

SIG/GALILEO

HERMETIC RECEPTACLE TEST PROGRAM FINAL REPORT

TES-33009-47

June 1979

DISCLAIMER

This document was prepared as an account of work sponsored by an agency of the United States Government. Neither the United States Government nor any agency thereof, nor any of their employees, makes any warranty, express or implied, or assumes any legal liability or responsibility for the accuracy, completeness, or usefulness of any information, apparatus, product, or process disclosed, or represents that its use would not infringe privately owned rights. Reference herein to any specific commercial product, process, or service by trade name, trademark, manufacturer, or otherwise, does not necessarily constitute or imply its endorsement, recommendation, or favoring by the United States Government or any agency thereof. The views and opinions of authors expressed herein do not necessarily state or reflect those of the United States Government or any agency thereof.

This report was prepared for the United States
Department of Energy under Contract Number
DE-AC01-78ET33009.

Prepared by: Sidney Roedel
S. Roedel
Instrumentation

Approved by: Wm E Osmeyer
W. Osmeyer
Program Manager

 TELEDYNE ENERGY SYSTEMS

110 W. Timonium Rd.
Timonium, Md. 21093

This document is
PUBLICLY RELEASEABLE
Larry P. Williams
Authorizing Official
Date: 09/20/2007

JB
DISTRIBUTION OF THIS DOCUMENT IS UNLIMITED

DISCLAIMER

This report was prepared as an account of work sponsored by an agency of the United States Government. Neither the United States Government nor any agency Thereof, nor any of their employees, makes any warranty, express or implied, or assumes any legal liability or responsibility for the accuracy, completeness, or usefulness of any information, apparatus, product, or process disclosed, or represents that its use would not infringe privately owned rights. Reference herein to any specific commercial product, process, or service by trade name, trademark, manufacturer, or otherwise does not necessarily constitute or imply its endorsement, recommendation, or favoring by the United States Government or any agency thereof. The views and opinions of authors expressed herein do not necessarily state or reflect those of the United States Government or any agency thereof.

DISCLAIMER

Portions of this document may be illegible in electronic image products. Images are produced from the best available original document.

NOTICE

"This report was prepared as an account of work sponsored by the United States government. Neither the United States nor the United States Department of Energy, nor any of their employees, nor any of their contractors, subcontractors, or their employees, make any warranty, expressed or implied, or assumes any legal liability or responsibility for the accuracy, completeness, or usefulness of any information, apparatus, product, or process disclosed, or represents that its use would not infringe privately-owned rights."

CONTENTS

	<u>Page</u>
Notice	ii
Contents	iii
List of Figures	vi
List of Tables	viii
1.0 Summary	1
2.0 Background and Major Milestones of the Receptacle Test Program	2
2.1 Initial Program Efforts	2
2.2 Selection of Deutsch Steel Shell Receptacle	5
2.3 Implementation of the Receptacle Test Program	8
3.0 The SIG/Galileo Receptacle Test Program	9
3.1 Introduction and Test Philosophy	9
3.2 The Receptacle Test Plan	10
3.2.1 Receptacle Test Operations by the Manufacturer	12
3.2.2 TES Quality Control Acceptance Inspection and Tests	13
3.2.3 Thermal Margin Receptacle Tests	15
3.2.4 Life and Cycle Receptacle Group Tests	18
3.2.4.1 Tests for Receptacle/Bimetal Transition Ring Assemblies	18
3.2.5 Reference Leak Rate Tests for Deutsch Receptacle/ Bimetal Ring Assemblies	19
3.2.6 Reference Leak Rate Tests for Dummy Receptacle/ Bimetal Ring Assemblies	19
3.2.7 Purpose of Separate Receptacle Test Groups	19
3.2.8 Post-Test Receptacle Inspections and Evaluations	24
3.3 Receptacle Test Fixtures and Tools	25
3.3.1 TES Quality Control Acceptance Leak Rate Test Fixture LCP 10030	25
3.3.2 Bimetal Transition Rings	26
3.3.3 Bimetal Ring Leak Rate Test Fixture LCP 10090	27
3.3.4 Leak Rate Test Fixture LCP 10120	27
3.3.5 Bimetal Ring Chill Block Weld Fixture LCP 10130	27
3.3.6 Test Loop Receptacle Test Fixture LCP 10150	28
3.3.7 Dummy Receptacle Configurations	28

CONTENTS (Cont.)

	<u>Page</u>
3.4 Receptacle Test Procedures	30
3.4.1 Receptacle Leak Rate Acceptance Test Procedures	30
3.4.2 Test Procedures for Functional Receptacle Tests	30
3.4.3 Test Procedure for Receptacle/Bimetal Ring Assemblies	31
3.5 The Receptacle Test Loop Installation	31
4.0 Test Results from the Receptacle Test Program	35
APPENDIX A: Bibliography and Listing of References	A-1
APPENDIX B-1: Description and Test Results of Thermal Margin Test of Deutsch Receptacle/Bimetal Transition Ring Assembly S/N-368	B-1-1
1.0 Thermal Safety Margin Test Report of Deutsch Receptacle/ Bimetal Ring Assembly S/N-368	B-1-1
2.0 Post-Test Inspection and Analysis	B-1-2
2.1 Pre-Margin Test History of Receptacle S/N-368	B-1-4
2.2 Comparison with Previous Thermal Margin Test Data and Discussion	B-1-6
2.3 Discussion of Test Results of 10 Thermal Margin Tests	B-1-6
2.4 Conclusions from Test Results of 13 Thermal Margin Tests	B-1-8
3.0 Further Testing of Receptacle S/N-368 and Other New Thermal Margin Samples with Dye Penetration Tests	B-1-9
APPENDIX B-2: Description and Test Results of Life Performance and Temperature Cycling Tests of Deutsch Receptacle/ Bimetal Transition Ring and Dummy Receptacle/Bimetal Transition-Ring Assemblies	B-2-1
1. Test Report of 10 Receptacle/Bimetal Ring Assemblies	B-2-1
2. Discussion of Test Results from 3 Deutsch Receptacle/Bimetal Ring and 7 Dummy Receptacle/Bimetal Ring Assemblies	B-2-2

CONTENTS (Cont.)

	<u>Page</u>
APPENDIX C: Description and Test Results of TES Quality Control C-1 Leak Rate Acceptance Test of Gulton Hermetically Sealed Aluminum and Steel Shell Receptacles	
1. Test Report of Gulton Hermetic Receptacles	C-1
2. Discussion of Test Results from 25 Aluminum Shell and 5 Steel Shell Gulton Receptacles	C-2
APPENDIX D: Description and Test Results of TES Quality Control Leak Rate Acceptance Test of Deutsch Hermetically Sealed Steel Shell Receptacles	D-1
1. Test Report of Deutsch Hermetic Receptacles	D-1
2. Discussion of Test Results from 60 New Deutsch Receptacles	D-1

LIST OF FIGURES

<u>Figure</u>		<u>Page</u>
1	Gulton Hermetic Receptacle J-2 with Aluminum Shell and Weld-Mount Flange	37
2	Deutsch Hermetic Receptacle 78033-16-26 PN with Steel Shell and Weld-Mount Flange	38
3	Bimetal Transition Ring LCP 10014	39
4	Leak Rate Test Fixture LCP 10090	40
5	Chill Block Weld Fixture LCP 10130	41
6	Disassembled Leak Rate Test Fixture LCP 10030	42
7	Leak Rate Test Fixture LCP 10030 with Gulton Aluminum Shell Receptacle J-2	43
8	Leak Rate Test Fixture LCP 10030 with Deutsch Steel Shell Receptacle	44
9	Leak Rate Test Fixture LCP 10150 with Welded Deutsch Receptacle/Bimetal Ring Assembly	45
10	Leak Rate Test Fixture LCP 10150 with Welded Dummy Receptacle/Bimetal Ring Assembly	46
11	Leak Rate Test Fixture LCP 10150 Installed in Test Station of Receptacle Test Loop	47
12	View of Receptacle Test Loop Installation	48
13	Plumbing System of Receptacle Test Loop	49
14	Control Panel of Receptacle Test Loop for Receptacle Test Station	50
15	Typical Electrical Wiring Diagram for Each Test Station of the Receptacle Test Loop	51
16	View of Top Cover of SIG/Galileo GDS-1 Generator Showing 3 Installed Deutsch Steel Shell Receptacle/Bimetal Transition Ring Assemblies with Mated Interface Cables	52

LIST OF FIGURES (Cont.)

<u>Figure</u>		<u>Page</u>
17	Leak Rate/Temperature Characteristic of Gulton Aluminum Shell Receptacle J-2, S/N-005	53
18	Leak Rate/Temperature Characteristic of Gulton Aluminum Shell Receptacle J-2, S/N-006	54
19	Leak Rate/Temperature Characteristic of Gulton Aluminum Shell Receptacle J-2, S/N-009	55
20	Leak Rate/Temperature Characteristic of Gulton Aluminum Shell Receptacle J-5, S/N-052	56
21	Leak Rate/Temperature Characteristic of Gulton Aluminum Shell Receptacle J-5, S/N-053	57
22	Leak Rate/Temperature Characteristic of Gulton Aluminum Shell Receptacle J-1, S/N-061	58
23	Leak Rate/Temperature Characteristic of Gulton Steel (SS 304L) Shell Receptacle J-40, S/N-003	59
24	Histogram at 392° F of 127 Deutsch Steel (SS20CB3) Shell Receptacles; Test Results of Leak Rate Thermal Acceptance Test, Viking Receptacle Test Program 5/21/74	60
25	Leak Rate/Temperature Characteristics of 4 Deutsch Steel Shell Receptacles S/N-206, 209, 211 and 213	61
26	Leak Rate/Temperature Characteristic of Deutsch Steel Shell Receptacle S/N-214	62
27	Leak Rate/Temperature Characteristic of Deutsch Steel Shell Receptacle S/N-322	63
28	Leak Rate/Temperature Characteristic of Deutsch Steel Shell Receptacle S/N-346	64
29	Leak Rate/Temperature Characteristic of Deutsch Steel Shell Receptacle S/N-349	65
30	Probability of No-Leak Failure for Deutsch Steel Shell (Type SS20CB3) Receptacle (Based on SNAP 19 Viking Receptacle Test Program Test Data, 1974)	66

LIST OF TABLES

<u>Table</u>		<u>Page</u>
1	Pre-Life and Cycle Tests, Thermal Margin Tests	67
2	Functional Receptacle Tests	68
3	Hermetic Receptacle/Bimetal Transition Ring Assembly Tests	71
4	Receptacle Allocation Matrix	72
5	Dummy Stainless Steel Shell Receptacle Attachment Demonstration Tests	73
6	Tabulation of TES Receptacle Test Programs	74
7	Test Results of Thermal Margin Tests of Receptacle S/N-368	B-1-3
8	Test Results of Thermal Margin Tests of 10 Receptacles	B-1-5
9	Test Results of Deutsch Receptacle/Bimetal Ring Assembly S/N-323 (Test Station 19)	B-2-4
10	Test Results of Deutsch Receptacle/Bimetal Ring Assembly S/N-370 (Test Station 20)	B-2-5
11	Test Results of Deutsch Receptacle/Bimetal Ring Assembly S/N-368 (Test Station 21)	B-2-6
12	Test Results of Dummy Receptacle/Bimetal Ring Assembly S/N-B0701 (Test Station 22)	B-2-7
13	Test Results of Dummy Receptacle/Bimetal Ring Assembly S/N-B0702 (Test Station 23)	B-2-8
14	Test Results of Dummy Receptacle/Bimetal Ring Assembly S/N-B0703 (Test Station 24)	B-2-9
15	Test Results of Dummy Receptacle/Bimetal Ring Assembly S/N-B0704 (Test Station 25)	B-2-10
16	Test Results of Dummy Receptacle/Bimetal Ring Assembly S/N-B0706 (Test Station 26)	B-2-11
17	Test Results of Dummy Receptacle/Bimetal Ring Assembly S/N-B0801 (Test Station 27)	B-2-12
18	Test Results of Dummy Receptacle/Bimetal Ring Assembly S/N-A1205 (Test Station 28)	B-2-13

LIST OF TABLES (Cont.)

<u>Table</u>		<u>Page</u>
19	Summary Tabulation of Test Results from Functional Receptacle/Bimetal Ring Tests	B-2-14
20	Test Results of Leak Rate Acceptance Tests of Gulton Aluminum Receptacles Type J-2	C-3
21	Test Results of Leak Rate Acceptance Tests of Gulton Aluminum Receptacles Type J-5	C-5
22	Test Results of Leak Rate Acceptance Tests of Gulton Aluminum Receptacles Type J-1	C-7
23	Test Results of Leak Rate Acceptance Tests of Gulton Steel Shell Receptacles Type J-40	C-9
24	Summary Tabulation of Test Results from Leak Rate Acceptance Tests of Gulton Aluminum Shell Receptacles	C-10
25	Summary Tabulation of Test Results from Leak Rate Acceptance Tests of Gulton Steel Shell Receptacles	C-11
26	Test Results of Leak Rate Acceptance Tests of New Deutsch Steel Shell Receptacles	D-3
27	Viking Surplus Electrical Receptacle Historical Data	D-9
28	Effect of Thermal Aging and Cycle Tests on Viking Deutsch Receptacle Leak Rate (4/2/74)	D-10
29	Reliability Demonstration Diffusion Bonded/Welded Viking Deutsch Electrical Receptacle (7/8/74)	D-11
30	Viking Deutsch Electrical Receptacle Applications by Lot Number (10/8/74)	D-12
31	Viking Deutsch Receptacle Leak Rate Test Results, First Flight Lot Set (10/15/74)	D-13
32	Viking Deutsch Receptacle Seal Leak Rate Test Results, Receptacle Lot 7346	D-14
33	Viking Deutsch Electrical Receptacle Assessment Data (10/15/74)	D-15
34	Viking Deutsch Electrical Receptacle Assessment Test Data (10/15/74)	D-16

LIST OF TABLES (Cont.)

<u>Table</u>		<u>Page</u>
35	Summary-Viking Deutsch Electrical Receptacle Thermal Margin Test Results (11/9/74)	D-17
36	Viking Deutsch Electrical Receptacle Seal Leak Rates (1975)	D-18
37	Viking Individual Receptacle/Weld Hours and Thermal Cycles (1975)	D-19
38	Viking ETG/RTG Deutsch Electrical Receptacle Reliability Assessment Summary (3/20/75)	D-20
39	SIG Steel Shell Electrical Receptacle/Bimetal Seal Ring Test Matrix	D-21
40	SIG Receptacle Reliability Assessment Matrix	D-22

1.0 Summary

The purpose of the receptacle test program was to test various types of hermetically sealed electrical receptacles and to select one model as the space-flight hardware item for SIG/Galileo thermoelectric generators. The design goal of the program was to qualify a hermetic seal integrity of $\leq 1 \times 10^{-9}$ std cc He/sec-atm at 400°F (204°C) and verify a reliability of 0.95 at a 50% confidence level for a flight mission in excess of 7 years.

Large numbers of hermetic receptacles with aluminum and steel shells were leak tested at room and elevated temperatures and these tests finally resulted in the selection of a steel shell receptacle used previously for spacecraft flight generators. A bimetal transition ring was developed to weld this receptacle to an aluminum generator housing. Functional performance tests (life, thermal cycling and thermal safety margin) were conducted successfully with test samples of hermetic receptacle/bimetal transition ring and dummy receptacle/bimetal transition ring assemblies during this program.

Another 60 new hermetic receptacles with steel shells, destined for flight hardware application, were successfully tested and their leak rates at 400°F were in the 1×10^{-10} to 1×10^{-9} std cc He/sec-atm region. Twenty of these units were then allocated to this program for further functional testing.

2.0 Background and Major Milestones of the Receptacle Test Program2.1 Initial Program Efforts

In August 1975 Teledyne Energy Systems (TES) planned to procure and test hermetically sealed electrical receptacles to be used as feedthroughs for power and instrumentation on the SIG/Galileo thermoelectric generators (Figure 16). It was contemplated to acquire receptacles with aluminum shells as well as with steel shells as backup and then select the model best suited for flight hardware.

The receptacle had to be attached to an aluminum generator housing. Severe weight constraints had been imposed on the generator design and for this reason hermetically sealed receptacles with aluminum shells were considered besides the conventional steel shell type. It should be noted that a steel shell receptacle could only be attached to the aluminum housing by means of a bimetal transition ring (a steel/silver/aluminum explosive-clad transition material). So-called O-rings were not considered as hermetic seal for reliability reasons.

An example is given to illustrate weight savings by using an aluminum shell receptacle instead of a steel shell unit with bimetal ring. The weight of an aluminum shell size 20 receptacle with 41 pins was approximately 39 grams (0.09 lbs.) whereas a steel shell size 16 receptacle with 26 pins was about 38.8 grams (0.09 lbs.) plus the weight of the bimetal ring of 106 grams (0.23 lbs.) or a total of 144.8 grams (0.32 lbs.). This weight reduction would have been almost a factor of 4!

A receptacle test program was developed for extensive testing of different types of receptacles to verify their hermetic seal integrity under simulated operational conditions equivalent to the mission profile and life of the generators. The design

goal was 0.95 reliability at a 50% confidence level for a 7-year mission duration.

Various receptacle specifications were drafted (References 26, 29, 30 and 42) and transmitted to a large number of manufacturers of hermetically sealed receptacles (References 24 and 28). Although some vendors responded to steel shell receptacle requirements, Gulton Industries, Costa Mesa, California, was the only company responsive to TES requirements for aluminum and steel shell hermetic receptacles with thermocouple material pins.

When the receptacle program was started, the following requirements had been established for:

- (1) hermetic receptacles with aluminum shells which could be directly welded to the aluminum housing of the generator;
- (2) hermetic receptacles with stainless steel shells as backup; these would be welded to a bimetal transition ring and then the aluminum section of the ring would be welded to the generator housing after thoroughly leak testing the receptacle/bimetal transition ring assembly as a subassembly component (Figure 16);
- (3) All hermetic sealed receptacles had the specification to be within a leak rate of $\leq 1 \times 10^{-9}$ std cc He/sec-1 atm over a temperature range from 70°F to 400°F.

Since, at the start of the receptacle program, the types of internal generator instrumentation were still undecided, both aluminum and steel shell receptacle types were subdivided in the following groups:

- (4) a model J-1 aluminum shell receptacle with 41 regular pins (gold-plated Inconel 750 steel pin inserts); to be used for the feedthrough of generated DC generator power for RTG's and ETG's and AC heater power for ETG's;
- (5) a model J-2 aluminum shell receptacle with 21 regular pins and 10 pairs of thermocouple (T/C) material pins of the 10% Rh/Pt-Pt (Platinum/Rhodium) type 'S'; to be used for temperature measurements in the thermoelectric modules of the generator (Figure 1);
- (6) a model J-3 aluminum shell receptacle with 41 T/C pins of Platinum/Rhodium type "S"; to be used for instrumentation for thermoelectric modules ;
- (7) a model J-4 aluminum shell receptacle with 21 regular pins and 10 pairs of T/C material pins of the W 3%/W 25% Re (Tungsten/Rhenium) type; to be used for feedthrough of AC heater power and heater compartment instrumentation of ETG's; the Tungsten/Rhenium T/C pin materials were actually type Hoskins Alloy 203 (equivalent T/C extension grade for W 3% Re) and Hoskins Alloy 225 (equivalent T/C extension grade for W 25% Re) ;
- (8) a model J-5 aluminum shell receptacle with 41 T/C pins of type 3%/25% Tungsten/Rhenium; to be used for the feed-through of instrumentation for the generator heater compartment ;
- (9) a model J-30 steel shell receptacle with 41 T/C pins of platinum type "S" similar to the model J-3 receptacle;

- (10) a model J-40 steel shell receptacle with the same pin arrangement as the model J-4 receptacle;
- (11) all aluminum (type 6061T-651) and steel (type SS 304) shell receptacles were size 20 shell, thread-coupling, weld-mount, 41 pin inserts, insert arrangement per MS27561 (USAF) and mateable with standard connector plug MS24266-20T41S per MIL-C-26500E (USAF) (References 11 to 15, 29 and 42).

Since the receptacle manufacturer (Gulton Industries, References 20, 24, 27, 29, 30, 31 36 to 38, 50 and 52) experienced difficulties in meeting leak rate specifications for aluminum shell receptacles at a 400°F temperature level, TES lowered this rating for aluminum shell receptacles from a 400°F to a 300°F level in July 1977.

On 11/15/77 Gulton Industries delivered 25 aluminum and 5 steel shell receptacles. All units were leak tested by TES Quality Control (Reference 34 and Figures 6 and 7) and only 5 aluminum shell receptacles passed these preliminary acceptance leak tests at 300°F. The remainder of the receptacles failed (leak rate increased $>3 \times 10^{-6}$ std cc He/sec-atm) at a temperature level of about 200°F (References 52, 57, 58, 63 and 64). The test results of these leak checks are presented in Appendix C and Tables 20 through 25.

2.2 Selection of Deutsch Steel Shell Receptacle

A decision was made on 12/15/77 to discontinue efforts with aluminum and steel shell receptacles manufactured by Gulton Industries and to use hermetically sealed receptacles which had been used successfully by TES in previous generator

programs.* This decision was based on extensive experiences by TES in hermetic connector test technology for the past 15 years and on the successful employment of this special steel shell (SS20CB3) receptacle model in numerous spacecraft and terrestrial hardware applications such as Pioneer spacecraft SNAP 19 Program generators, Viking Lander spacecraft SNAP 19 Program generators, HPG Program generators as well as HPG MOD 3 Program generators (References 1 through 21, 25, 48, 49, 51, 53, 65, 66, 72 through 75, 78 through 80 and 90). This design change also included the connector hardware for the first SIG test generator GDS-1 (Ground Demonstration System) which was a prototype unit (References 53, 54, 55, 58, 68 and 75).

At the time of this design change in the receptacle test program for the SIG/Galileo Program generators, 10 old surplus steel shell receptacles from the Viking Program were located in TES storage. These were originally manufactured by the Deutsch Company, Electronics Component Division, Banning, California, over the period 1972-1973 and were successfully leak tested by TES upon delivery in 1972 and 1973 (References 46, 54 and Figure 2). All 10 units were again leak tested (Figure 8) at 392°F on 1/27/78 (Reference 53) and found to be leak tight. Their leak rates varied from NDL (no detectable leak) on 6 units to 7×10^{-10} std cc He/sec-atm on the other 4 units. Three of these were allocated for the receptacle test program until a new batch of this model receptacle could be procured.

The 3 test samples were Deutsch Company model and P/N 78033-16-26 PN and shell size 16, 26 No. 20 gauge pins, bayonet-lock coupling type, weld-mount flange receptacles which were originally procured with the Viking Program hermetically sealed

* See Table 6

receptacle specifications 452A6000044-001 (Reference 49: Reference 69 for SIG/Galileo Program was identical). The receptacle manufacturer rated these units at 200°C (392°F) with a maximum allowable leak rate of $\leq 1 \times 10^{-8}$ std cc He/sec-atm.

Each of the 3 units (Figure 2) was welded to a bimetal transition ring (Figures 3 and 5) after these rings alone were successfully leak tested (Figure 4). Thereafter, the Deutsch receptacle/bimetal ring assemblies were again leak tested (Figures 6 and 8) prior to their installation into receptacle test fixtures (References 32, 33, 34, 91 and Figure 9) and mounting into the receptacle test loop stations (Figures 12 through 15).

Sixty new hermetically sealed receptacle units of the same model were procured from the Deutsch Company in June 1978. Since this company did not manufacture these custom-made hermetic receptacles for a number of years, some concern prevailed at TES whether the units from the new batch would be as good as previous units. For this reason, 20 units from the new receptacle batch were assigned to the receptacle test program for different performance life tests. Upon delivery of the 60 new receptacles in November 1978 all units were leak tested by TES Quality Control (References 70, 73, 76 and Figures 6 and 8) and the test results were excellent. The detailed test results are presented in Appendix D.

2.3 Implementation of the Receptacle Test Program

On 6/10/77 the plumbing assembly, instrumentation and heater control wiring, test station leak checks and final operational tests of the receptacle test loop installation (References 44, 86 and Figures 12 through 15) were completed.

