.395	0.349	0.081	0.361	
Power Out to Leakage A	IR (ohms)	43 K	11250 K	2610 K	18000 K	171 M
	V (Vdc)	45	45	45	45	45
	EMF (Vdc)	0.392	0.294	-0.091	0.354	
Power Out to Chamber	IR (ohms)	61 K	7425 K	2430 K	8190 K	54 G
	V (Vdc)	45	45	45	45	45
	EMF (Vdc)	0.335	0.319	0.173	0.288	
Ground Wire to Chamber	IR (ohms)	24 K	752 K	657 K	1238 K	122 G
	V (Vdc)	45	45	45	45	45
	EMF (Vdc)	-0.141	-0.020	0.164	-0.056	
Leakage A to Chamber	IR (ohms)	25 K	743 K	648 K	1755 K	45 G
	V (Vdc)	45	45	45	45	45
	EMF (Vdc)	-0.059	0.024	0.288	-0.038	
Leakage B to Chamber	IR (ohms)	26 K	734 K	747 K	2070 K	45 G
	V (Vdc)	45	45	45	45	45
	EMF (Vdc)	-0.056	0.116	0.296	-0.035	

Table A3-10
Terminal Block 10 Megohm Measurements

		Elapsed Time: 120 Hrs T = 106°C 5 to 6 psig	Elapsed Time: 140 Hrs T = 24°C 0 psig	Elapsed Time: 266 Hrs T = 17°C 0 psig TB Removed, Cables Only	Elapsed Time: 309 Hrs T = 22°C 0 psig TB Removed, Cables Only	Elapsed Time: 621 Hrs TB Removed, Cables Only
Power Out to Ground Wire	IR (ohms)	52 K	21 M	1125 G	193 M	29250 G
	V (Vdc)	45	45	45	45	45
	EMF (Vdc)	0.427	0.196	0	-0.262	
Power Out to Leakage A	IR (ohms)	50 K	21 M	57 G	612 K	250000 G
	V (Vdc)	45	45	45	45	500
	EMF (Vdc)	0.399	0.182	0	-0.075	
Power Out to Leakage A	IR (ohms)	61 K	23 M	1035 G	16 K	125000 G
	V (Vdc)	45	45	45	45	500
	EMF (Vdc)	0.386	0.180	0	-0.047	
Power Out to Chamber	IR (ohms)	77 K	26 M	32 G	590 K	900 G
	V (Vdc)	45	45	45	45	45
	EMF (Vdc)	0.356	0.150	0	-0.07	
Ground Wire to Chamber	IR (ohms)	49 K	7740 K	41 G	1035 K	900 G
	V (Vdc)	45	45	45	45	45
	EMF (Vdc)	-0.071	0.016	0	0.212	
Leakage A to Chamber	IR (ohms)	43 K	8010 K	230 M	639 K	225 G
	V (Vdc)	45	45	45	45	45
	EMF (Vdc)	-0.043	0.038	0.007	0.006	
Leakage B to Chamber	IR (ohms)	59 K	9000 K	29 G	603 K	135 G
	V (Vdc)	45	45	45	45	45
	EMF (Vdc)	-0.0298	0.035 (SEE NOTE)	0	-0.0247	

NOTE: TB removed at 109 hrs elapsed time for chemical analysis. This measurement made before removal.

Table A3-11
Terminal Block 11 Megohm Measurements
(Transmitter Circuit)*

		Elapsed Time: 120 Hrs T = 106°C 5 to 6 psig	Elapsed Time: 140 Hrs T = 24°C 0 psig	Elapsed Time: 266 Hrs T = 17°C 0 psig	Elapsed Time: 309 Hrs T = 22°C 0 psig	Elapsed Time: 621 Hrs TB Removed, Cables Only
Power In to Power Out Power Supply Side	IR (ohms)	34 K	10350 K	1575 K	3285 K	62 M
	V (Vdc)	45	45	45	45	45
	EMF (Vdc)	0.549	0.392	-0.033	0.566	
Power In to Ground Wire	IR (ohms)	30 K	16200 K	2025 K	4275 K	2520 M
	V (Vdc)	45	45	45	45	45
	EMF (Vdc)	0.606	0.365	0.142	0.604	
Power Out to Ground Wire	IR (ohms)	20 K	1053 M	675 K	2160 K	3240 M
	V (Vdc)	45	45	45	45	45
	EMF (Vdc)	0.575	-0.0341	0.185	0.047	
Power In to Chamber	IR (ohms)	25 K	5760 K	990 K	1665 K	43 M
	V (Vdc)	45	45	45	45	45
	EMF (Vdc)	0.510	0.283	-0.011	0.595	
Power Out to Chamber	IR (ohms)	14 K	315 K	306 K	648 K	45 M
	V (Vdc)	25	45	45	45	45
	EMF (Vdc)	-0.0392	-0.10	0.024	0.089	
Ground Wire to Chamber	IR (ohms)	13 K	360 K	220 K	209 K	45 M
	V (Vdc)	25	45	45	45	45
	EMF (Vdc)	-0.0965	-0.068	-0.164	0.048	