On 5/10/78 tests were started with 3 Deutsch receptacle/bimetal transition ring assemblies, mounted in their LCP10150 test fixtures (Reference 33 and Figure 11), in 3 test stations of the receptacle test loop. The detailed results of these tests are presented in Appendices B-1, B-2 and Tables 6 through 11 and 19. The tests were successfully conducted at 400°F temperature.

On 5/25/78 tests were initiated with 7 dummy receptacle/bimetal transition ring assemblies, mounted in their LCP10150 test fixtures, in 7 test stations of the loop. The tests were successfully conducted at 300°F and 400°F levels with 2 test groups. Test results of these 7 test samples are presented in Appendix B-2 and Tables 12 through 18. All references stated in this report are listed in Appendix A.

3.0 The SIG/Galileo Receptacle Test Program

3.1 Introduction and Test Philosophy

The purpose of the receptacle test program was to gather life performance and operational reliability data about the hermetic seal integrity as well as life expectancy of candidate receptacle types for flight hardware. The goal of this effort was to prove a 0.95 reliability at a 50% confidence level for the selected hermetic receptacle model to be employed for generator spaceflight missions in excess of 7 years (Table 40).

In order to achieve this design goal a detailed and comprehensive receptacle test program was derived and executed. Functional performance tests were planned not only for the receptacle units alone but also for steel shell receptacles in combination with bimetal rings which were necessary for attachment to the aluminum generator housing. A further aim of this program was the determination of the thermal limit of the seal integrities of the receptacle as well as of the bimetal ring. This was mandatory in order to establish a satisfactory thermal safety margin above the anticipated operational temperature levels at the receptacle mounting location on the generator throughout the entire mission temperature profile.

In general, hermetic receptacles are manufactured in batches. The glass or ceramic bead or diaphragm insert material of a number of units is fired at about 950°F for aluminum and at about 1800°F for steel shell receptacles. The units are then cooled with precise process controls and the hermetic insert material solidifies. The hermeticity of the receptacle compression seal is then established by inducing stresses in the order to 20,000 to 50,000 psi in the glass material at room temperature.

These stresses between seal material, pins and the receptacle shell, however, decrease rapidly as the receptacle is exposed to increasing temperature. The cause for this is the different expansion characteristics of the various receptacle materials. Thus, a leak-tight receptacle at room temperature might exhibit a high leak rate after heatup.

For this reason, tradeoff studies were conducted to determine representative numbers of test receptacles from each receptacle batch for the test program. Economy factors, on the other hand, had also to be considered. Therefore, the samples for the miscellaneous types of tests were limited to minimum, but still significant numbers of specimens, to obtain a maximum test data yield. Test samples quantities and test allocations are shown in Tables 1 through 5 and are discussed in paragraph 3.2.

3.2 The Receptacle Test Plan

A detailed receptacle test plan was delineated at the start of the program and periodically updated as changes or directions of efforts occurred during this program (References 27, 31, 41, 59, 60 and 67). The receptacle test plan, in general, followed test philosophies for high reliability hermetic receptacles used in previous TES generator programs. The rationale for specific receptacle tests had already been developed during other major programs such as SNAP 11, SNAP 29, Nimbus SNAP 19, Pioneer SNAP 19, Viking SNAP 19, KIPS, HPG MOD 3 and various other HPG generator programs.

Extensive experiences with hermetically sealed receptacles had been gained from all these programs over the past 15 years and test data as well as receptacle reliability aspects could be directly compared or correlated with the SIG generator receptacles after receptacles, manufactured by the Deutsch Company, were selected as the future generator hardware components (Table 6).

Basically, the receptacle test plan could be divided into a number of progressive steps; these were:

- (a) Mechanical and physical inspections of receptacles by the manufacturer (100% screening); leak rate tests at room temperature were conducted by the receptacle manufacturer (100% screening) prior to delivery;
- (b) TES Quality Control acceptance tests with 100% screening; these acceptance tests included optical inspection (at 20x magnification) of the hermetic seal insert material for anomalies and leak tests at room and 392°F temperatures;
- (c) Leak tests of bimetal transition rings prior to their weldment to respective receptacles (100% screening);
- (d) Welding of the bimetal transition ring to each Deutsch steel shell receptacle. Subsequent leak tests of each of the receptacle assemblies were conducted at 70°F and 400°F temperature (100% screening);
- (e) Welding of the bimetal transition ring to a dummy steel receptacle (solid 304L steel plug with a receptacle configuration) and the same leak tests as in (d) above;
- (f) Welding of Deutsch receptacle/bimetal ring assemblies and dummy receptacle/bimetal ring assemblies into LCP10150 test fixtures for thermal margin life (thermal aging) and thermal cycle tests; all mounted assemblies were leak tested after assembly into their test fixtures at 70°F and 400°F temperature (100% screening);

- (g) Installation of LCP10150 test fixture assemblies into test stations of the receptacle test loop installation and leak tests of each test station after assembly at room and elevated temperatures;
- (h) Short term (1000 hours) and extended (8000 hours) receptacle life (thermal aging at elevated temperature) tests;
- (i) Thermal cycle tests before and after life tests;
- (j) Thermal safety margin tests with a representative quantity of virgin receptacles (not burnt in) and additional safety margin tests of burnt-in receptacle units after thermal cycle and life tests to determine any effects of previous types of testing. Post-life margin test data would have been compared with test results of the virgin samples;
- (k) Diagnostic failure and reliability analyses were performed to determine failure mode(s), life expectancy and prediction of hermetic seal integrity.

3.2.1 Receptacle Test Operations by the Manufacturer

Detailed specifications for Deutsch Company receptacle P/N 78033-16-26 PN (Figure 2), that were deviations from Deutsch receptacle model DBA54H-16-26 PN, a standard catalogue item, were delineated in References 49 and 69. The manufacturer performed mechanical and physical inspection of each unit (100% screening), but was not required to perform any leak rate tests at elevated temperature. However, each receptacle unit was leak tested at ambient room temperature at a go/no go leak check setting (100% screening) by Deutsch Quality Control. This pre-delivery leak rate

acceptance setting was in the order of a 10^{-8} to 10^{-9} std cc He/sec-atm leak rate band.

No reports about receptacle leak rate failures were received from the manufacturer during the June-September 1978 period when the manufacturing process took place.

3.2.2 TES Quality Control Acceptance Inspections and Tests

A Quality Control receptacle acceptance test procedure (Reference 34) was used to conduct TES receptacle receiving inspections and leak rate acceptance tests. Receptacle documentation and data furnished by the supplier were verified for compliance with TES procurement documentation. The various inspections included also the verifications of the receptacle materials as well as the following significant items:

- (a) an optical inspection of the hermetic seal insert (total glass diaphragm) and specifically the areas around each penetration of a pin insert in the glass seal; this inspection was conducted with at least 20 times magnification;
- (b) inspection and verification of straightness conditions of pins of each receptacle; the 5 keyways and the mateability of each unit;
- (c) inspection and verification of supplied interfacial seal supplied with each unit and the quality of the goldplated pins;
- (d) inspection and verification of legible pin insert identifications;
- (e) inspections of cleanliness of the unit and the unit weight;
- (f) inspection and verification of proper receptacle unit identification versus vendor-furnished documentation (marked vendor receptacle part number, date of manufacture and batch code on the receptacle unit proper and its individual packaging container).

Mechanical inspections comprised verifications of receptacle dimensions and functional operation of the receptacle coupling arrangement (threaded coupling type for Gulton manufactured receptacles, bayonet-lock type for Deutsch manufactured units). Electrical measurements were limited to insulation resistance and the verifications of conductive shell finish.

Hereafter, each unit was serialized for traceability and the leak rates were measured. Each receptacle was temporarily installed into an LCP 10030 acceptance leak test fixture (Reference 32 and Figures 6 and 8) and leak rate tests were conducted at room temperature, at elevated temperature (392°F to 400°F for 15 minutes) and again at room temperature after checking the hermetic seal integrity of the test fixture alone prior as well as after these initial acceptance tests (100% screening).

One of the purposes for these 3 TES leak rate tests as part of acceptance inspections was to establish an initial correlation between supplier and TES test results with minimum time elapsed between supplier and TES tests. The rationale for anticipated possible differences in leak rate test data was:

- the supplier and TES leak rate tests were conducted by different technicians (human error factor);
- the same receptacles were tested in different test fixtures with possibly different background noise (leak rate variations of test fixtures);
- the receptacle leak rate was measured with different test instrumentation which was calibrated with different leak rate standards (instrumentation error).

After the TES Quality Control acceptance leak tests were completed, the test results were compared with the manufacturer's data and used as base line for further testing. The acceptance test results of the 3 old Deutsch control receptacle test samples (unit S/N-323, -368 and -370) are presented in Appendix B-2, of the 60 new Deutsch receptacle units in Appendix D and of the 30 Gulton aluminum and steel shell receptacles in Appendix C.

3.2.3 Thermal Margin Receptacle Tests

Since thermal safety margin test data are of primary importance for reliability analysis of each manufactured receptacle batch (References 8, 37 through 39, 45 through 47, 55, 58, 61, 68 and 75), test samples of each incoming receptacle batch manufactured by the Deutsch Company were assigned to these tests. Some of these margin tests were scheduled with virgin receptacles (not burnt-in) prior to the start of the group life and cycle tests as shown in Table 1.

The test results would have then been compared with receptacle/bimetal ring assembly data from thermal margin tests performed after life and cycle tests shown in Table 2 as well as with data from thermal margin tests of previous receptacle batches. By using this technique it would have been possible to better evaluate the thermal margin rating of each receptacle batch and also use the results for qualification of new receptacle lots.

In order to obtain an accurate and meaningful determination of the maximum thermal receptacle rating/failure point for a batch test specimen, leak checks were conducted after each 20°F (36°C) increment of temperature increase above the nominal receptacle test temperature of 400°F (204°C). After failure occurred the

receptacle leak rate was then again checked periodically during cooldown to room temperature. Another point of singular importance during this test operation also was to investigate if the test specimen had the characteristic of resealing during cooldown. In case resealing occurred, the thermal rating test was repeated to establish whether the leak failure temperature level would be the same or much lower as was experienced with some of the test samples from previous receptacle batches.

In order to establish the thermal rating of a receptacle it was necessary to define a reasonable magnitude of leak rate increase for the failure point of a test sample. Therefore, two orders of magnitude of the nominal receptacle leak rate value were defined for receptacle failure (from $\leq 1 \times 10^{-9}$ to 1×10^{-7} std cc He/sec-atm) as a criterion for this test program. This was based on the facts that results of previous thermal margin tests during other receptacle programs showed sudden changes in receptacle hermetic seal integrity from $< 1 \times 10^{-10}$ or $< 1 \times 10^{-9}$ std cc He/sec-atm to $> 3 \times 10^{-6}$ std cc He/sec-atm (wide open).

A quantity of 3 virgin units from each new batch of Deutsch receptacles was assigned to margin tests prior to life/cycle tests of other units from the same batch (Table 1). After completion of the group life and cycle tests of these other receptacle units, thermal margin tests were again planned with 4 burnt-in samples from each new batch (Table 2).

A thermal margin test with Deutsch S/N-368 receptacle/bimetal transition ring assembly was performed on 7/19/78 (Reference 61) and the test results were good. A thermal margin rating of 698°F (370°C) temperature was determined and the receptacle did not reseal after cooldown to room temperature. Prior to the thermal margin test this receptacle had the following test history:

- (a) the unit was manufactured on 11/15/73 by the Deutsch Company and leak tested at room temperature;
- (b) upon delivery in 1973 TES leak tested this unit and the leak rate at 400°F was 8.7×10^{-10} std cc He/sec-atm (Table 27);
- (c) the receptacle was in storage until January 1978 when it was retested for SIG receptacle test program application and the leak rate at 400°F was $< 1 \times 10^{-10}$ std cc He/sec-atm (Table 27);
- (d) the receptacle was welded to a bimetal transition ring in March 1978 and exhibited no detectable leak rate at room temperature and 400°F;
- (e) the receptacle/bimetal ring assembly was welded into a LCP10150 receptacle test fixture (References 33 and Figures 9 and 11) and the test fixture assembly was installed in the receptacle test loop installation (Figures 12 through 15); the 5/10/78 leak rate at 81°F was 4.5×10^{-10} and at 303°F was 1.9×10^{-9} std cc He/sec-atm (Table 11);
- (f) after 2 thermal cycles from 300°F to 150°F to 300°F, the receptacle leak rate at 148°F was 6.7×10^{-10} and at 302°F was 1.1×10^{-9} std cc He/sec-atm;
- (g) after a short term 1170 hour life performance test at 400°F, the receptacle leak rate at 399°F was 1.45×10^{-9} std cc He/sec-atm;
- (h) prior to the start of 30 thermal cycle tests from 400°F to 150°F to 400°F the receptacle leak rate at 148°F was 7.8×10^{-10} and at

399°F was 1.45×10^{-9} std cc He/sec-atm; after these tests the leak rate at 112°F was 4.2×10^{-10} and at 400°F was 9.0×10^{-10} std cc He/sec-atm;

- (i) at the start of the thermal margin test the leak rate of the receptacle at 400°F was 3.2×10^{-9} std cc He/sec-atm.

A detailed description with additional test results and an analysis of this thermal margin test of the Deutsch receptacle S/N-368/bimetal transition ring assembly are presented in Appendix B-1.

3.2.4 Life and Cycle Receptacle Group Tests

3.2.4.1 Tests for Receptacle/Bimetal Transition Ring Assemblies

The TES receptacle test loop installation (References 44 and 86 and Figures 12 through 15) had 36 test stations available for the miscellaneous types of receptacle tests. Ten of these stations were used for short-term and long-term life performance (thermal aging) tests of 3 old Deutsch receptacle/bimetal transition ring assemblies and 7 dummy receptacle/bimetal transition ring assemblies. The 3 old Deutsch receptacles (surplus units from the SNAP 19 Viking Lander Generator Program) were to be employed as control units for the test samples from the new batches of receptacles.

Therefore, a tradeoff study between quantities of the various test type receptacles was conducted to optimize test results for maximum data yield. Thus, 9 units from the first batch and 4 units from the second batch of new receptacles were selected for life and cycle group tests (Table 2). This allocation of a total of 13 test stations for life and cycle group tests left a remainder of 13 stations; 6 stations of these were allotted for 6 receptacle samples for thermal margin tests and the remaining 7 stations were reserved for a life and cycle tests for receptacle/bimetal ring assemblies of a possible third batch of new Deutsch receptacles.

3.2.5 Reference Leak Rate Tests for Deutsch Receptacle/Bimetal Ring Assemblies

In order to establish a common reference leak rate base for all new Deutsch receptacle/bimetal ring assemblies prior to their group tests, it was planned to heat all ring assemblies in their test loop test fixtures to 400°F and to stabilize them for 2 hours (Table 2). Then a leak check at 400°F was to be conducted; thereafter, all units were supposed to be twice temperature cycled from 400°F to 150°F to 400°F and leak tested again during their last cycle at 150°F and 400°F. Thus, the hermetic seal integrity of each test sample would be qualified before the beginning of the life and cycle group tests. The same procedure was employed with the old Deutsch receptacle/bimetal ring assemblies which served as control samples (Table 3). All test results are presented in Appendix B-2.

3.2.6 Reference Leak Rate Tests for Dummy Receptacle /Bimetal Ring Assemblies

A similar procedure as described in the preceding paragraph 3.2.5 was used to establish a common reference leak rate base for all dummy receptacle/bimetal ring assemblies prior to their group tests. All 7 assemblies were heated up in their test loop test fixtures to 475°F and stabilized for 30 minutes (Table 5). Then a leak check at 475°F was performed and, thereafter, all units were twice temperature cycled from 475°F to 100°F to 475°F and leak tested during the last cycle at 100°F and at 475°F. All test results are shown in Appendix B-2.

3.2.7 Purpose of Separate Receptacle Test Groups

The old and new Deutsch receptacle/bimetal ring as well as the dummy receptacle/bimetal ring assemblies were divided into different test groups. The purpose of this group division was to obtain maximum qualitative statistical data for reliability analysis for short and long term hermetic seal integrity at different operational temperatures of the receptacles and/or bimetal transition rings due to the effects of:

- Operational temperature level
- Temperature cycling
- Temperature aging (life performance testing)
- Sequence of functional testing
- Possible different techniques and/or materials used in the manufacturing of successive batches of receptacles and/or bimetal transition rings
- Unforeseen factors to be analyzed from test data

Referring to Tables 2 through 5 (References 61 and 67 of Appendix A), the Deutsch receptacle/bimetal ring and the dummy receptacle/bimetal ring assembly test groups were organized as follows:

(a) Elevated Temperature Level

All Deutsch receptacle/bimetal ring assembly groups were to be operated at 400°F operational temperature (Table 2). This level was identical with the old Deutsch receptacle/bimetal ring assembly control group of Table 3 (old Deutsch receptacles as control group).

The dummy receptacle/bimetal ring assembly groups were divided into 2 temperature groups. Four assemblies were operated at 300°F and three at 400°F (Table 5).

(b) Temperature Cycling

New Deutsch receptacle/bimetal ring assembly group 1 was supposed to be subjected to a total of 60 temperature cycles from 400°F to 150°F to 400°F, group 2 to 30 cycles. Leak checks were to be performed after each 30 cycles

at 150°F and at 400°F. Peak temperatures of thermal cycles were to be held for 15 minutes. It should be noted that part of the cycling for group 1 was to be conducted after 8000 hours of thermal aging at 400°F (Table 2).

The 3 old Deutsch receptacle/bimetal ring assemblies were divided into 2 test groups (Table 3). Group 1, consisting of 2 assemblies, S/N-323 and S/N-370, was subjected to 36 temperature cycles from 400°F to 150°F to 400°F prior to their 8000 hour life performance (thermal aging at 400°F) tests and leak checks were performed at 150°F and 400°F during the first and last cycle test. Group 1 comprised only 1 assembly, S/N-368, which was subjected to 30 temperature cycles from 400°F to 150°F to 400°F after its 1000 hours life performance test. Leak checks on this assembly were conducted at 150°F and 400°F at the start of the cycle tests and at 100°F and 400°F after the cycle tests.

The dummy receptacle/bimetal ring assemblies were divided into 2 test groups (Table 5). Group 1 comprised 4 assemblies (S/N-B0704, -B0706, -B0801 and -A1205) and 30 temperature cycle tests from 300°F to 100°F to 300°F were conducted with these 4 assemblies prior to their 10,000 hour life performance (thermal aging at 300°F) tests. Leak checks were performed at 100°F and 300°F during the last temperature cycle. Group 2 consisted of 3 assemblies (S/N-B0701, -B0702 and -B0703) and 30 temperature cycle tests from 400°F to 100°F to 400°F were conducted with these 3 assemblies prior to their 10,000 hour life performance (thermal aging at 400°F) tests. Leak checks were performed at 100°F and 400°F during the last temperature cycle.

(c) Life Performance (thermal aging or burn-in)

The new Deutsch receptacle/bimetal ring assemblies were divided into 2 test groups (Table 2). A long term 8000 hour life performance test at 400°F was planned for group 1, whereas a 1000 hour test at 400°F was planned for group 2. The reason for the short-term life test span for group 2 was to be able, at an early stage of the test program, to commence with post-life thermal margin tests with burnt-in receptacle test samples. However, the tests of group 1 were considered to be more significant; therefore, 7 receptacle test samples were assigned to group 1 and only 6 to group 2.

The old Deutsch receptacle/bimetal ring assemblies were also divided into 2 test groups (Table 3). A long term 8000 hour life performance test at 400°F was performed with group 1 (S/N-323 and S/N-370) and a short term 1000 hour life test with group 2 (S/N-368). The reason for the short term life test for group 2 was the same as stated above.

The dummy receptacle/bimetal ring assemblies were also organized into 2 test groups (Table 5). A long term 10,000 hour life performance test at 300°F was conducted with group 1 (4 test samples) and a similar long-term 10,000 hour life performance test at 400°F was conducted with group 2 (3 test samples). After these life performance test spans of 10,000 hours, 2 test samples from group 1 were subjected to temperature cycling tests and 2 other test samples were continued with another 10,000 hours of life performance tests (total now of 20,000 hours of thermal aging at 300°F) with monthly leak checks at 300°F. A similar test program arrangement was made with group 2 of the dummy receptacle/bimetal ring assemblies. Here, one test sample was now subjected to temperature cycling tests whereas 2 test samples were continued with another 10,000 hours of life performance tests (total now of 20,000 hours of thermal aging at 400°F) with monthly leak checks at 400°F.

The life performance tests were steady-state operations of the test samples at the defined temperature levels. Periodic leak checks of the test samples were taken biweekly for the first 3 months (every 336 hours) and then once per month (about every 900 hours). One facility power outage occurred during the life performance tests and the heater power of the test fixture was interrupted for 4 hours on the 3 old Deutsch receptacle/bimetal ring assemblies and the 7 dummy receptacle/bimetal ring assemblies.

(d) Sequence of Functional Receptacle Tests

It was planned to subject the new Deutsch receptacle/bimetal ring assemblies of group 1 to temperature cycling tests prior to and after thermal aging tests. Group 2 of the new Deutsch receptacle/bimetal ring assemblies, on the other hand, were supposed to go first through thermal aging tests before the start of the temperature cycling tests. Since cycling tests were supposed to be repeated with group 1 test samples and thermal aging and cycling test sequence was reversed between groups 1 and 2 test samples, a complete analysis could have been made to investigate the leak integrity dependence versus the different functional parameters for the receptacles proper as well as for the quality of the weld attachment method of the bimetal transition rings. For the same reason, thermal margin tests were scheduled at the beginning of the test program with virgin (not burnt-in) receptacle units and at the end of the group tests with burnt-in and temperature cycled test samples (Table 2).

The same test philosophy for different sequences of functional receptacle tests was executed with the old Deutsch receptacle/bimetal ring assemblies. Here, temperature cycling test were completed with test samples of group 1 before the start of the thermal aging tests of these 2 test samples. Group 2 of the old Deutsch receptacle/bimetal ring assemblies (only 1 test sample) had a reversed sequence of

life performance and temperature cycling tests. In this case, a life performance (thermal aging) test was conducted first and then followed by temperature cycling tests (Table 3).

A similar test philosophy was applied to the 2 groups of the dummy receptacle/bimetal ring assemblies. Here, after temperature cycling and 10,000 hours of life performance testing, half of the group 1 units (2 test samples) were again subjected to temperature cycling tests and the other half to additional life performance testing. Units from group 2 were also divided and temperature cycling tests were conducted with 1 test sample whereas life performance tests were continued with 2 test samples (Table 5).

All test results of these group tests are presented in Appendix B-2 and Tables 9 through 19.

3.2.8 Post-Test Receptacle Inspections and Evaluations

Post-test receptacle and bimetal transition ring evaluations were planned including reliability and failure analyses of possible receptacle failures. Receptacle and bimetal ring examinations would have included visual, mechanical, metallurgical and electrical inspections of tested samples. Any deformation or other anomalies due to the test parameters would have been evaluated and the results would have been used as basis for further testing and/or testing of additional receptacle units, if required.

The forced failure of the old Deutsch receptacle/bimetal transition ring assembly S/N-368 by a destructive thermal margin test was analyzed and evaluated. Details on this test and its results are described in paragraph 3.2.3, Appendix B-1 and Table 7.

3.3 Receptacle Test Fixtures and Tools

A large number of different types of receptacle test fixtures, test tools and other items used with receptacle testing was already designed, developed and manufactured for implementation of previous receptacle test programs (References 21-d through 21-j). For some tests, receptacle leak rate test fixtures and test tools from the SNAP 19 Pioneer and Viking generator receptacle test programs for Deutsch receptacles were reactivated and/or adapted for usage in the SIG receptacle test program. Some of the old items and new test fixtures, developed to implement this receptacle program, are described in the following paragraphs.

3.3.1 Quality Control Acceptance Leak Rate Test Fixture LCP10030

Initial receptacle leak rate acceptance tests by Quality Control were performed at room and elevated temperatures with either test fixture LCP10130 (SIG Program, Reference 32) or fixture 452A6040016 (Viking Program, Reference 21-e) or fixture 452B5140038 (Pioneer Program, Reference 21-d). All these test fixtures were modified to be adaptable (Figures 6 through 8) for:

- either an aluminum shell size 20 receptacle, manufactured by Gulton Industries, weld-mount type;
- or a steel shell size 20 receptacle, manufactured by Gulton Industries, weld-mount type, alone or for the same receptacle with a bimetal transition ring welded to the receptacle flange;
- or a steel (SS20CB3) shell size 16 receptacle, manufactured by the Deutsch Company, weld-mount type, alone or for the same receptacle with a bimetal transition ring welded to the receptacle flange;

- or a steel (stainless 304L) shell size 16 or 20 dummy receptacle configuration, weld-mount type, alone or for the same dummy receptacle with a bimetal transition ring welded to the configuration flange.

Thus, these test fixtures were not only used for initial receptacle leak rate acceptance tests, but also for leak check tests of receptacle/bimetal ring assemblies and dummy receptacle/bimetal ring assemblies after bimetal transition rings were welded to steel shell receptacles or dummy receptacle configurations.

The hermetic seal integrity (leak background noise) of a test fixture alone was always checked out prior to and after completion of receptacle leak tests by using a solid steel dummy receptacle configuration. The test fixtures were instrumented with 2 temperature sensors, premium grade chromel/alumel thermocouple junctions, for measuring the temperature of the shell flange of the receptacle and the internal temperature of the test fixture adjacent to the protruding shell rim of the receptacle. The latter was in an upside down position when installed in this fixture (Figures 7 and 8).

3.3.2 Bimetal Transition Rings

Bimetal (explosive clad 6061 aluminum/0.035 inch silver/304L stainless steel) transition rings were designed, developed and manufactured for size 16 and 20 steel shell receptacles (Figures 3 and 9 through 11). The material for the bimetal rings was manufactured per DuPont Company specifications Deta 605M. After the machining of the rings, each unit was ultrasonically inspected (Reference 99) and leak tested (References 43, 95, 98 and Figure 4).

The bimetal rings for the stainless steel (type 304L) shell size 20 of the Gulton Industries receptacle was P/N LCP10014-009 (Reference 87) and for the stainless steel (type 20CB3) shell size 16 of the Deutsch Company receptacle were P/N LCP10082-009 (Reference 84) and P/N SIG 110062-009 (Reference 97). All bimetal transition rings were serialized for identification and traceability.

After weldment of a bimetal transition ring to a dummy receptacle or a hermetically sealed receptacle, the assembly (Reference 96) was again leak checked (References 32, 94 through 101 and Figure 5).

3.3.3 Bimetal Ring Leak Rate Test Fixture LCP10090

The bimetal ring leak rate test fixture LCP10090 was employed for leak rate tests of bimetal transition rings for either size 16 or 20 steel shell receptacles prior to their weldment to dummy or real receptacles (Reference 43 and Figures 3 and 4). The fixture was provided with premium grade chromel/alumel thermocouple junctions as temperature sensors to control the test process.

3.3.4 Leak Rate Test Fixture LCP10120

This test fixture LCP10120 was used as a tool for leak rate testing dummy receptacle/bimetal ring assemblies for initial checkout (Reference 95).

3.3.5 Bimetal Ring Chill Block Weld Fixture LCP10130

The bimetal ring chill block weld fixture LCP10130 was used to weld the bimetal transition ring to weld-mount type, size 16 or 20 steel shell receptacles (Reference 94 and Figure 5). The fixture was instrumented with premium grade chromel/alumel thermocouple junctions as temperature sensors for controlling the test process.

3.3.6 Test Loop Receptacle Test Fixture LCP10150

This test fixture was only used in the receptacle test loop. Receptacle/bimetal ring assemblies were welded into test fixture LCP10150 (Reference 33 and Figures 9 through 11) prior to their functional tests in the receptacle test loop installation. The fixture was designed to be adaptable for size 16 or 20 shell receptacle and any type of receptacle/bimetal ring assembly combination enumerated in paragraph 3.3.1 above.

All life performance and temperature cycling tests were performed with this test fixture. Thermal margin tests which were conducted up to very high temperatures had to be performed with this fixture since only this fixture design could withstand temperature levels in excess of 700°F (371°C) to force a Deutsch receptacle leak failure.

The 2 parts of the fixture were constructed from solid aluminum blocks and the lower half of the fixture was instrumented with 2 premium grade chromel/alumel thermocouple junctions as temperature sensors for controlling the test conditions. One thermocouple was used for manual readout and the second one was employed as temperature sensor for an automatic data acquisition system. Both temperature sensors were located inside the fixture in wells adjacent to the rim of the weld-mount flange of the receptacle configuration.

3.3.7 Dummy Receptacle Configurations

The dummy receptacle configurations were employed in functional tests of bimetal transition rings in the receptacle test loop. Another usage for the dummy receptacles was to serve as a solid seal plug for quality checkouts for the hermetic seal integrity of receptacle test fixtures by determining the possible leak rates of the test fixtures alone (fixture background leak noise) as described in paragraph 3.3.1.

Three types of dummy receptacles with 2 different receptacle shell sizes were designed to simulate hermetically sealed receptacles. The dummy units were machined out of solid 304L stainless steel blocks. The shapes and outline dimensions of the dummy unit shells and weld-mount flanges were identical to the actual receptacles. After a dummy receptacle was welded to a bimetal transition ring (Reference 96), leak tests at room and elevated temperatures were then conducted (References 32, 94 and Figures 5 and 6) with this assembly.

Dummy receptacle LCP10006-009 (Reference 89) was intended for simulations of Gulton Industries hermetically sealed, aluminum (type 6061T-651) shell size 20 receptacles J-1, J-2, J-3, J-4 and J-5 (Reference 30); dummy receptacle LCP10007-009 (Reference 88) was designed for simulations of Gulton Industries hermetically sealed, stainless steel (type 304L) shell size 20 receptacles J-30 and J-40 (Reference 42).

A number of dummy receptacles for simulations of the Deutsch Company hermetically sealed, stainless steel (type 20-CB3) shell size 16 receptacle had been previously made during the SNAP 19 Viking generator receptacle test program (Reference 92). These dummy units were identical in their configuration to the hermetic receptacle Deutsch P/N 78033-16-26 PN (Figure 2) which was custom-made by the Deutsch Company for TES originally as TES P/N 452A6000044-001 (Reference 49).

This Viking Program hermetic receptacle part number was updated as P/N SIG110026-001 for the SIG/Galileo Program (Reference 69). The old Viking Program dummy receptacle P/N-NSK-1193 was also updated as dummy receptacle LCP10083 for this test program (Reference 83). All old Deutsch dummy receptacles as well as additional new ones were used in the course of this test program.

3.4 Receptacle Test Procedures

Numerous and different types of receptacle test procedures were released as SIG/Galileo Program documentation (Table 39). These test procedures were updated whenever a change in the receptacle test program took place. The procedures included step by step instructions for the various types of receptacle tests and data format sheets for recording of test data.

3.4.1 Receptacle Leak Rate Acceptance Test Procedures

The initial leak rate acceptance tests upon delivery of new receptacles were conducted by TES Quality Control personnel at room and elevated temperatures according to test procedure LCP10031 (Reference 34) for Gulton Industries units and according to test procedure SIG110027 (Reference 70) for Deutsch Company units. These acceptance leak rate tests took place in the climate-controlled TES Quality Control inspection room. Details of these tests are discussed in paragraph 3.3.1 and test results are presented in Appendices C and D respectively for Gulton and Deutsch receptacles.

Test procedures LCP10031 and SIG110027 were both based on previous test procedures for the same Deutsch receptacle model which was used during the SNAP 19 Pioneer and Viking Programs and various HPG programs (Reference 21).

3.4.2 Test Procedures for Functional Receptacle Tests

Functional receptacle/bimetal ring assembly tests were performed by laboratory test technicians under supervision of a test engineer per test procedures LCP10032 (Reference 35) and SIG115001 (Reference 71). All functional tests were conducted in the 36-station receptacle test loop installation (Reference 44 and 86 and Figures 12 through 15) located in the temperature-controlled TES Test Department laboratories.

3.4.3 Test Procedure for Dummy Receptacle/Bimetal Ring Assemblies

Test procedure LCP10065 (Reference 85) was used for functional testing of dummy receptacle/bimetal transition ring assemblies in the receptacle test loop installation.

3.5 The Receptacle Test Loop Installation

Figure 12 shows a view of the receptacle test loop installation which had 36 individual receptacle test stations. Figure 13 presents a diagram of the plumbing system of the receptacle test loop (Reference 44) which consisted of dual vacuum and helium manifolds, each for 18 test stations. An instrumentation and test fixture heater control panel assembly was located at each end of the about 15-foot long test station (Reference 86 and Figures 14 and 15). The main and auxiliary vacuum pumping stations for the total installation were located in the center of the station layout (Figure 13).

The main vacuum pumping station was a Sargent-Welch model 3115-D turbo-molecular pump set. At the ends of the vacuum manifolds of the test loop were thermocouple vacuum gauges which were monitored during the receptacle tests. The plumbing systems leading to individual receptacle test stations were provided with 3-way valves to enable the removal or addition of receptacle test fixtures (paragraph 3.3.6, Reference 33 and Figures 9 through 11) without shutdown of the total station or disturbing other test station with tests in progress.

The leak rate test gas of the receptacle test loop was high-purity helium, Helium Federal Specifications BB-H-1168 Grade A. Provisions were incorporated in the design of the test loop to facilitate the purging of the total plumbing system. The leak rate tests of individual test receptacle assemblies in their test fixtures (Figure 11) were accomplished by wheeling and positioning a helium leak detector instrument, Veeco model MS-18 or equivalent, along the length of the loop installation to any particular test station. A flexible metal test hose was then connected between the test fixture and the leak detector by means of sealed metal flanges.

A very good hermetic seal integrity and very low vacuum of the plumbing system of the test loop alone was verified in periodic checkouts of the station despite the many valves, seals, connections and the large size of this station. This was achieved by: very large size piping used in the vacuum manifolds, pre-assembled plumbing sections were leak tested prior to their final installation and the high efficiency of the main vacuum pumping station as well as the roughing pumps.

The instrumentation and control panels of the station were provided with individual heater power switches for each test station as well as test group switches to facilitate temperature cycling of groups of test samples. The rest of the panel instrumentation consisted of counters for cycle tests and running hour meters for life tests, heater power Variacs for individual test stations, pilot light indicators for test stations, digital thermometers (United Systems Corp. Digitec, model 590KF), multipoint thermocouple switches, temperature recorders, and interface equipment with Doric Digitrend model 240 digital data logger and overtemperature alarm system.

The instrumentation of all 36 receptacle test stations was identical (Figure 15). Each test fixture contained 2 temperature sensors and the temperature measurement system consisted of premium grade chromel/alumel thermocouple wiring. Each test fixture was provided with a precision thermal switch (thermostat) which was manually adjusted and calibrated for tests at different temperature levels as an additional safety feature for preventing overtemperatures (Figure 11).

The test station assignments of the receptacle test loop were as follows:
Stations 1 through 3: Thermal margin tests for 3 virgin Deutsch receptacle/bimetal ring assemblies of the first batch of new Deutsch receptacles (Table 1);

Stations 4 through 6: Thermal margin tests for 3 virgin Deutsch receptacle/bimetal ring assemblies of the second batch of new Deutsch receptacles (Table 1);

Stations 7 through 9: Reserved for thermal margin tests for virgin Deutsch receptacle/bimetal ring assemblies of a third batch of new Deutsch receptacles;

Stations 10 through 14: Group 1, 30 cycles/8000 hour life/30 cycles tests for 5 Deutsch receptacle/bimetal ring assemblies of the first batch of new Deutsch receptacles (Table 2);

Stations 15 and 16: Group 1, 30 cycles/8000 hour life/30 cycles tests for 2 Deutsch receptacle/bimetal ring assemblies of the second batch of new Deutsch receptacles (Table 2);

Stations 17 and 18: Group 2, 1000 hour life/30 cycles tests for 2 Deutsch receptacle/bimetal ring assemblies of the second batch of new Deutsch receptacles (Table 2);

Station 19: 400°F, 36 cycles/8000 hour life/30 cycles tests for old Deutsch receptacle/bimetal ring assembly S/N-323 (Table 3);

Station 20: 400°F, 36 cycles/8000 hour life/30 cycles tests for old Deutsch receptacle/bimetal ring assembly S/N-370 (Table 3);

Station 21: 400°F, 1000 hour life/30 cycles for old Deutsch receptacle/bimetal ring assembly S/N-368 (Table 3);

Station 22: 400°F, 30 cycles/20,000 hour life tests for dummy receptacle/bimetal ring assembly S/N-B0701 (Table 5);

Station 23: 400°F, 30 cycles/20,000 hour life tests for dummy receptacle/bimetal ring assembly S/N-B0702 (Table 5);

Station 24: 400°F, 30 cycles/10,000 hour life/30 cycles tests for dummy receptacle/bimetal ring assembly S/N-B0703 (Table 5);

Station 25: 300°F, 30 cycles/10,000 hour life/30 cycles tests for dummy receptacle/bimetal ring assembly S/N-B0704 (Table 5);

Station 26: 300°F, 30 cycles/10,000 hour life/30 cycles tests for dummy receptacle/bimetal ring assembly S/N-B0706 (Table 5);

Station 27: 300°F, 30 cycles/20,000 hour life tests for dummy receptacle/bimetal ring assembly S/N-B0801 (Table 5);

Station 28: 300°F, 30 cycles/20,000 hour life tests for dummy receptacle/bimetal ring assembly S/N-A1205 (Table 5);

Stations 29 through 32: Group 2, 1,000 hour life/30 cycles tests for 4 Deutsch receptacles/bimetal ring assemblies of the first batch of new Deutsch receptacles (Table 2);

Stations 33 through 36: Reserved for 30 cycles/8000 hour life/30 cycles tests for 4 Deutsch receptacles/bimetal ring assemblies of a third batch of new Deutsch receptacles.

4.0 Test Results from the Receptacle Test Program

Three old Deutsch receptacle/bimetal ring assemblies and 7 dummy receptacle/bimetal ring assemblies were successfully tested per procedures of this receptacle test program. No leak failures of any of the 10 test samples occurred during their miscellaneous functional tests and no detrimental effects were detected due to the programmed sequence of functional tests (see paragraph 3.2.7.d) nor due to the performance of any particular test. Even long-term life performance tests at elevated temperatures did not indicate any noticeable deteriorations of the samples tested.

Detailed test results of all test samples are presented in Appendix B-2 and Tables 9 through 19. One destructive thermal margin test was successfully performed with a Deutsch receptacle/bimetal ring assembly and the test results were very good. Details of this test and results are presented and discussed in paragraph 3.2.3 and Appendix B-1.

Sixty receptacle units from a new batch, manufactured by the Deutsch Company, Banning, California, in the June-November 1978 period, were leak checked successfully per TES Quality Control receptacle acceptance test procedures. The results of these tests are presented and discussed in Appendix D and Table 26. Bimetal transition rings were planned for these receptacles in preparation for 20 test samples destined for the receptacle test program. Since these rings were made from a new stock of a bimetal material plate, extensive testing was performed to assure that the characteristics of this batch of material was comparable with the previous materials.

Twenty-five aluminum and 5 steel shell receptacle units, manufactured by Gulton Industries, Costa Mesa, California, in the July-November 1977 period, were leak tested per TES Quality Control receptacle acceptance test procedures. Only 5 of these 30 units passed these acceptance tests. The test results are presented in

Appendix C, Tables 20 to 25 and Figures 17 through 23.

All documentation, memos, reports, drawings and other pertinent items which concerned the receptacle test program are listed as references and presented in Appendix A. Data, test results and other information from previous TES receptacle test programs, stated in discussions and analyses of test results from this program, are also presented as references in Appendix A and in Tables 6 and 28 through 38.