*Transmitter removed from circuit when measurements made.

Table A3-12
Terminal Block 12 Megohm Measurements

		Elapsed Time: 120 Hrs T = 106°C 5 to 6 psig	Elapsed Time: 140 Hrs T = 24°C 0 psig	Elapsed Time: 266 Hrs T = 17°C 0 psig	Elapsed Time: 309 Hrs T = 22°C 0 psig	Elapsed Time: 621 Hrs TB Removed, Cables Only
Power Out to Ground Wire	IR (ohms)	11 K	743 K	229 K	1350 K	5760 M
	V (Vdc)	25	45	45	45	45
	EMF (Vdc)	0.357	0.516	-0.127	0.285	
Power Out to Leakage A	IR (ohms)	7.5 K	383 K	9.25 K	405 K	792 M
	V (Vdc)	15	45	25	45	45
	EMF (Vdc)	0.327	0.405	-0.155	0.351	
Power Out to Leakage B	IR (ohms)	25 K	657 K	239 K	1395 K	3150 M
	V (Vdc)	45	45	45	45	45
	EMF (Vdc)	0.294	0.573	0.106	0.444	
Power Out to Chamber	IR (ohms)	57 K	535 K	3511 K	540 K	45 G
	V (Vdc)	45	45	45	45	45
	EMF (Vdc)	0.213	0.533	0.183	0.405	
Ground Wire to Chamber	IR (ohms)	60 K	774 K	504 K	900 K	54 G
	V (Vdc)	45	45	45	45	45
	EMF (Vdc)	-0.142	0.105	0.302	0.160	
Leakage A to Chamber	IR (ohms)	58 K	450 K	351 K	549 K	59 G
	V (Vdc)	45	45	45	45	45
	EMF (Vdc)	-0.114	0.216	0.331	0.146	
Leakage B to Chamber	IR (ohms)	76 K	824 K	540 K	693 K	63 G
	V (Vdc)	45	45	45	45	45
	EMF (Vdc)	-0.086	0.054	0.076	0.0148	

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FRANCE
Attn: G. Chauvin
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Hiratsuka, Kanagawa Pref
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CANADA
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SF-00101 Helsinki 10
FINLAND
Attn: B. Regnell
K. Koskinen

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Department of Reactor Safety
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00101 Helsinki 10
FINLAND
Attn: L. Reiman

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3141 C. M. Ostrander (5)
3151 W. L. Garner
8424 M. A. Pound

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13. ABSTRACT (200 words or less)

Twenty-four terminal blocks were tested in simulated Design Basis Event (DBE), Loss of Coolant Accident (LOCA) environments. The terminal blocks were powered at voltages of 4 Vdc, 45 Vdc, and 125 Vdc. Resulting currents associated with these voltage levels were 1.8 mA, 20 mA, and 1 A, respectively. Terminal-to-terminal and terminal-to-ground leakage currents were monitored on a discrete time basis throughout the test. Based on these measurements, insulation resistances were calculated. During exposure to the LOCA steam environment insulation resistance was observed to decrease from initial values of 10^8 to 10^{10} ohms to 10^2 to 10^5 ohms. These decreases in IR are interpreted as being caused by conduction in surface moisture films rather than bulk conduction through the insulation material. Insulation resistance for all applied voltage levels appear to be approximately the same. Sporadic breakdowns lasting from fractions of a second to several minutes were observed. Further, rapid increases in applied voltage caused large decreases in insulation resistance. The measured IR was also dependent upon temperature. Subsequent to the test, terminal block insulation resistance returned to acceptable levels (10^6 to 10^8 ohms), though not to pre-test levels. The comparison of spray and no-spray results shows that no discernable difference in IRs existed between the periods with and without chemical spray.

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ADM-DIV OF TIDC
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WASHINGTON DC 20555

Sandia National Laboratories