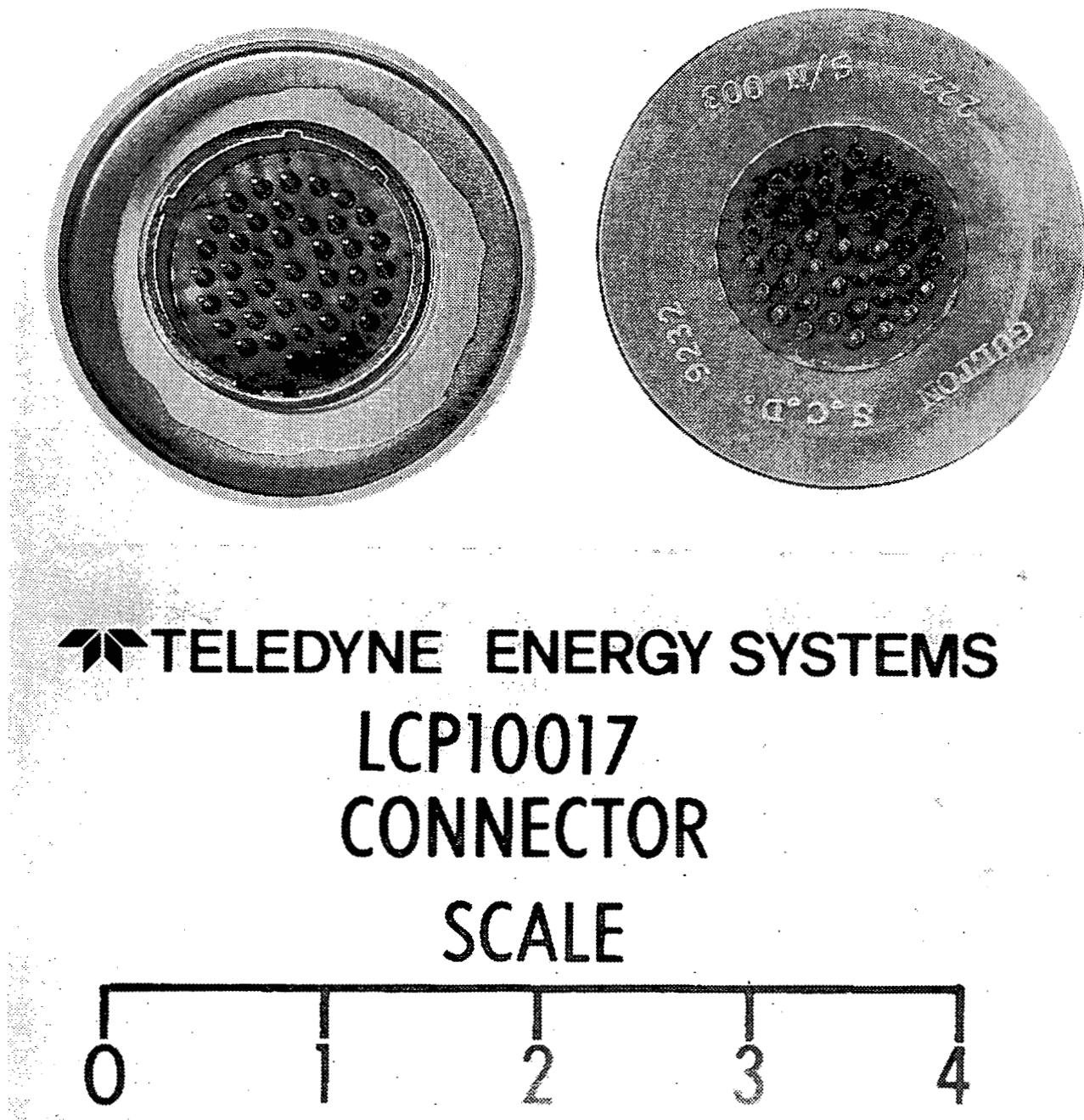


FIGURE 1. GULTON HERMETIC RECEPTACLE J-2 WITH ALUMINUM SHELL AND WELD-MOUNT FLANGE

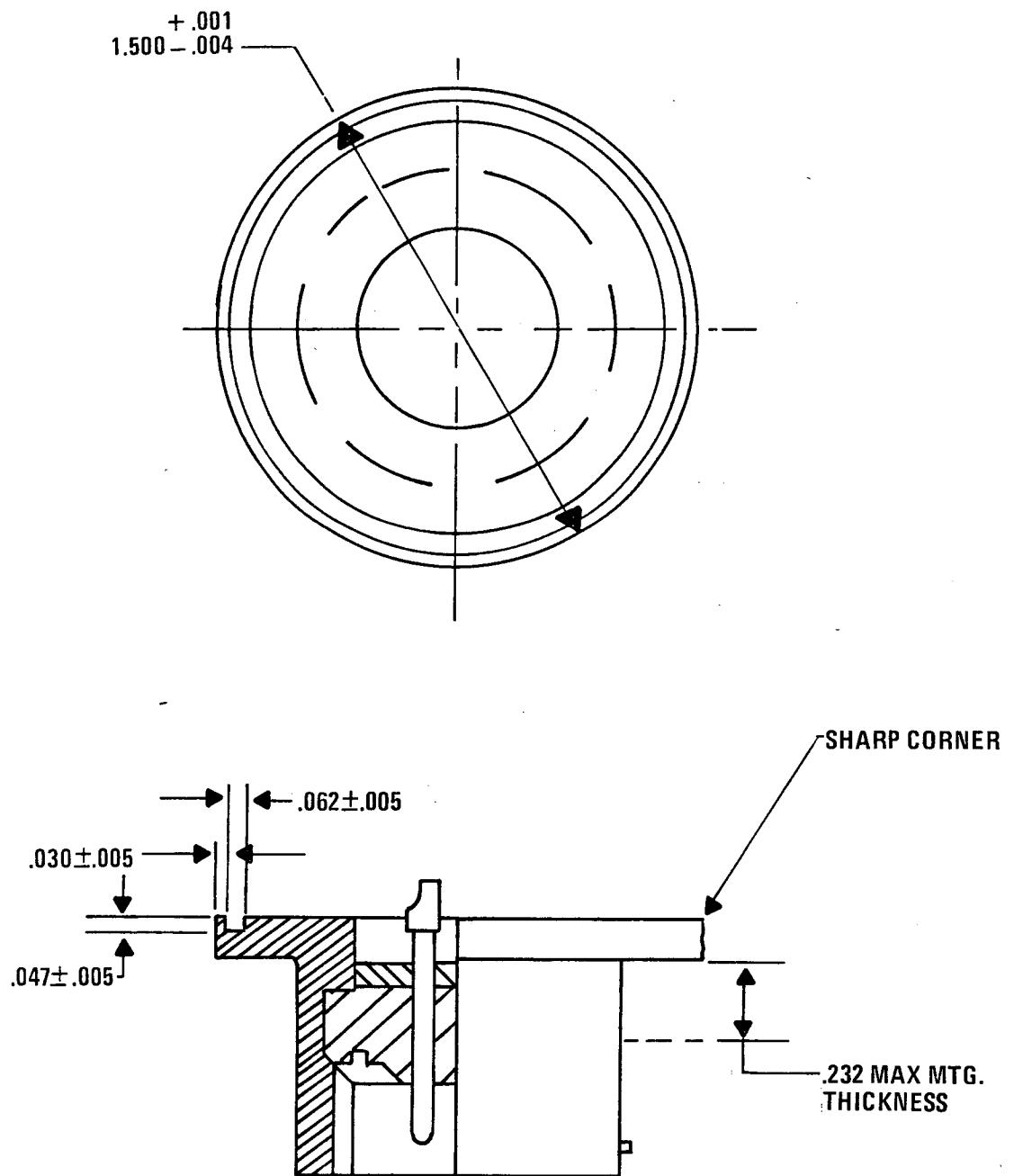


FIGURE 2. DEUTSCH HERMETIC RECEPTACLE 78033-16-26 PN
WITH STEEL SHELL AND WELD-MOUNT FLANGE



TELEDYNE ENERGY SYSTEMS
LCP 10014
BIMETAL RECEPTACLE RING

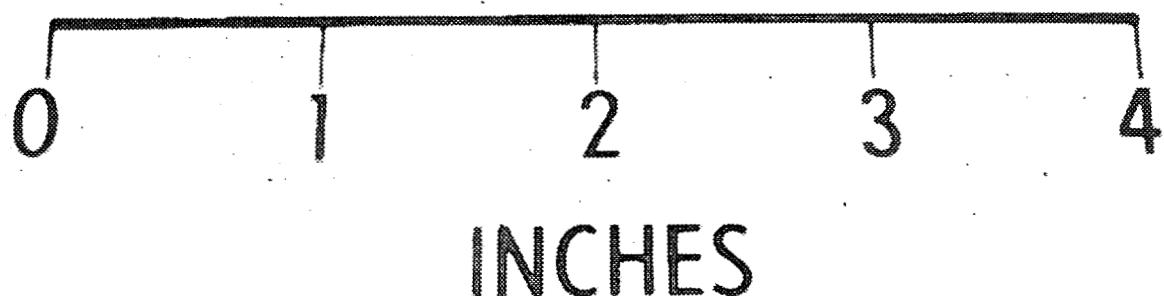


FIGURE 3. BIMETAL TRANSITION RING LCP 10014

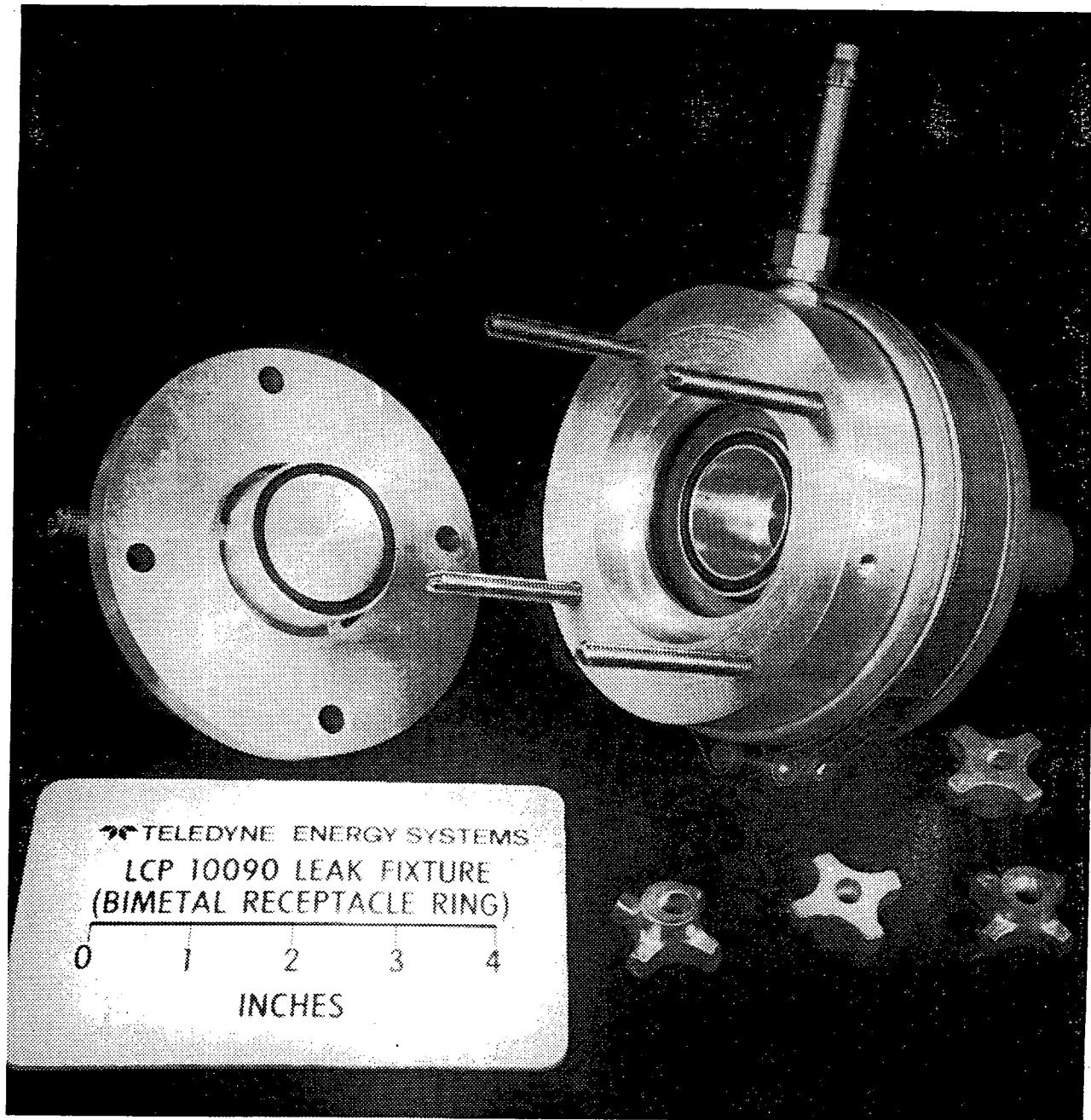


FIGURE 4. LEAK RATE TEST FIXTURE LCP 10090

TES-33009-47

41

41

41

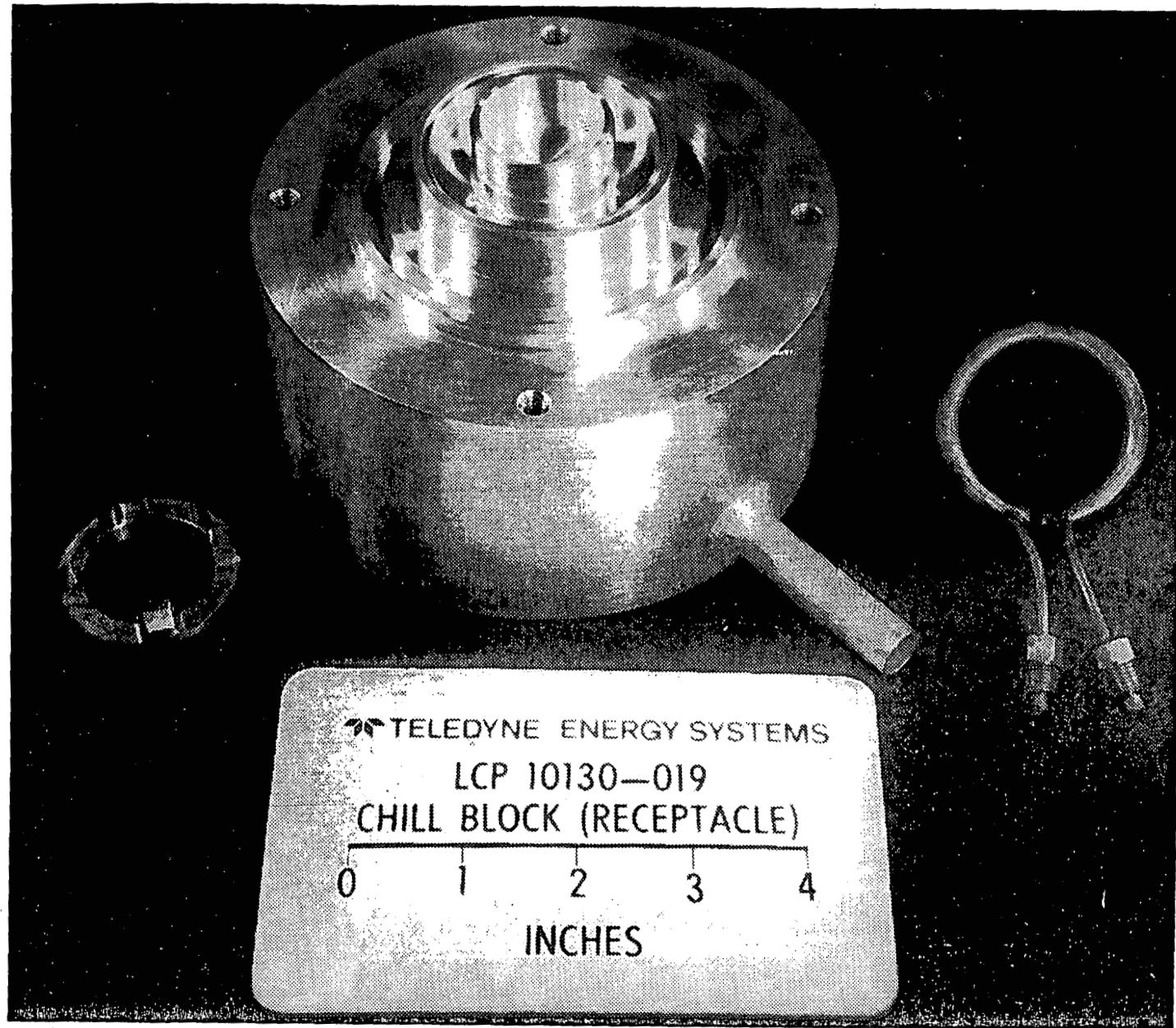
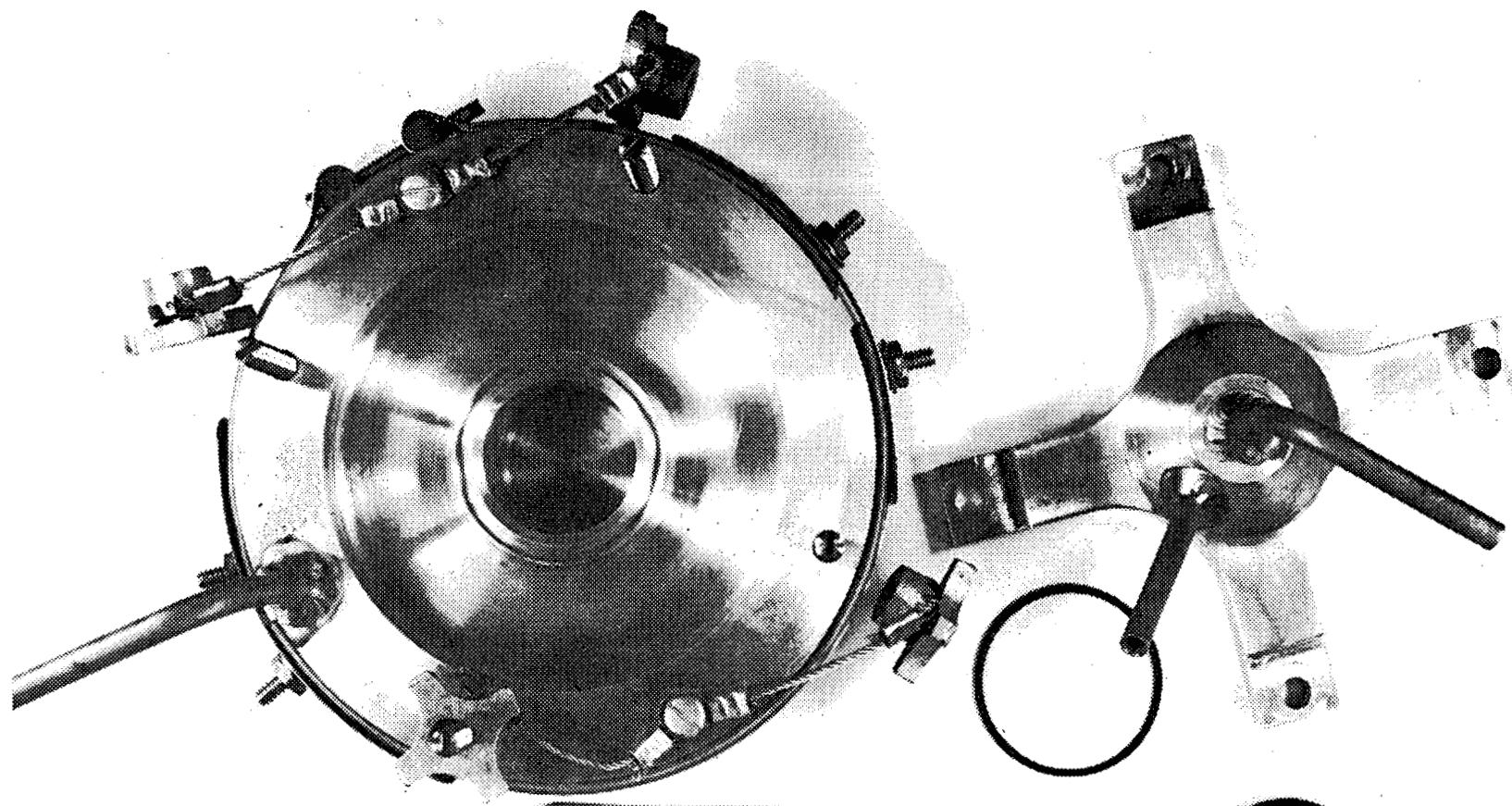


FIGURE 5. CHILL BLOCK WELD FIXTURE LCP 10130

TES-33009-47



TELEDYNE ENERGY SYSTEMS

LCP 10030 LEAK FIXTURE
(ALUM RECEPTACLE)

0 1 2 3 4

INCHES

42.

FIGURE 6. DISASSEMBLED LEAK RATE TEST FIXTURE LCP 10030

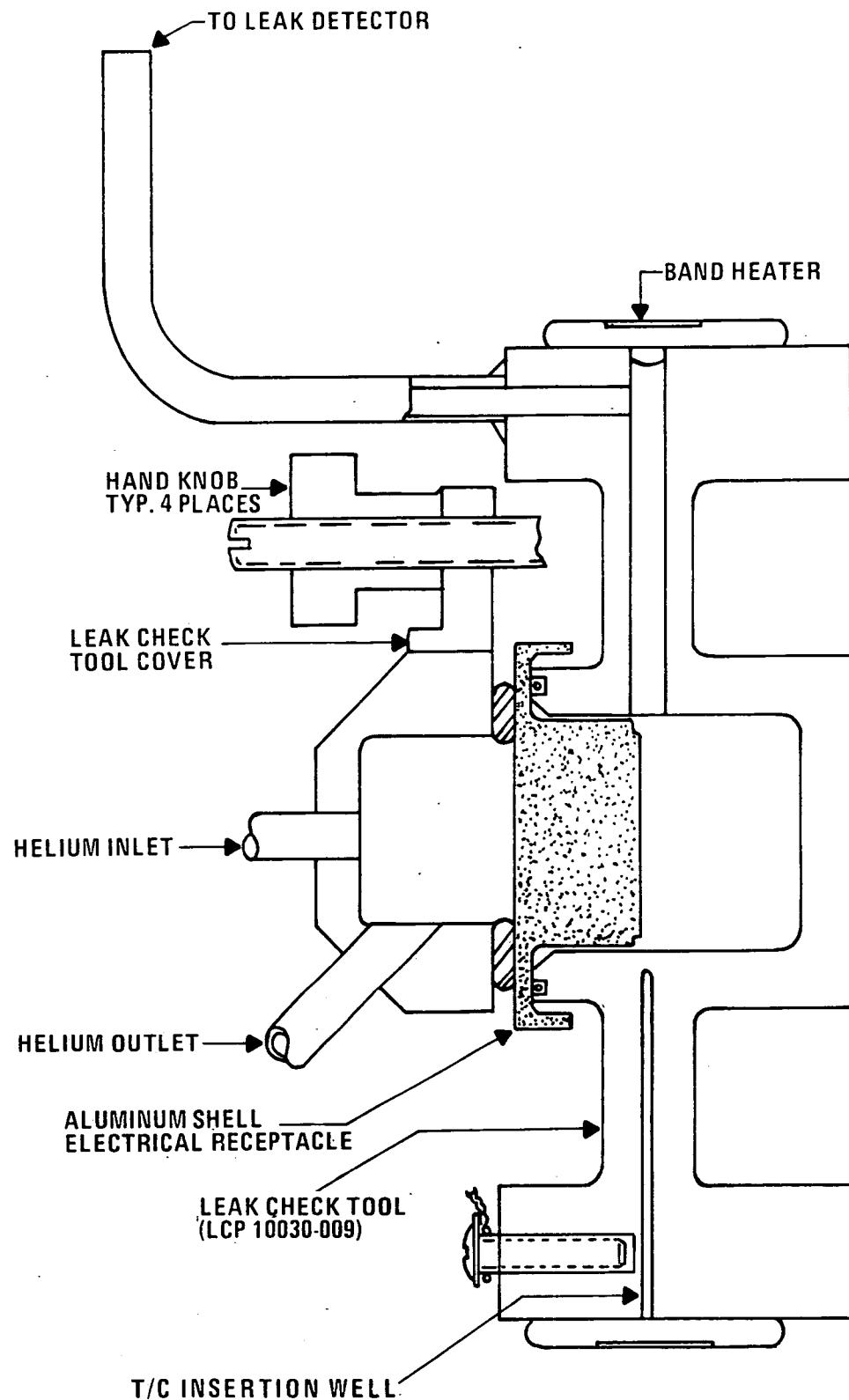


FIGURE 7. LEAK RATE TEST FIXTURE LCP 10030 WITH
GULTON ALUMINUM SHELL RECEPTACLE J-2

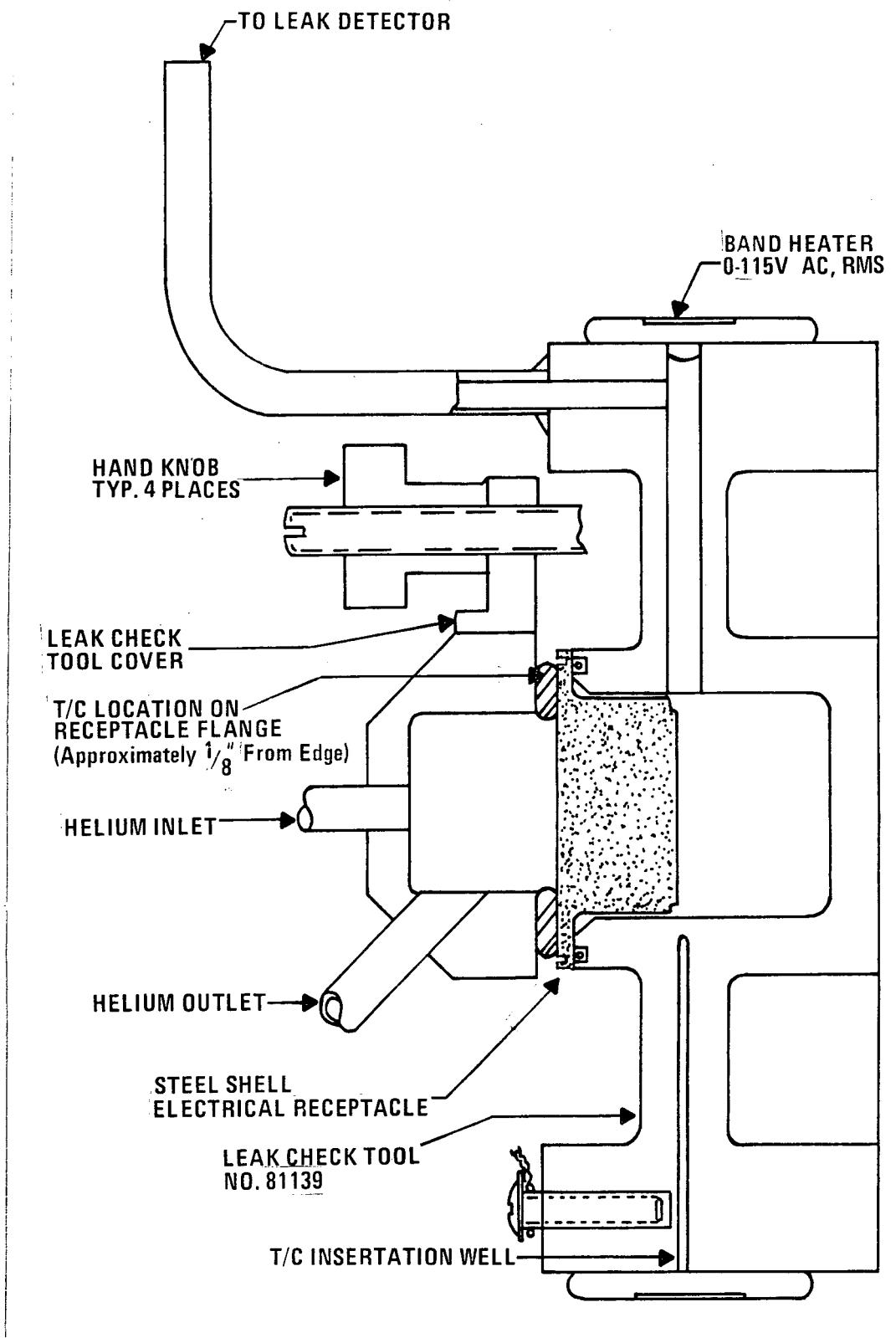


FIGURE 8. LEAK RATE TEST FIXTURE LCP 10030 WITH DEUTSH STEEL SHELL RECEPTACLE

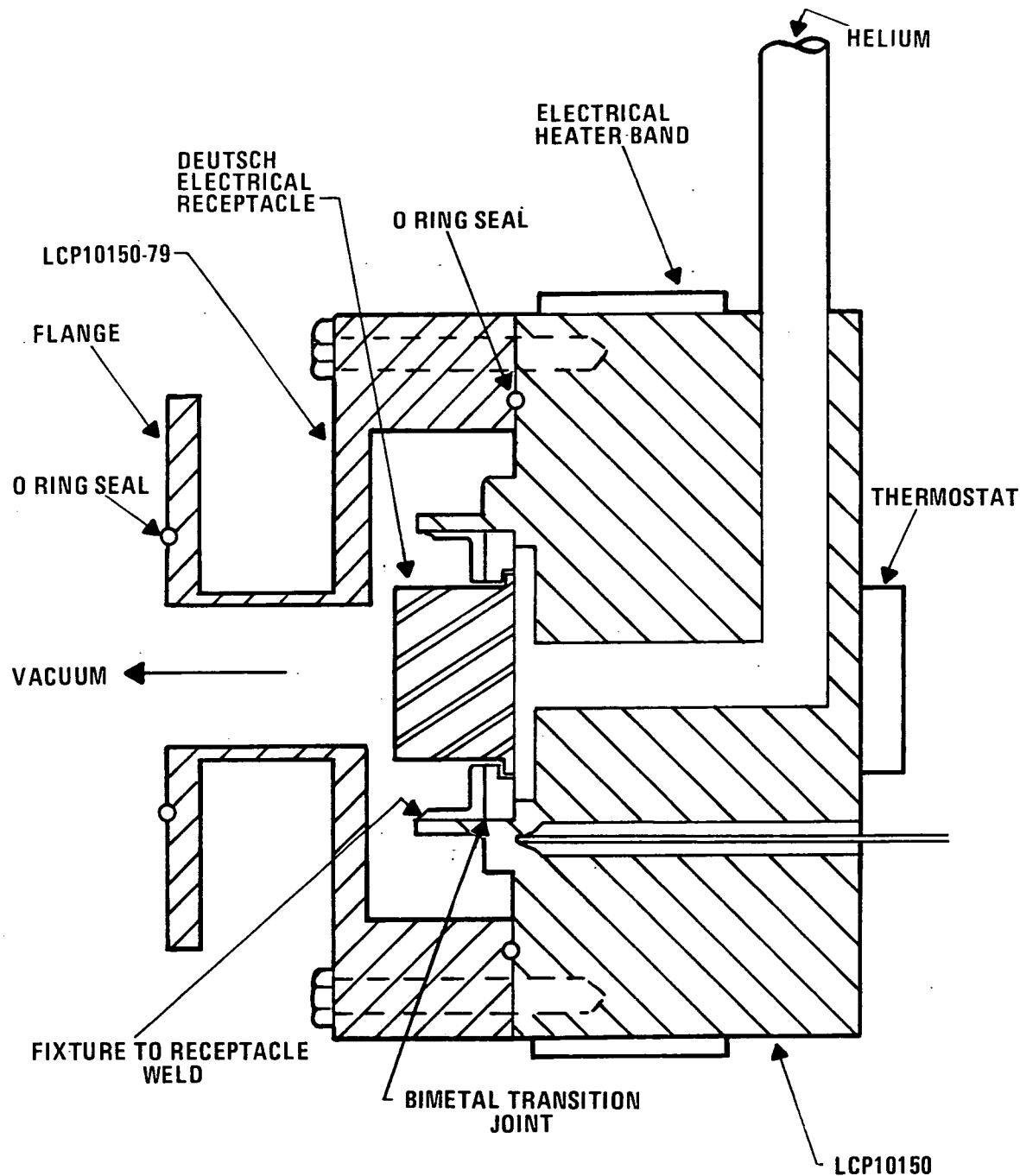


FIGURE 9. LEAK RATE TEST FIXTURE LCP 10150 WITH
WELDED DEUTSCH RECEPTACLE/BIMETAL
RING ASSEMBLY

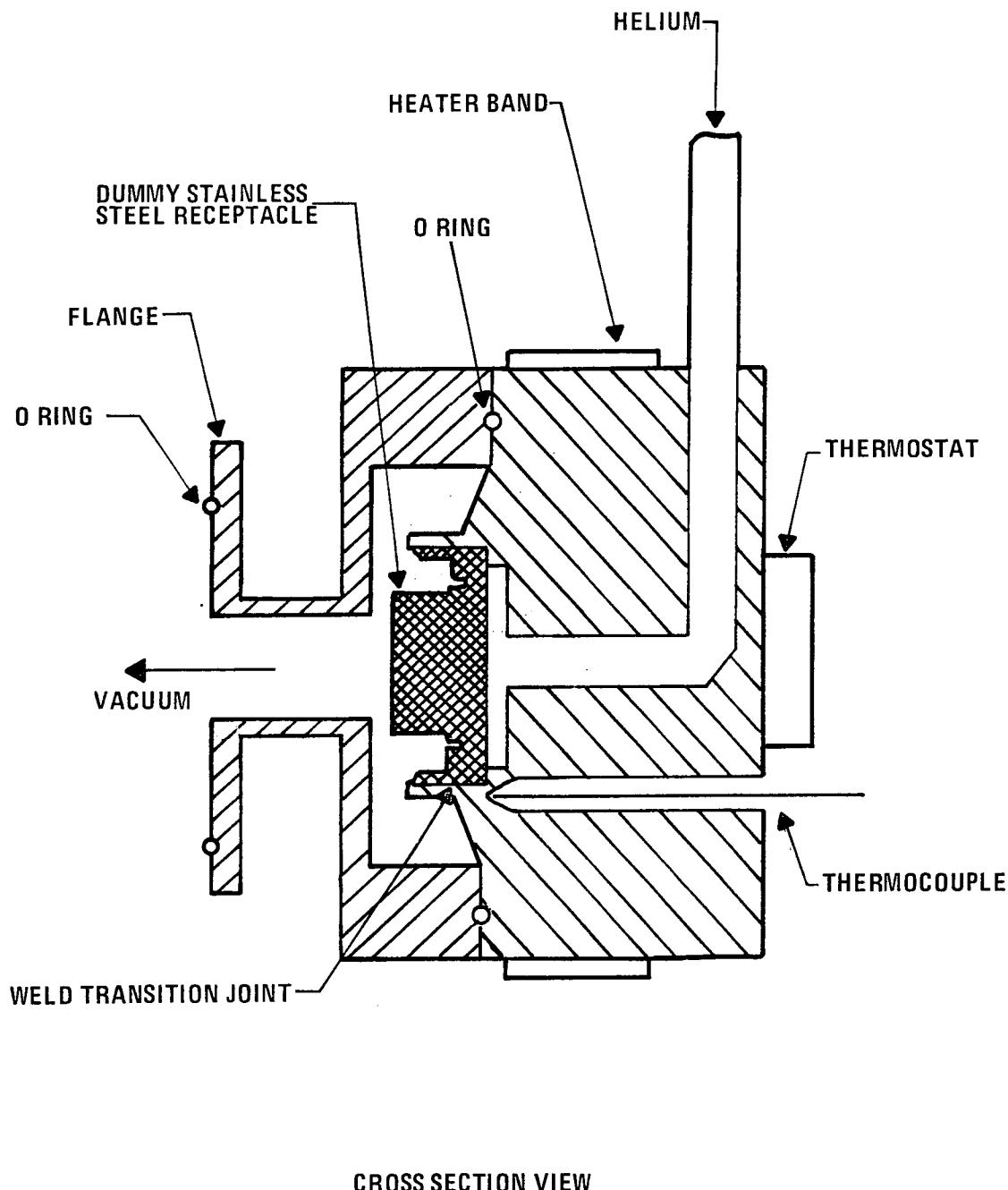
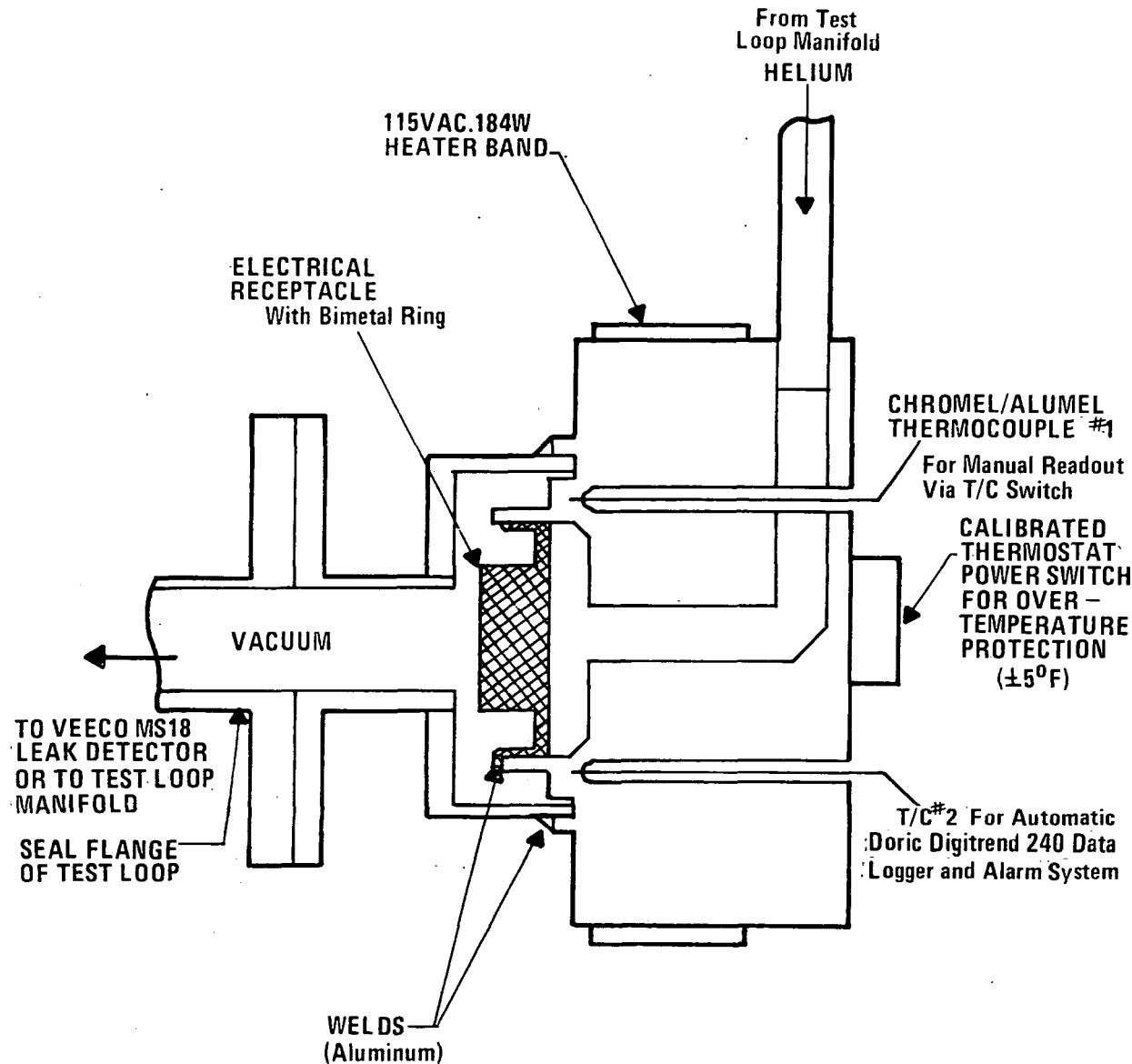


FIGURE 10. LEAK RATE TEST FIXTURE LCP 10150 WITH WELDED DUMMY RECEPTACLE/BIMETAL RING ASSEMBLY



CROSS SECTION VIEW

FIGURE 11. LEAK RATE TEST FIXTURE LCP 10150 INSTALLED IN TEST STATION OF RECEPTACLE TEST LOOP

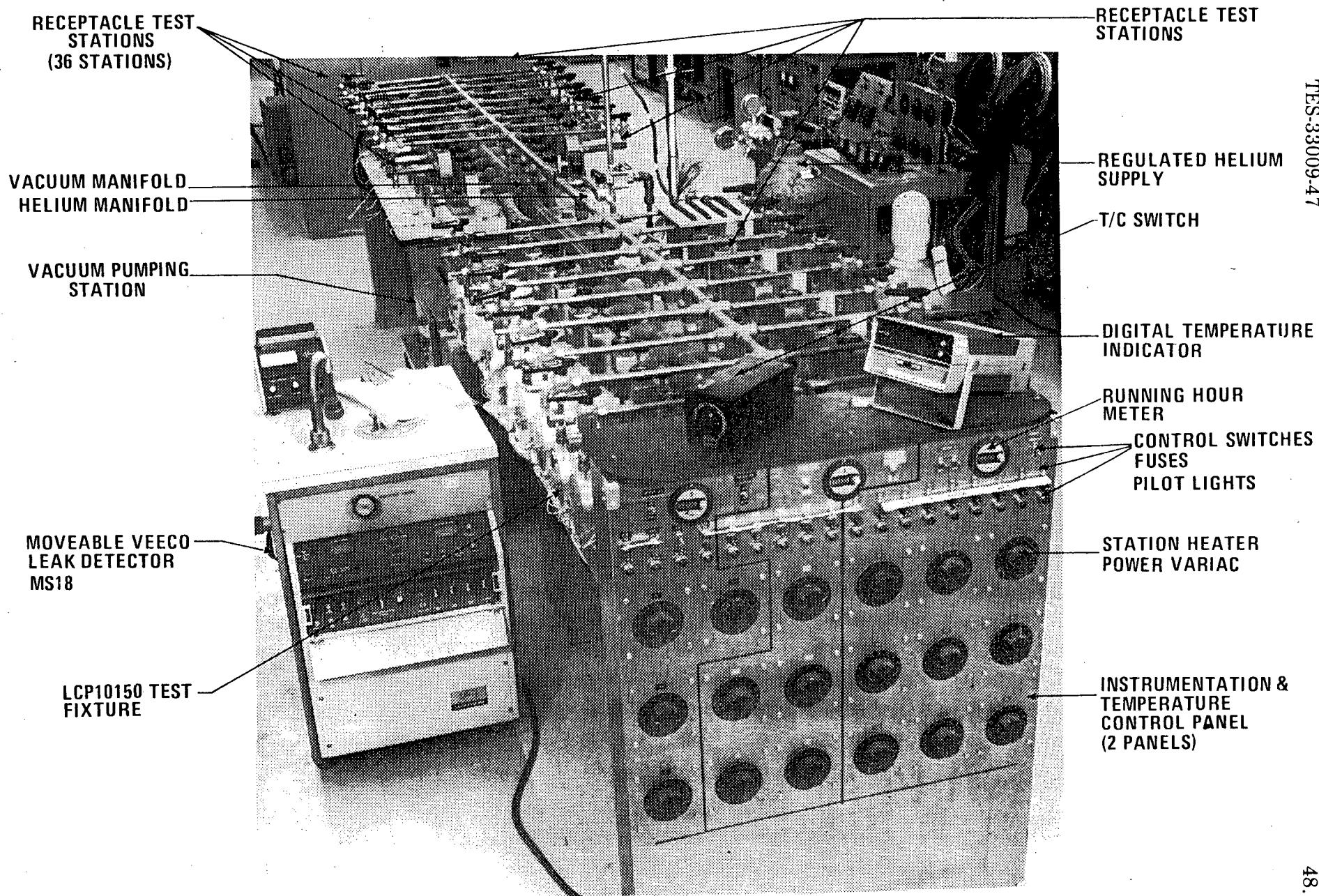


FIGURE 12. VIEW OF RECEPTACLE TEST LOOP INSTALLATION

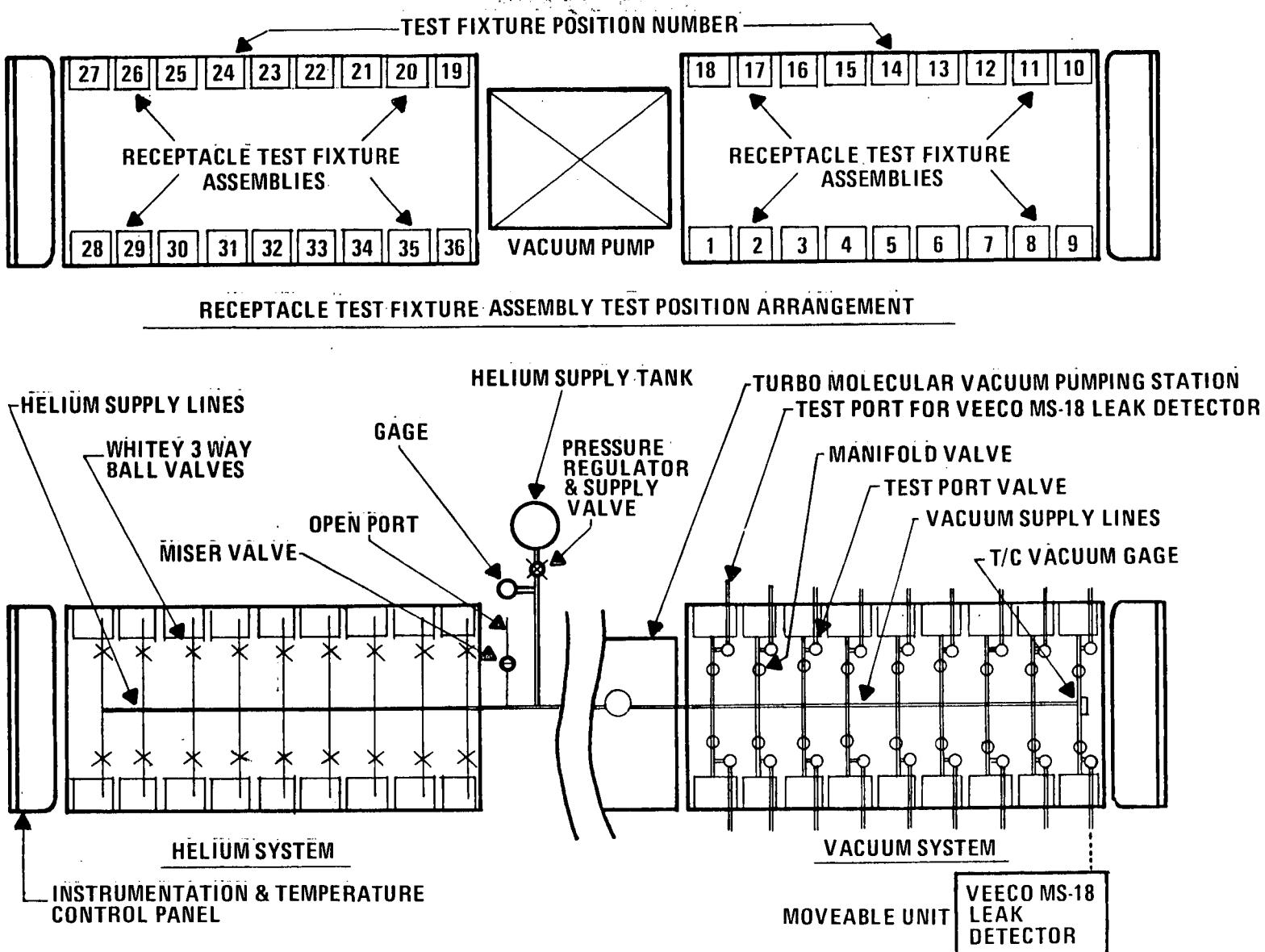


FIGURE 13. PLUMBING SYSTEM OF RECEPTACLE TEST LOOP

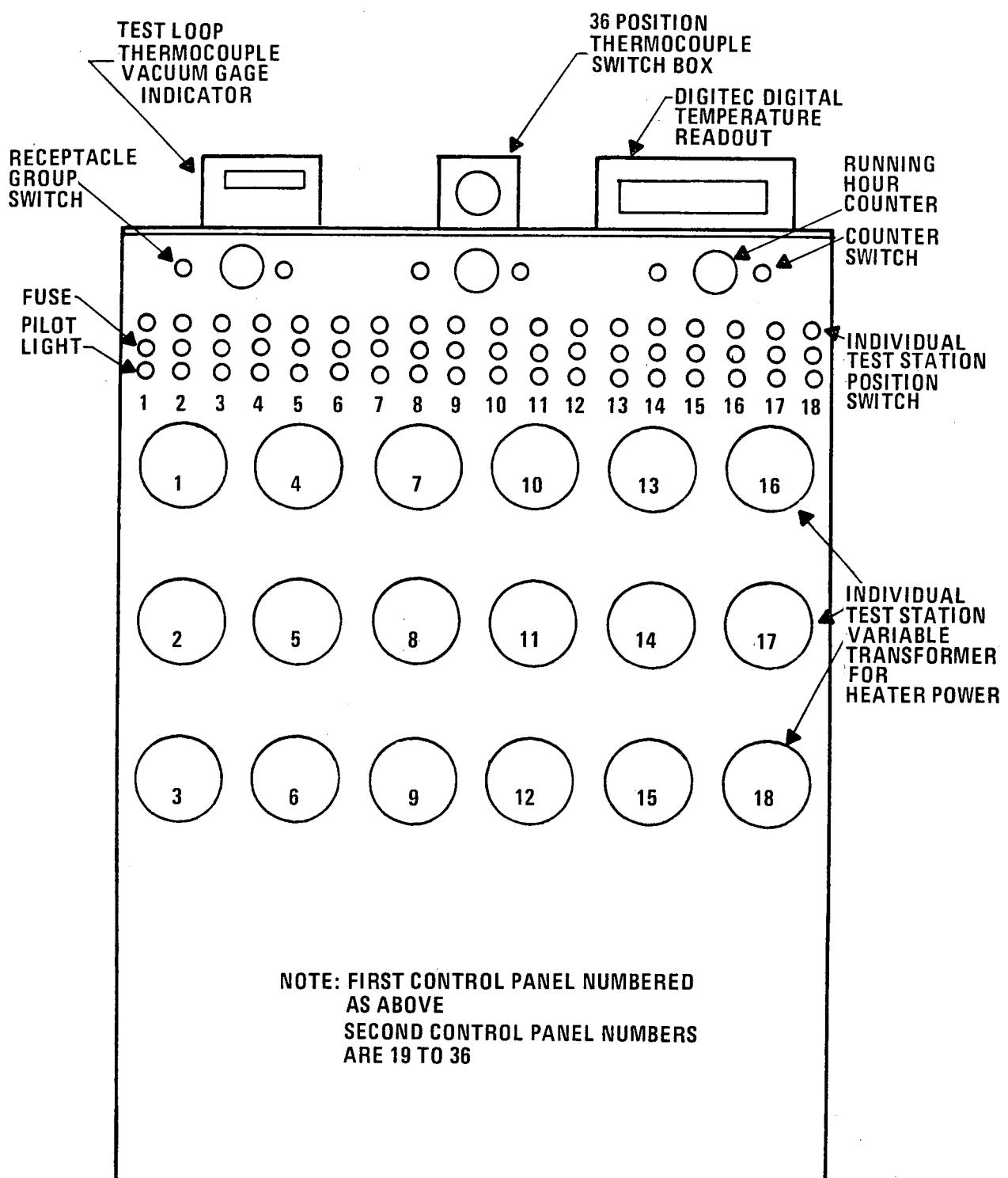


FIGURE 14. CONTROL PANEL OF RECEPTACLE TEST LOOP FOR RECEPTACLE TEST STATIONS

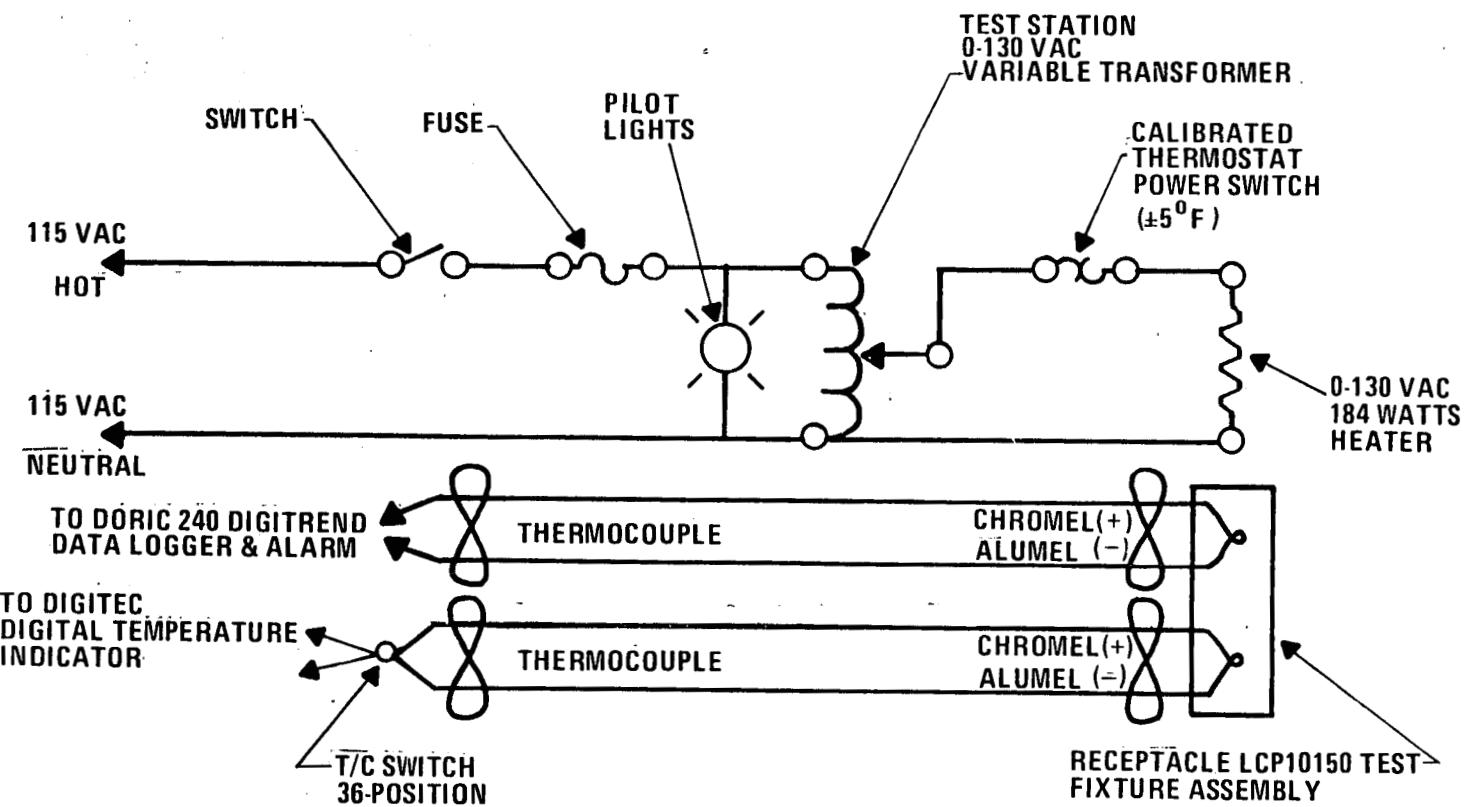


FIGURE 15. TYPICAL ELECTRICAL WIRING DIAGRAM FOR EACH TEST STATION OF THE RECEPTACLE TEST LOOP

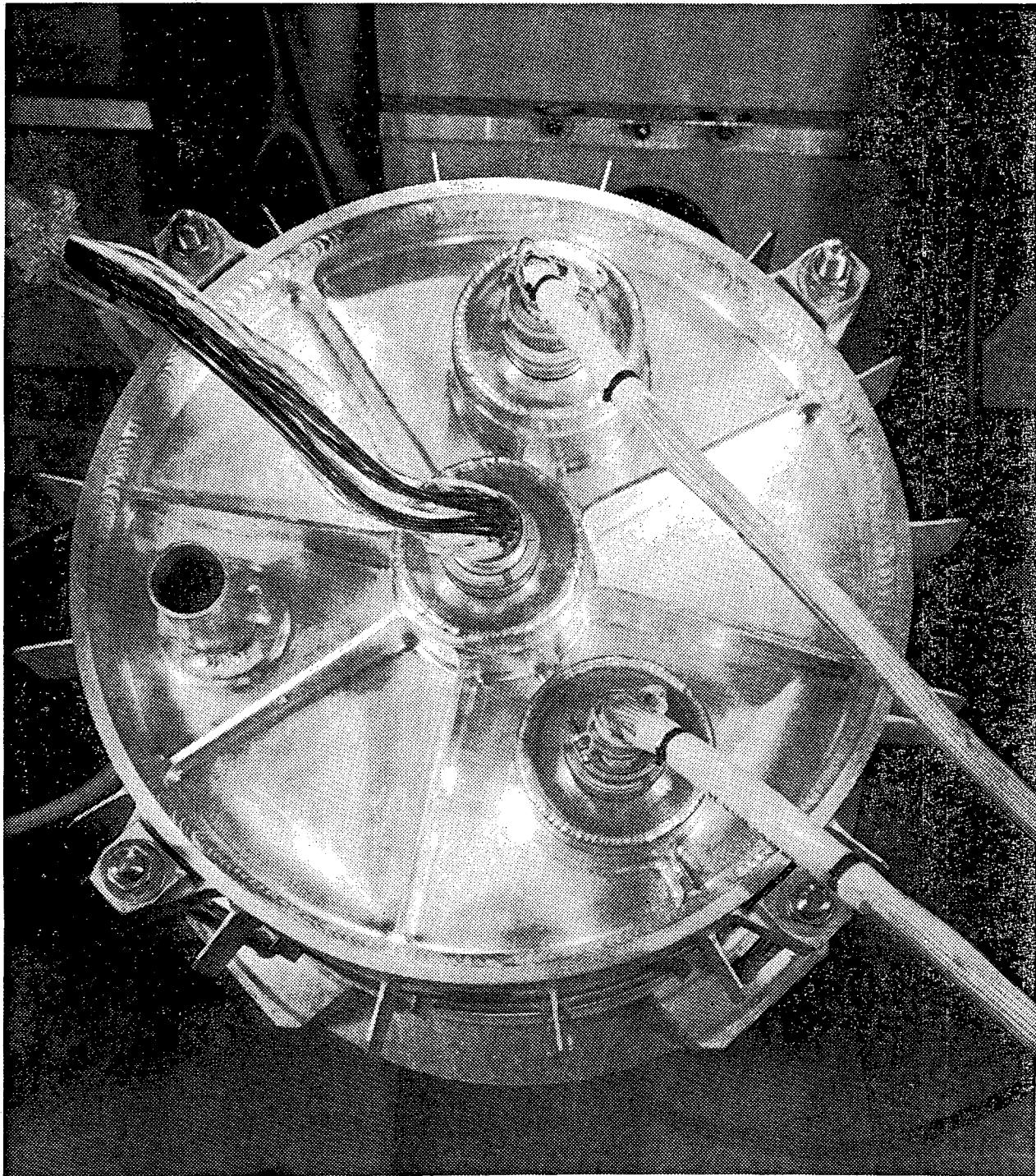


FIGURE 16. VIEW OF TOP COVER OF SIG/GALILEO GDS-1 GENERATOR
SHOWING 3 INSTALLED DEUTSCH RECEPTACLE/BIMETAL
TRANSITION RING ASSEMBLIES WITH MATED INTERFACE
CABLES

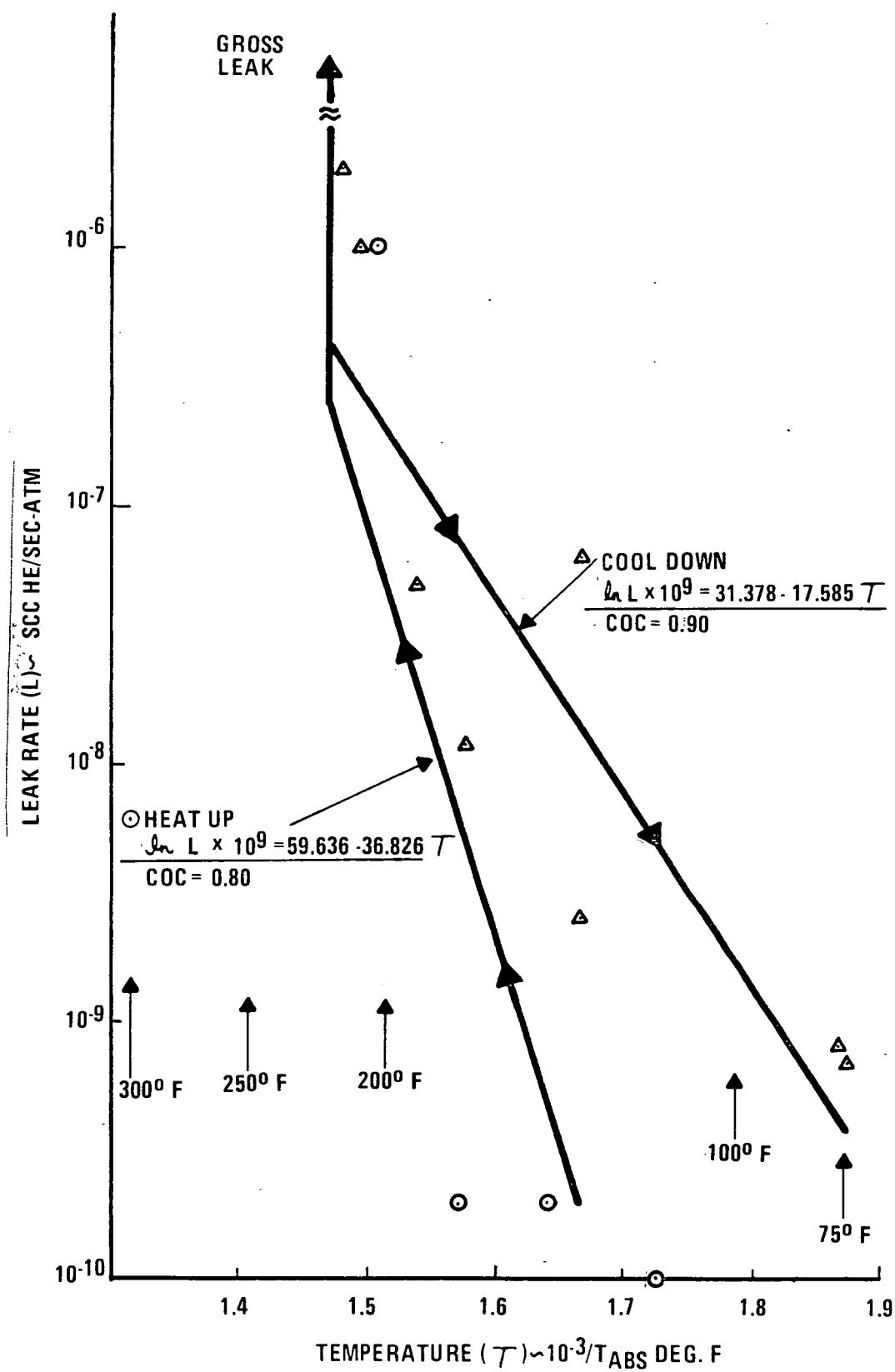


FIGURE 17. LEAK RATE/TEMPERATURE CHARACTERISTIC OF GULTON ALUMINUM RECEPTACLE J-2, S/N-005

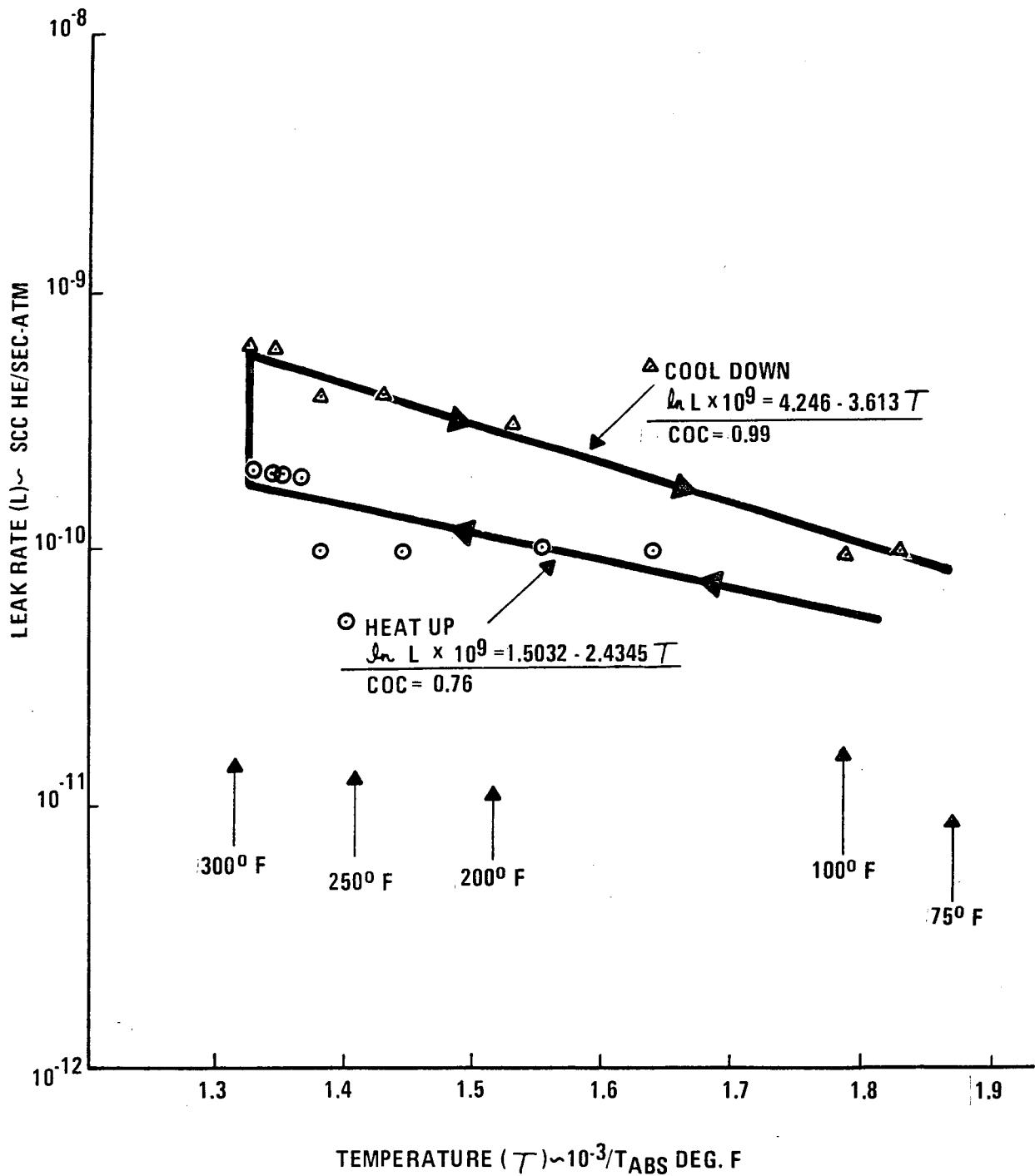


FIGURE 18. LEAK RATE/TEMPERATURE CHARACTERISTIC OF GULTON ALUMINUM RECEPTACLE J-2, S/N-006

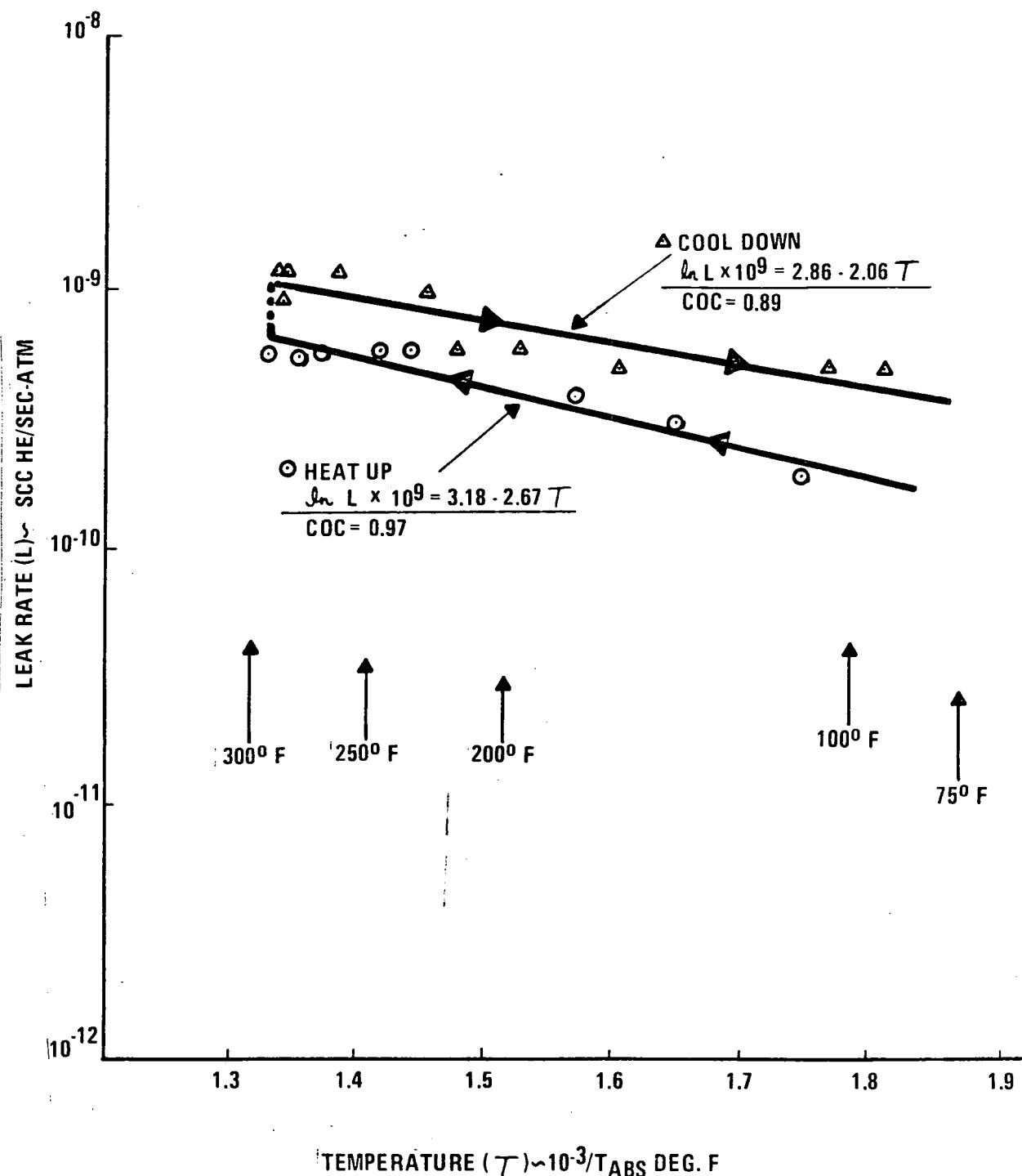


FIGURE 19. LEAK RATE/TEMPERATURE CHARACTERISTIC OF GULTON ALUMINUM RECEPTACLE J-2, S/N-009

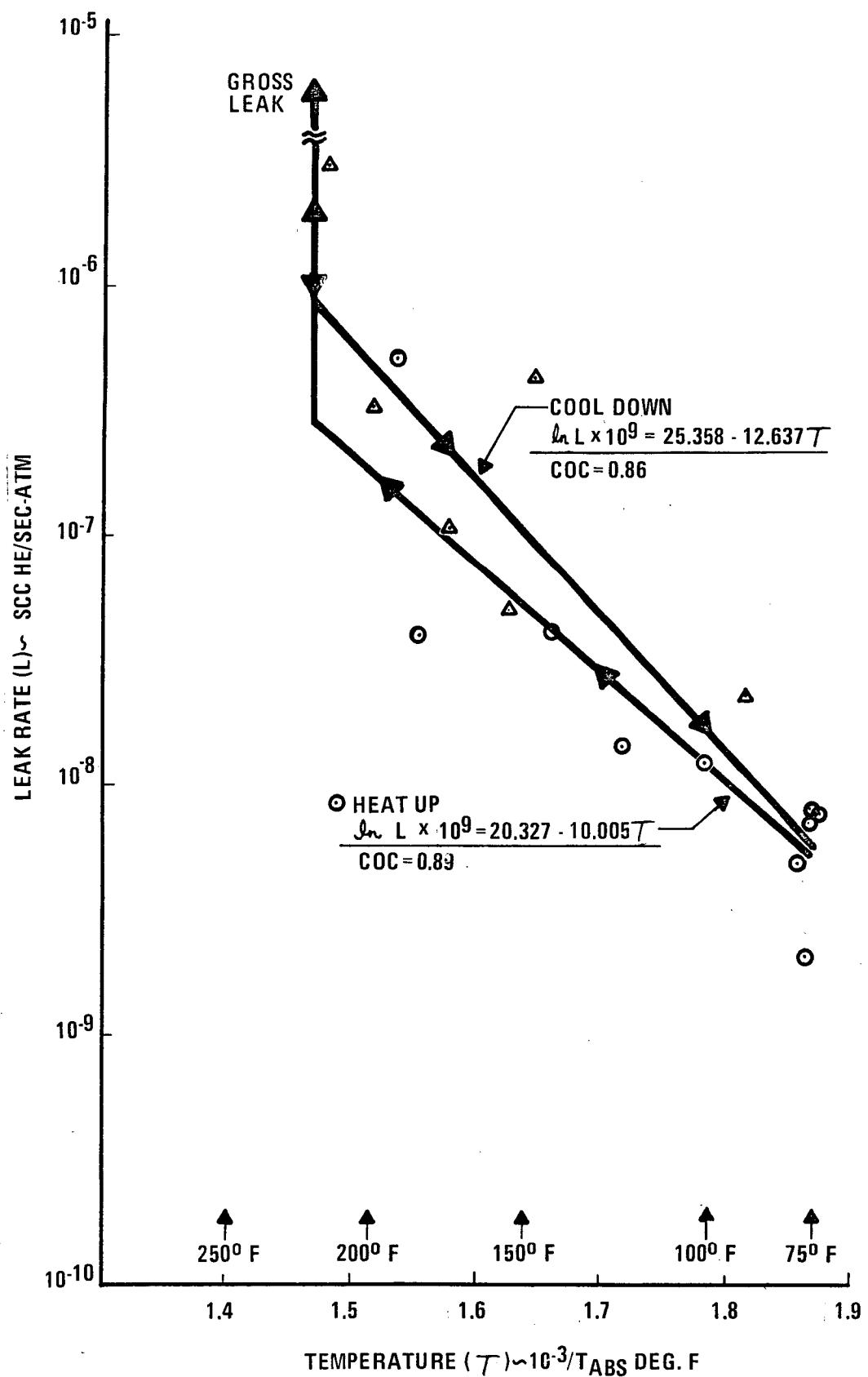


FIGURE 20. LEAK RATE/TEMPERATURE CHARACTERISTIC OF GULTON ALUMINUM RECEPTACLE J-5, S/N 1052

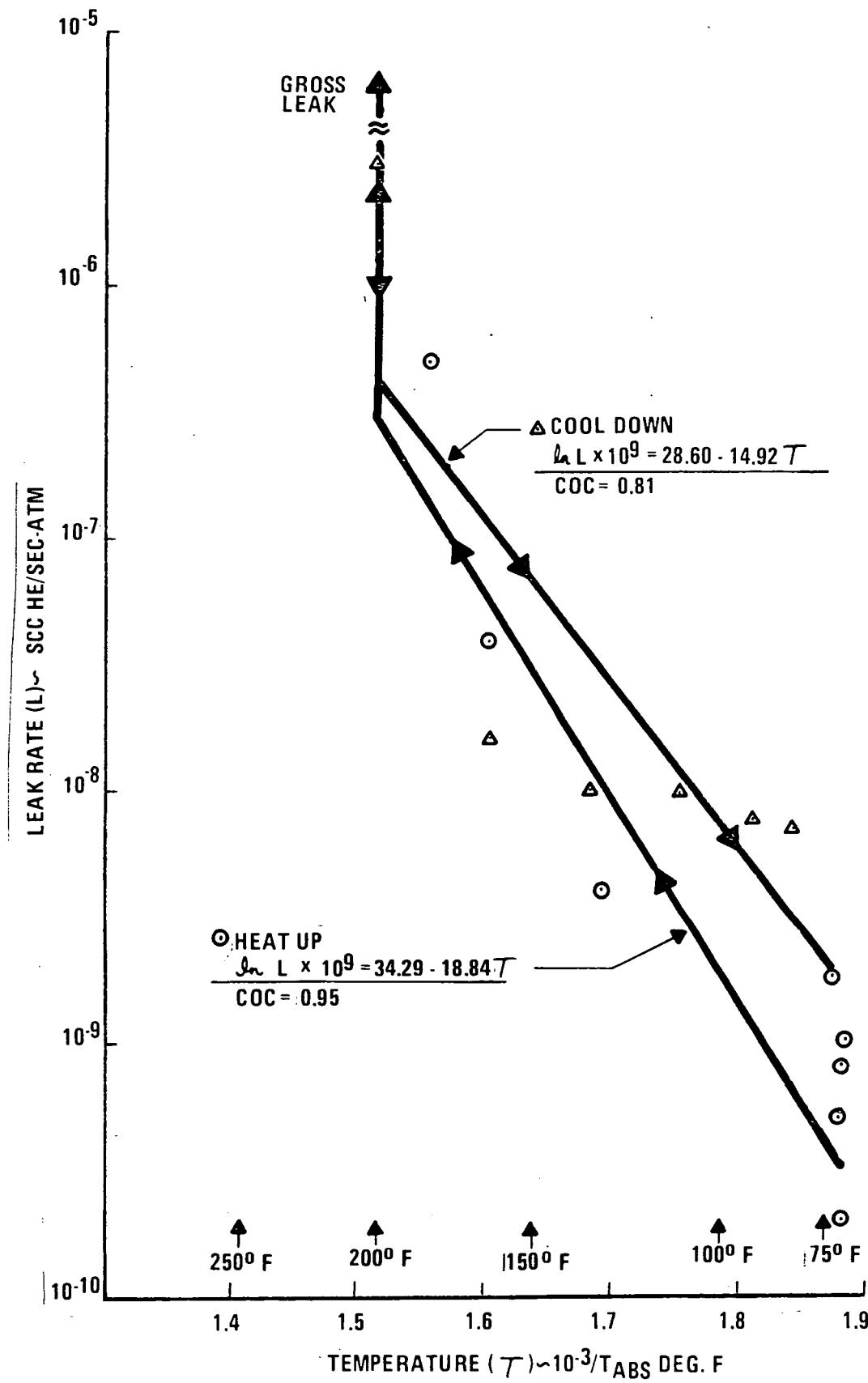


FIGURE 21. LEAK RATE/TEMPERATURE CHARACTERISTIC OF GULTON ALUMINUM RECEPTACLE J-5, S/N-053

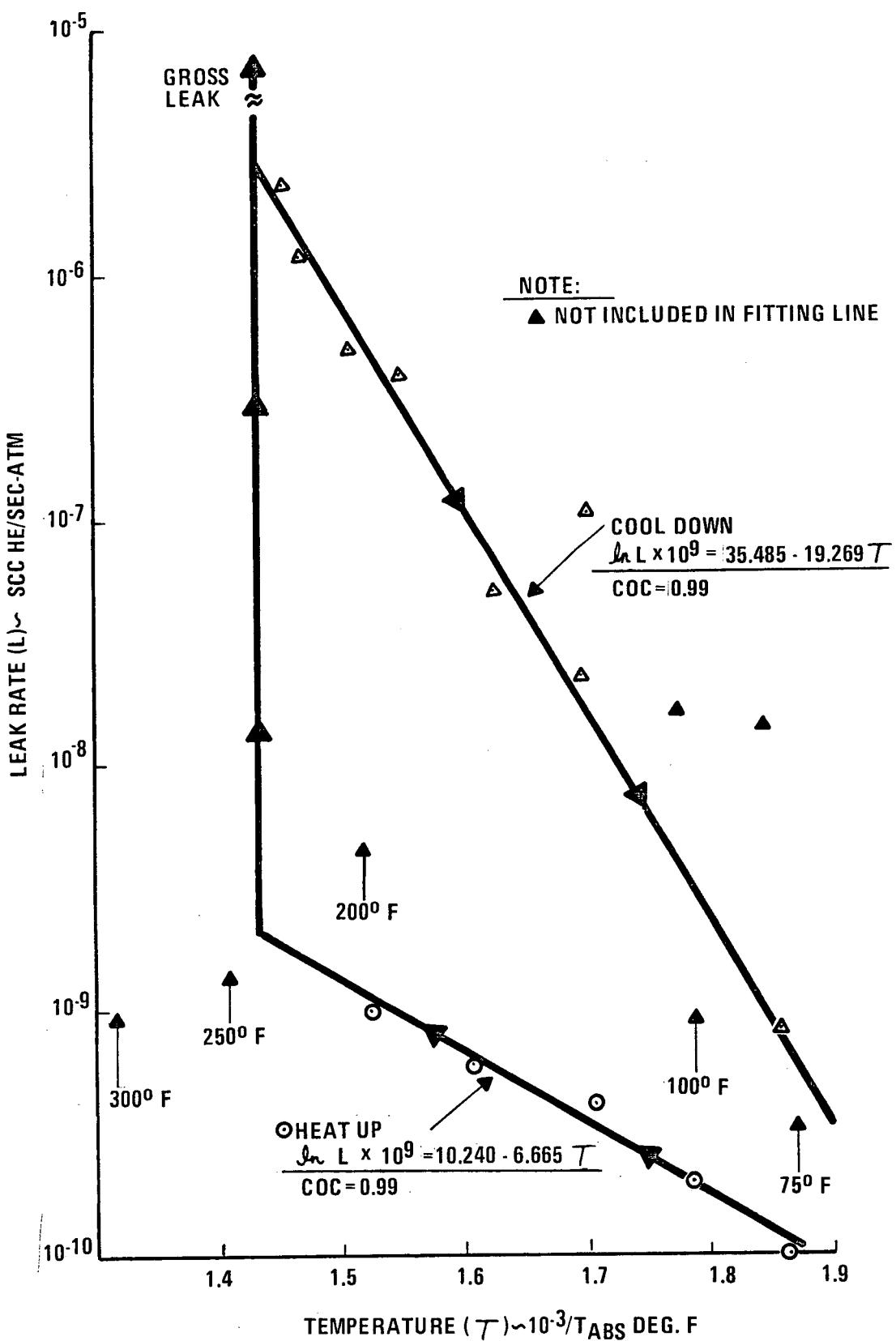


FIGURE 22. LEAK RATE/TEMPERATURE CHARACTERISTIC OF
GULTON ALUMINUM RECEPTACLE J-1, S/N- 061

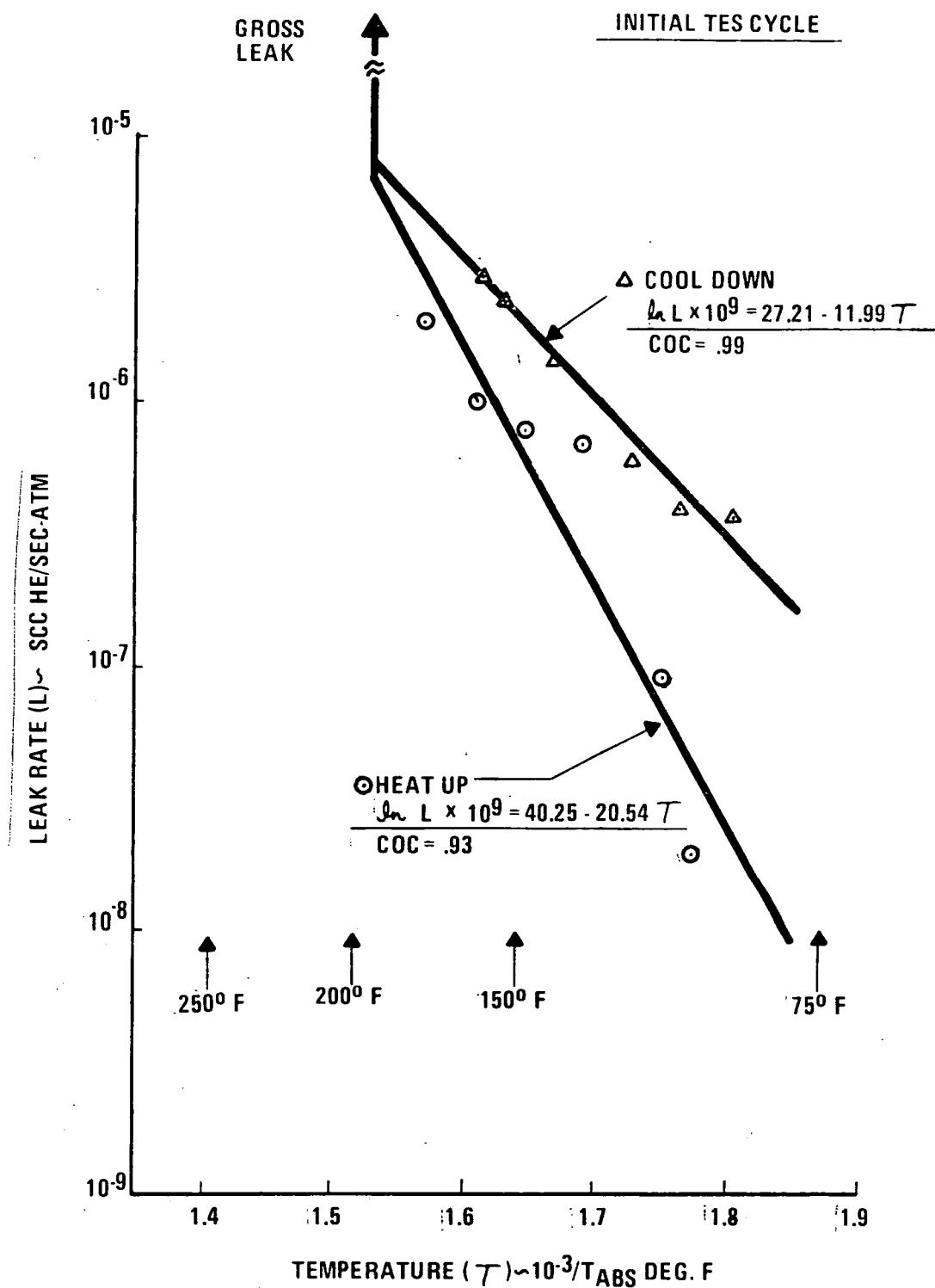


FIGURE 23. LEAK RATE/TEMPERATURE CHARACTERISTIC OF GULTON STEEL (SS 304L) SHELL RECEPTACLE J-40, S/N-003

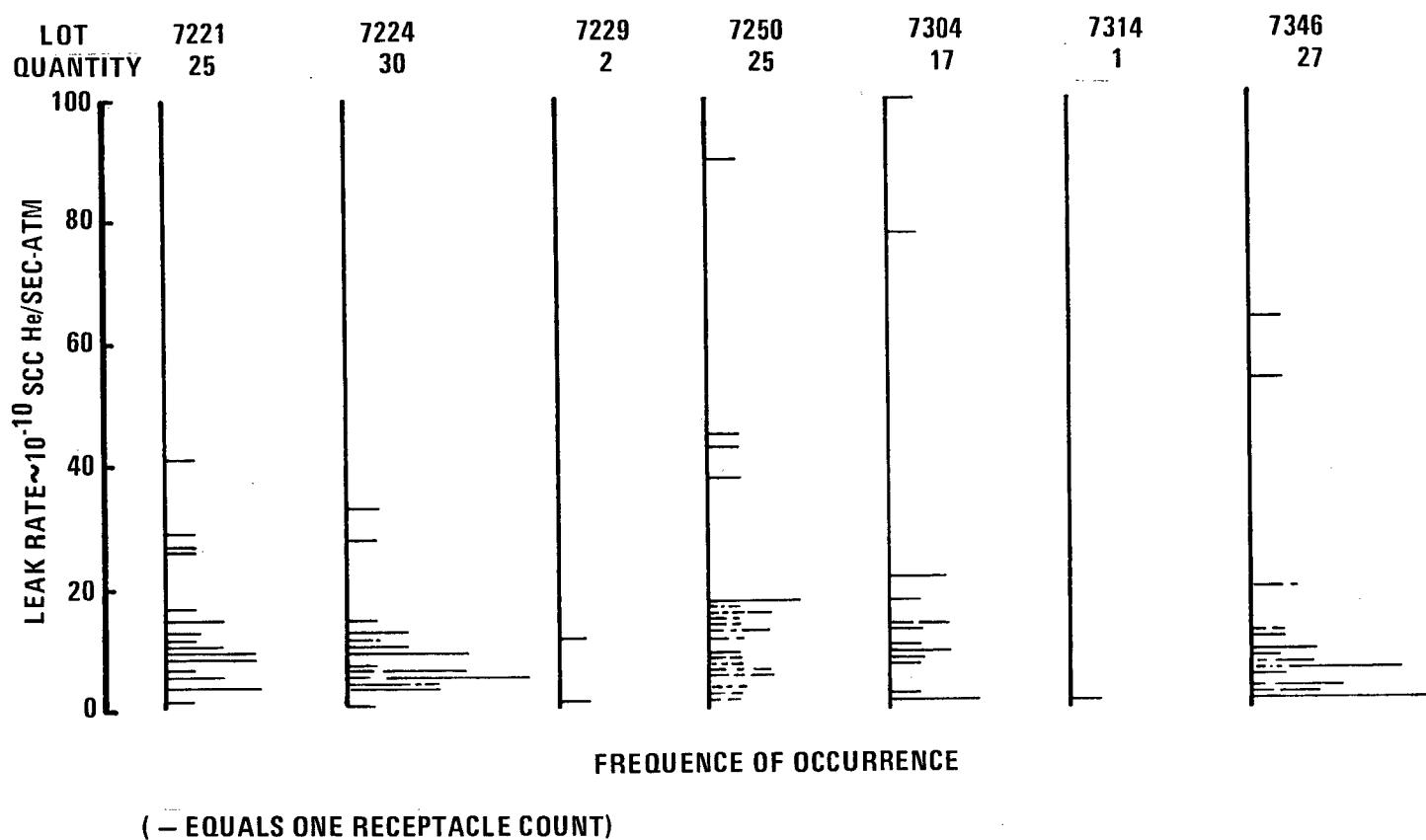


FIGURE 24. HISTOGRAM AT 392° F OF 127 DEUTSCH STEEL (SS 20CB3)
TEST RESULTS OF LEAK RATE THERMAL ACCEPTANCE TESTS,
VIKING RECEPTACLE TEST PROGRAM (5/21/74)

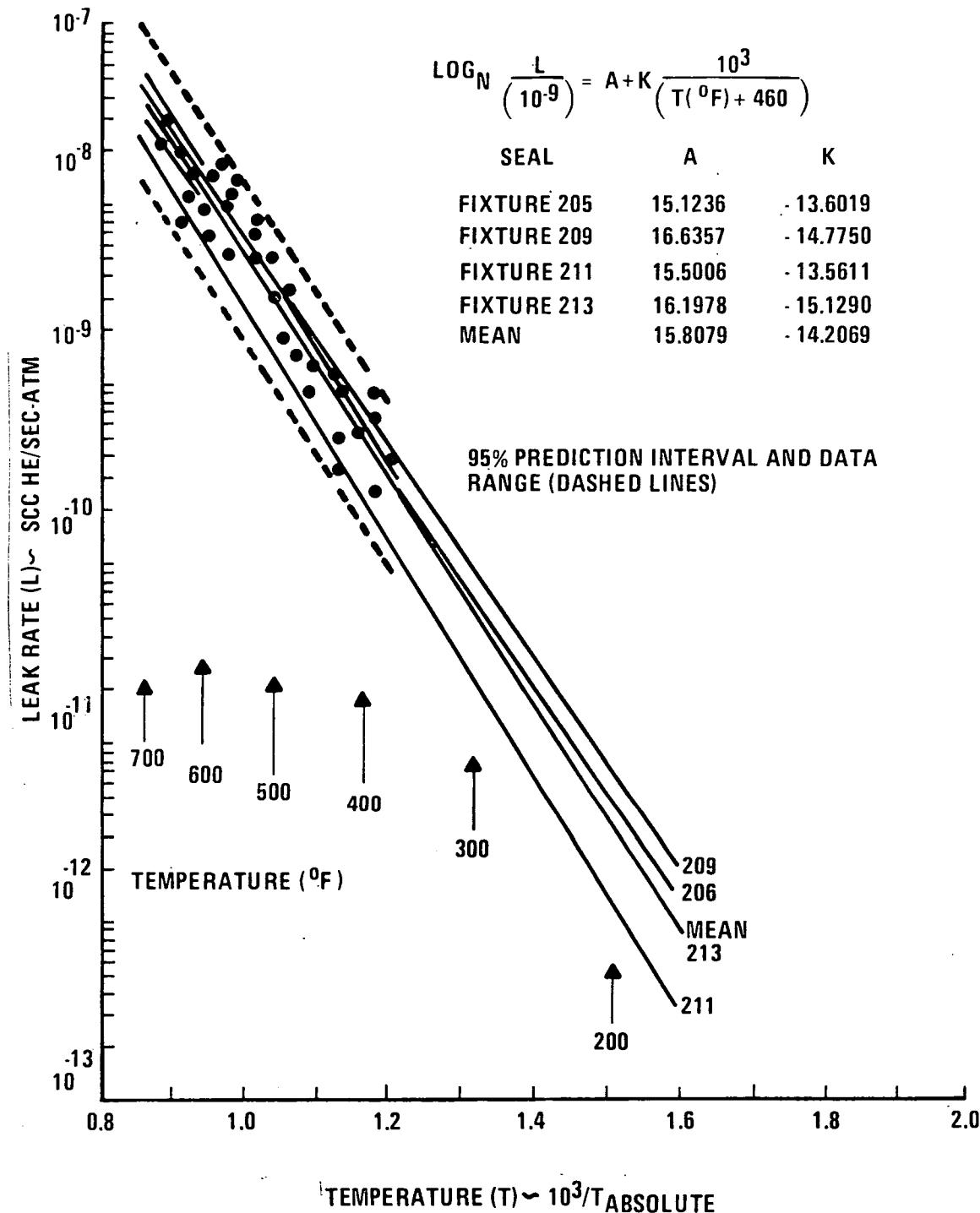


FIGURE 25. LEAK RATE/TEMPERATURE CHARACTERISTICS OF 4 DEUTSCH STEEL SHELL RECEPTACLES S/N-206, 209, 211 AND 213

TEST DATE 9/30/74
 RECEPTACLE LOT # 7224
 LABORATORY TEST FIXTURE #19

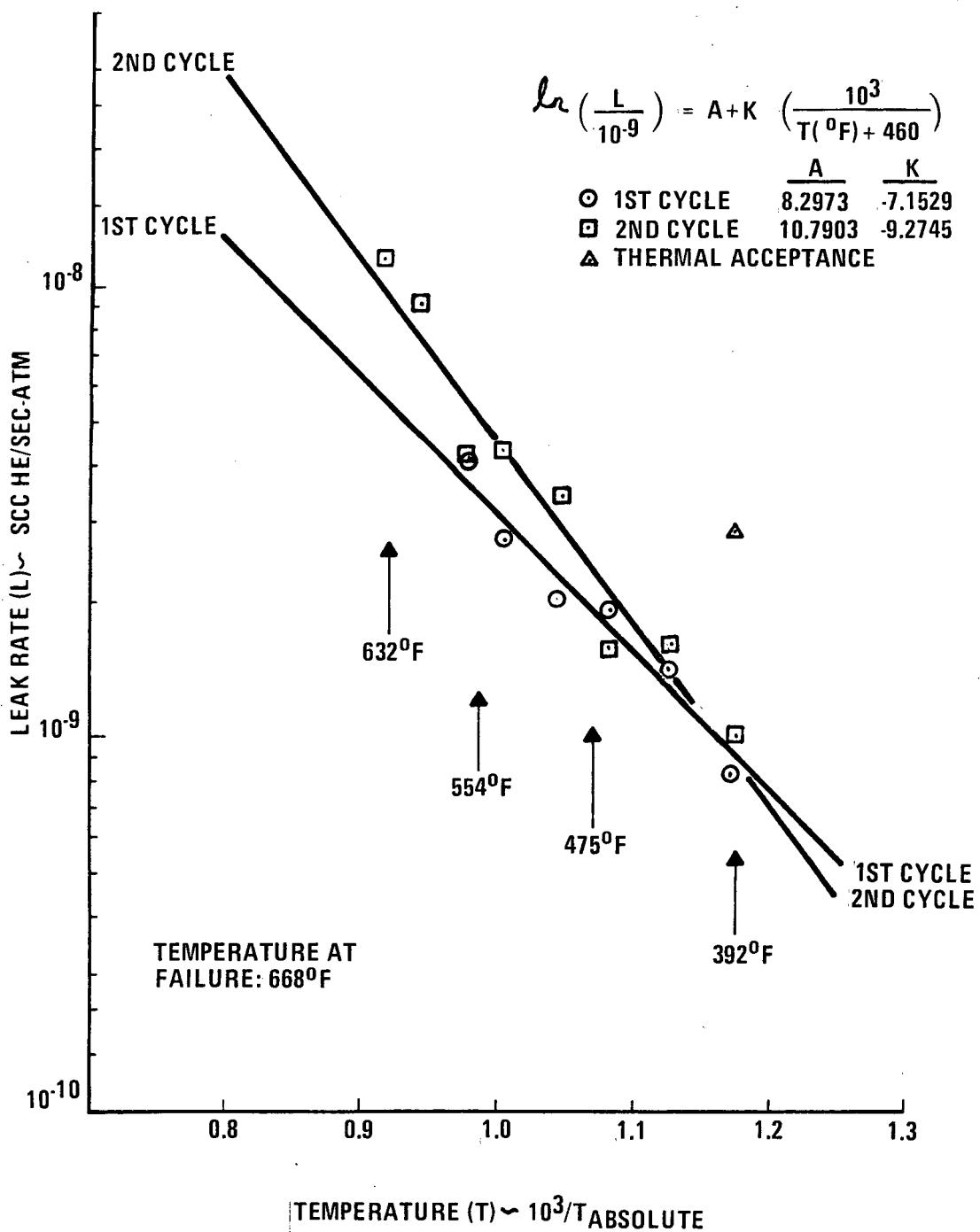


FIGURE 26. LEAK RATE/TEMPERATURE CHARACTERISTIC OF DEUTSCH STEEL SHELL RECEPTACLE S/N-214

TEST DATE 9/24/74
 RECEPTACLE LOT # 7250
 QUALITY TEST FIXTURE #2

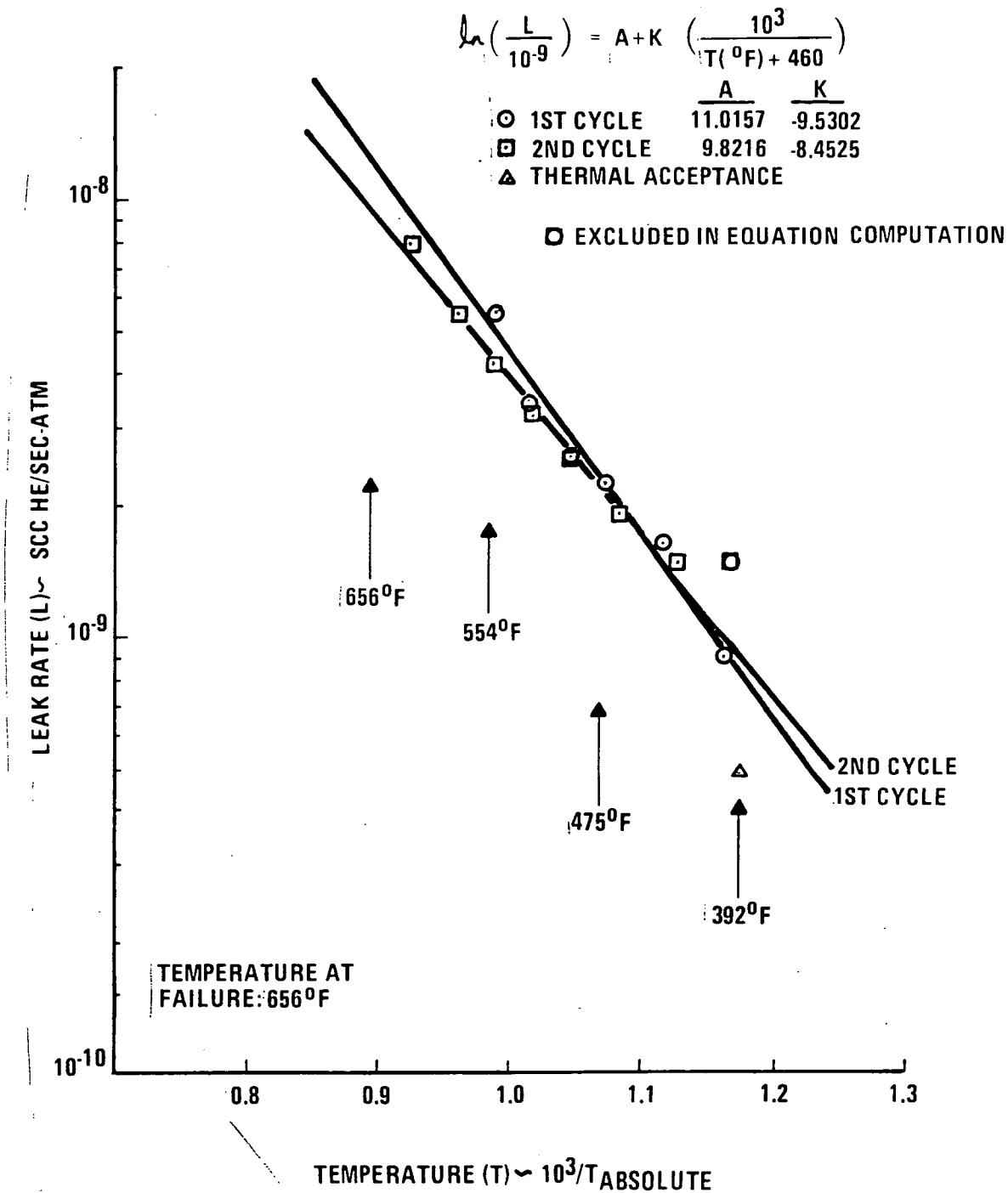


FIGURE 27. LEAK RATE/TEMPERATURE CHARACTERISTIC OF DEUTSCH STEEL SHELL RECEPTACLE S/N -322

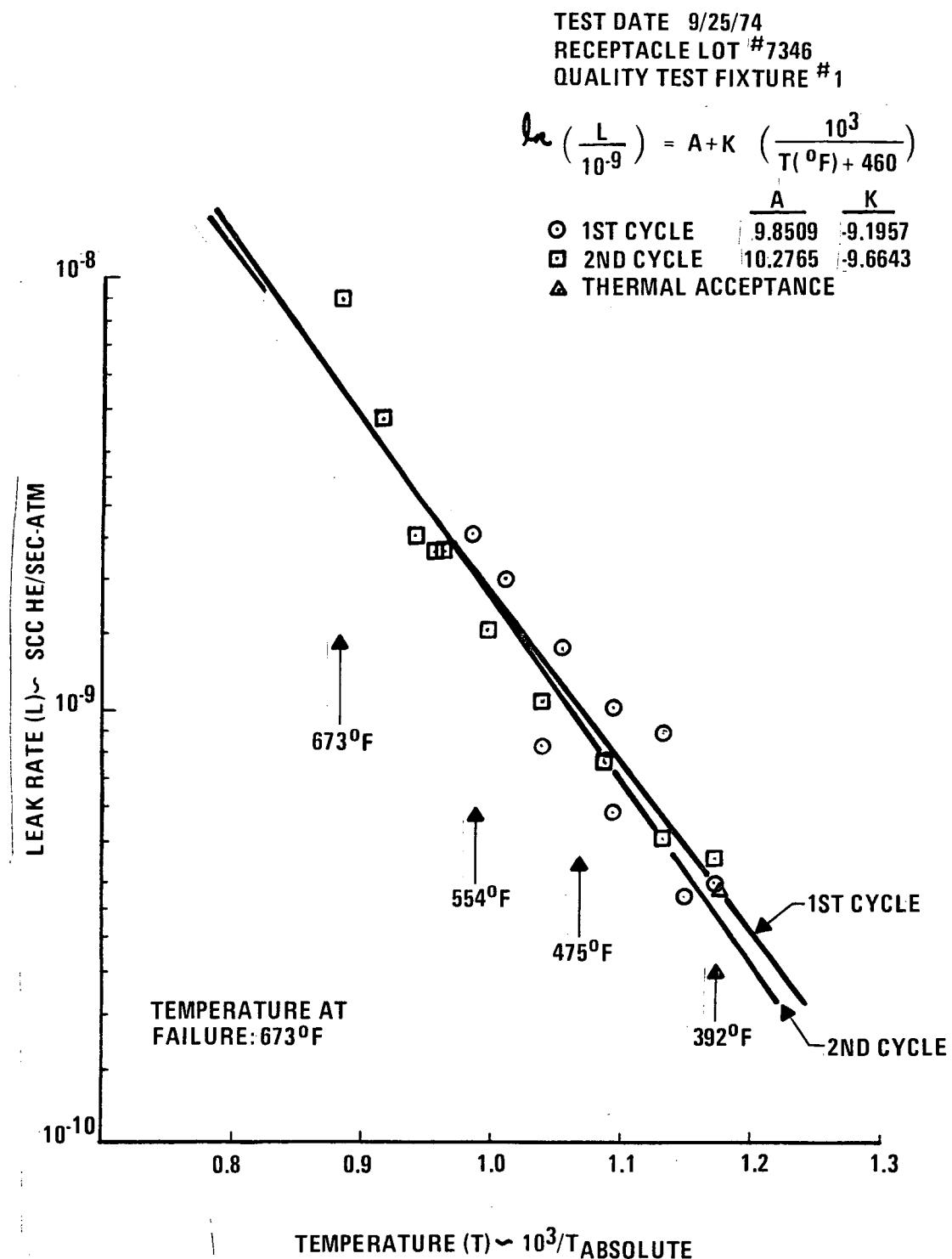


FIGURE 28. LEAK RATE/TEMPERATURE CHARACTERISTIC OF DEUTSCH STEEL SHELL RECEPTACLE S/N-346

TEST DATE 10/3/74
RECEPTACLE LOT #7346
QUALITY TEST FIXTURE #2

○ 1ST CYCLE
□ 2ND CYCLE

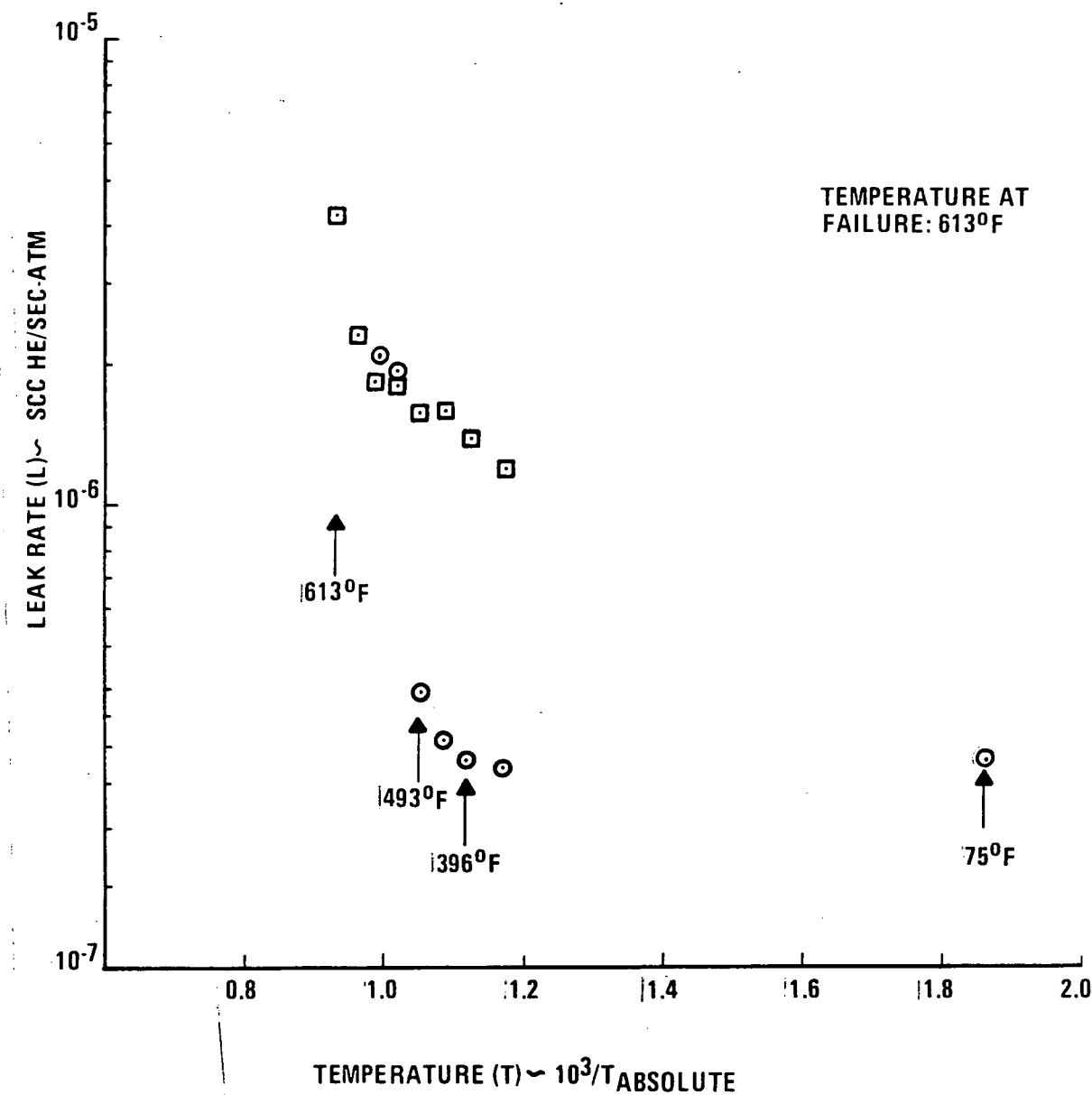


FIGURE 29. LEAK RATE/TEMPERATURE CHARACTERISTIC OF DEUTSCH STEEL SHELL RECEPTACLE S/N-349

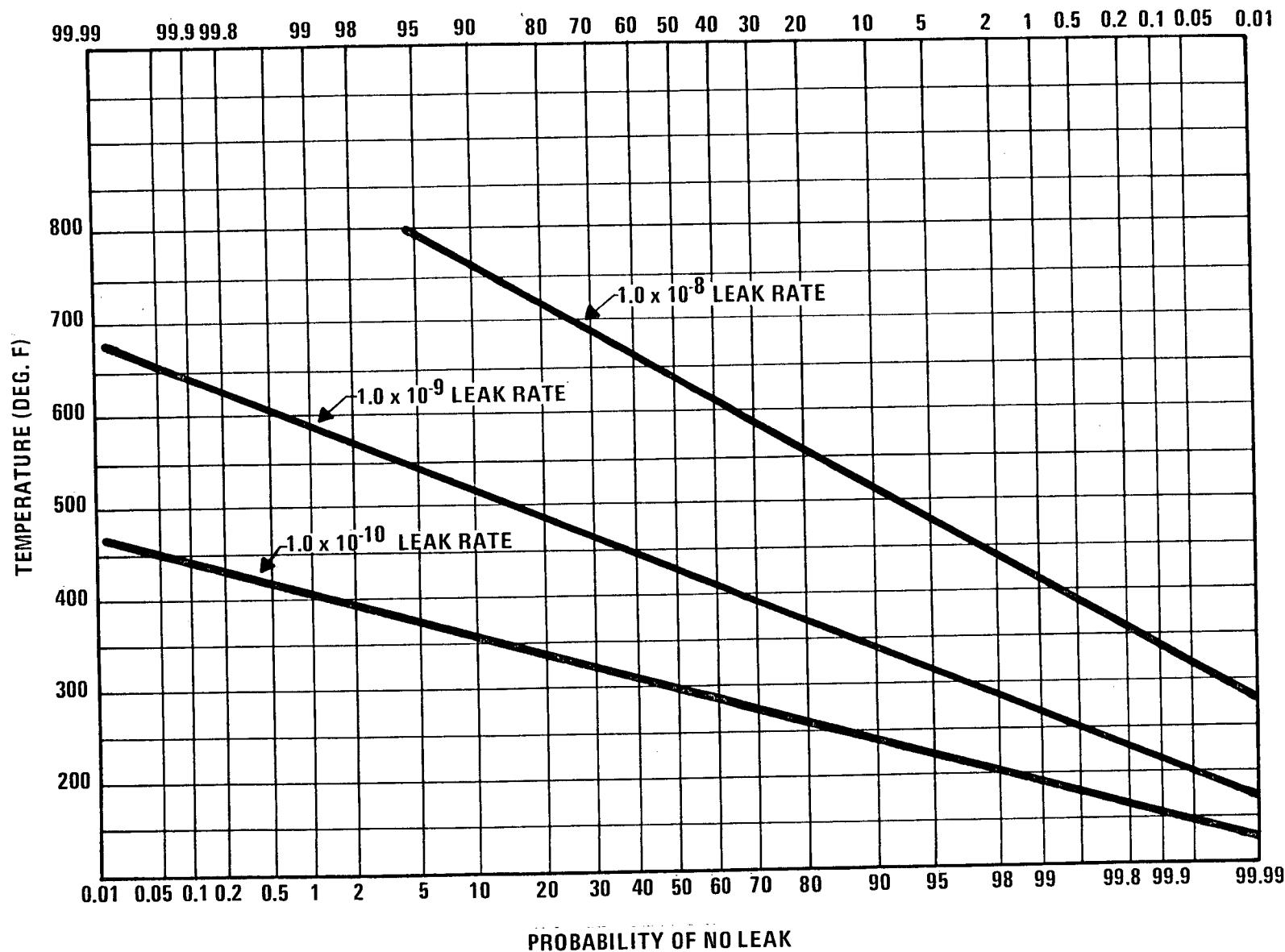


FIGURE 30. PROBABILITY OF NO-LEAK FAILURE FOR DEUTSCH STEEL (TYPE SS20CB3) RECEPTACLES, BASED ON SNAP-19 VIKING RECEPTACLE TEST PROGRAM TEST DATA, 1974.

TABLE 1

PRE-LIFE AND CYCLE TESTS. THERMAL MARGIN TESTS

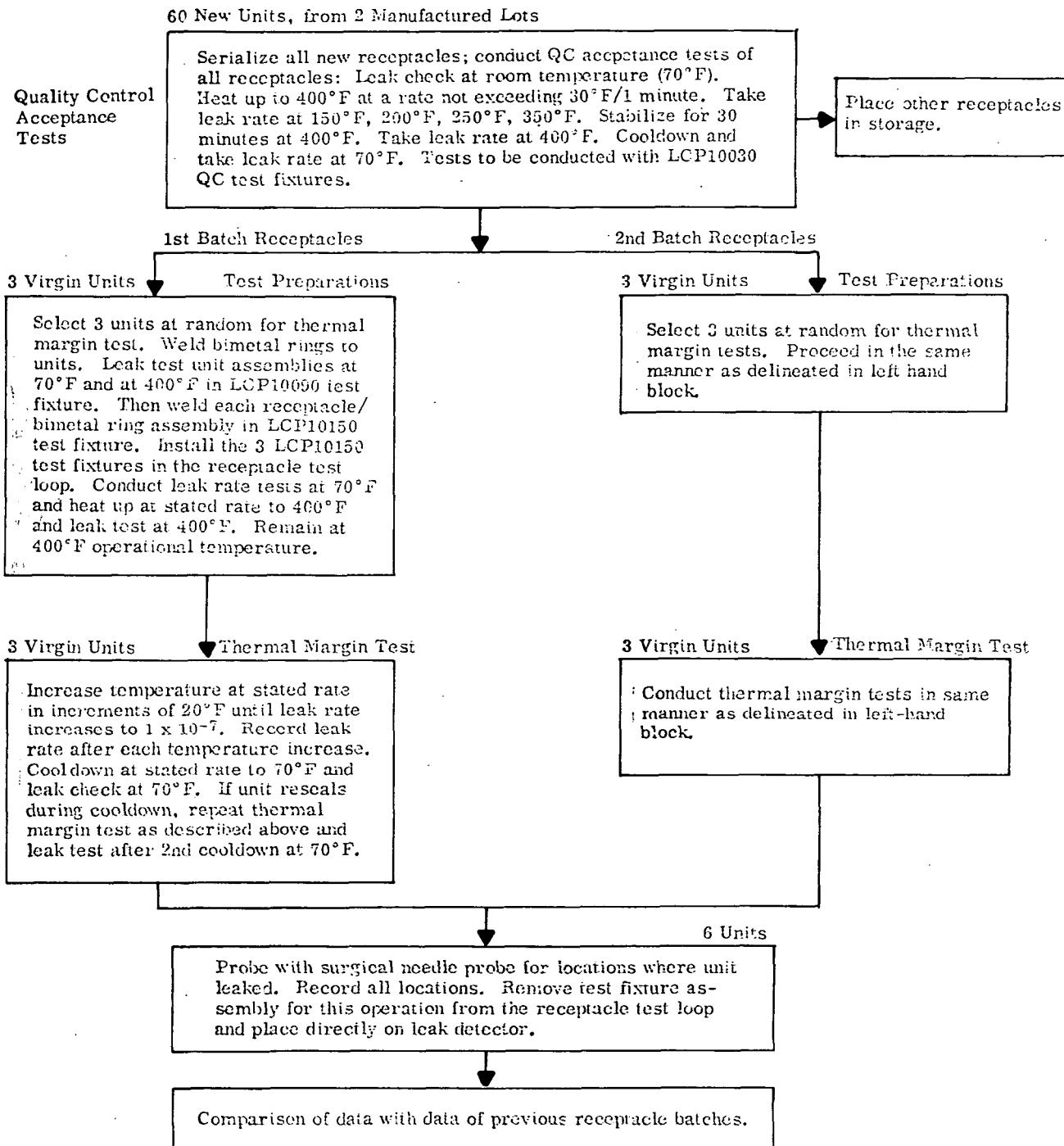


TABLE 2
FUNCTIONAL RECEPTACLE TESTS

54 Units from 2 Batches

After QC acceptance tests, units are put in storage for testing or hardware application.

9 Units from 1st Batch
4 Units from 2nd Batch Test Preparation

Select 13 virgin units. Weld bimetal rings to units. Leak test unit assemblies at 70°F and heat up at a rate not exceeding 30°F/1 minute to 400°F. Leak test at 400°F and after cooldown, at stated rate, at 70°F in LCP10090 test fixture. Then weld each receptacle/bimetal ring assembly in a LCP10150 test fixture. Install the LCP10150 test fixtures in the receptacle test loop. Conduct leak rate tests at 70°F and heat up at stated rate to 400°F. Leak test at 400°F. Remain at 400°F.

9 Units from 1st Batch
4 Units from 2nd Batch Total of 13 Units

Stabilize at 400°F for 2 hours. Leak check at 400°F. Cycle twice from 400°F to 150°F to 400°F. On last cycle leak check at 150°F and 400°F. Remain at 400°F.

TABLE 2 (Continued)

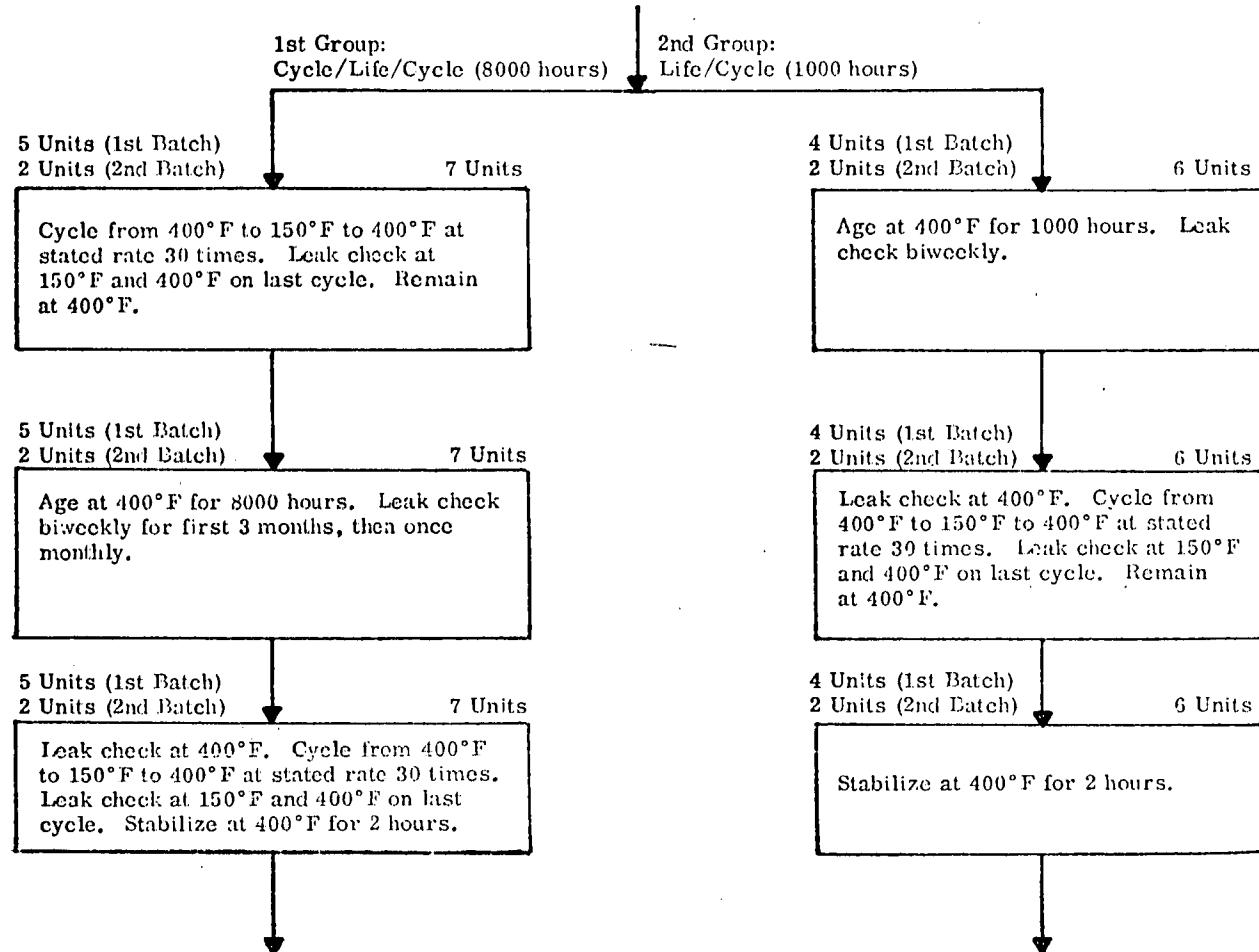


TABLE 2 (Continued)

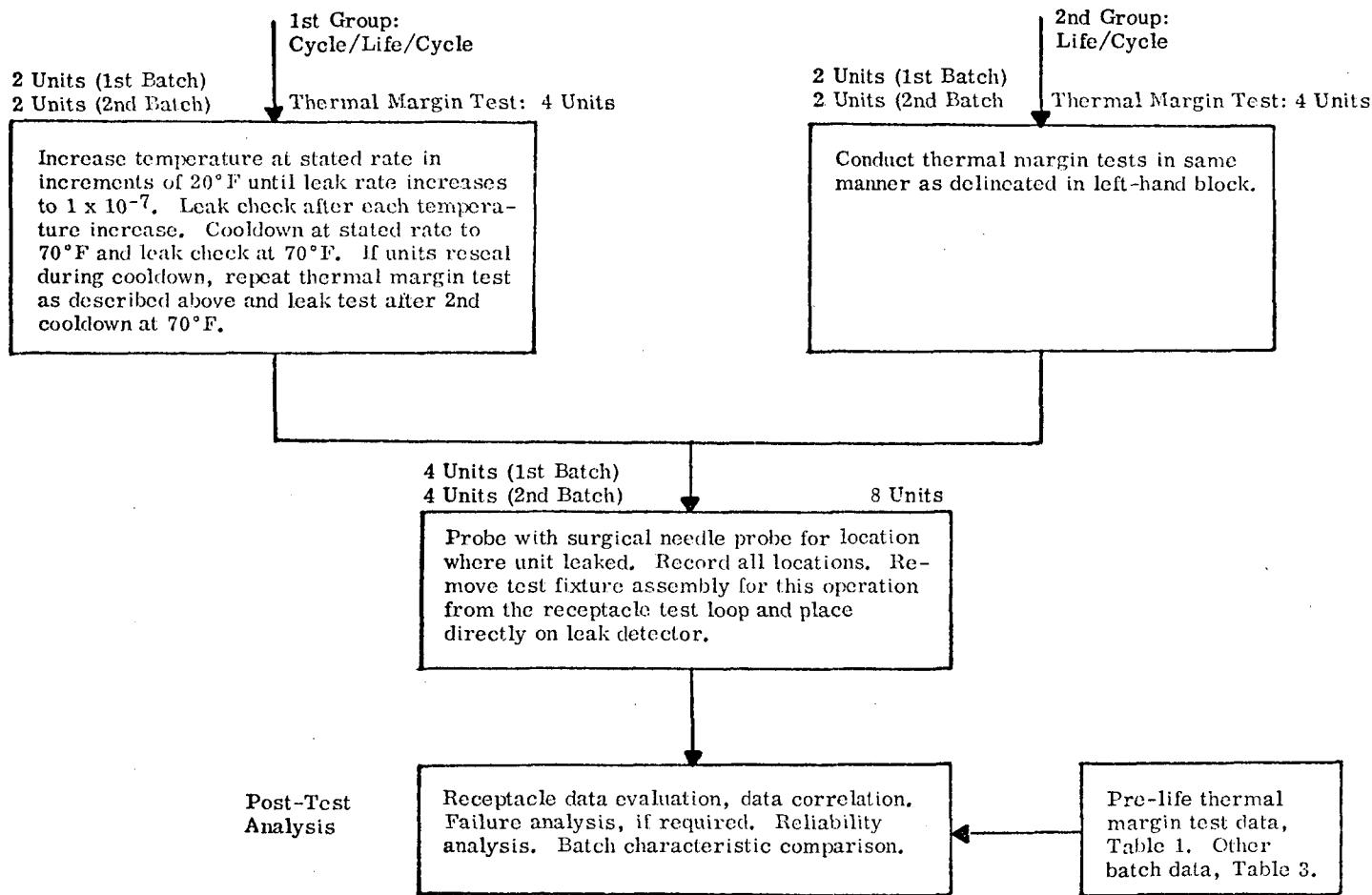


TABLE 3
HERMETIC RECEPTACLE/BIMETAL TRANSITION RING ASSEMBLY TESTS

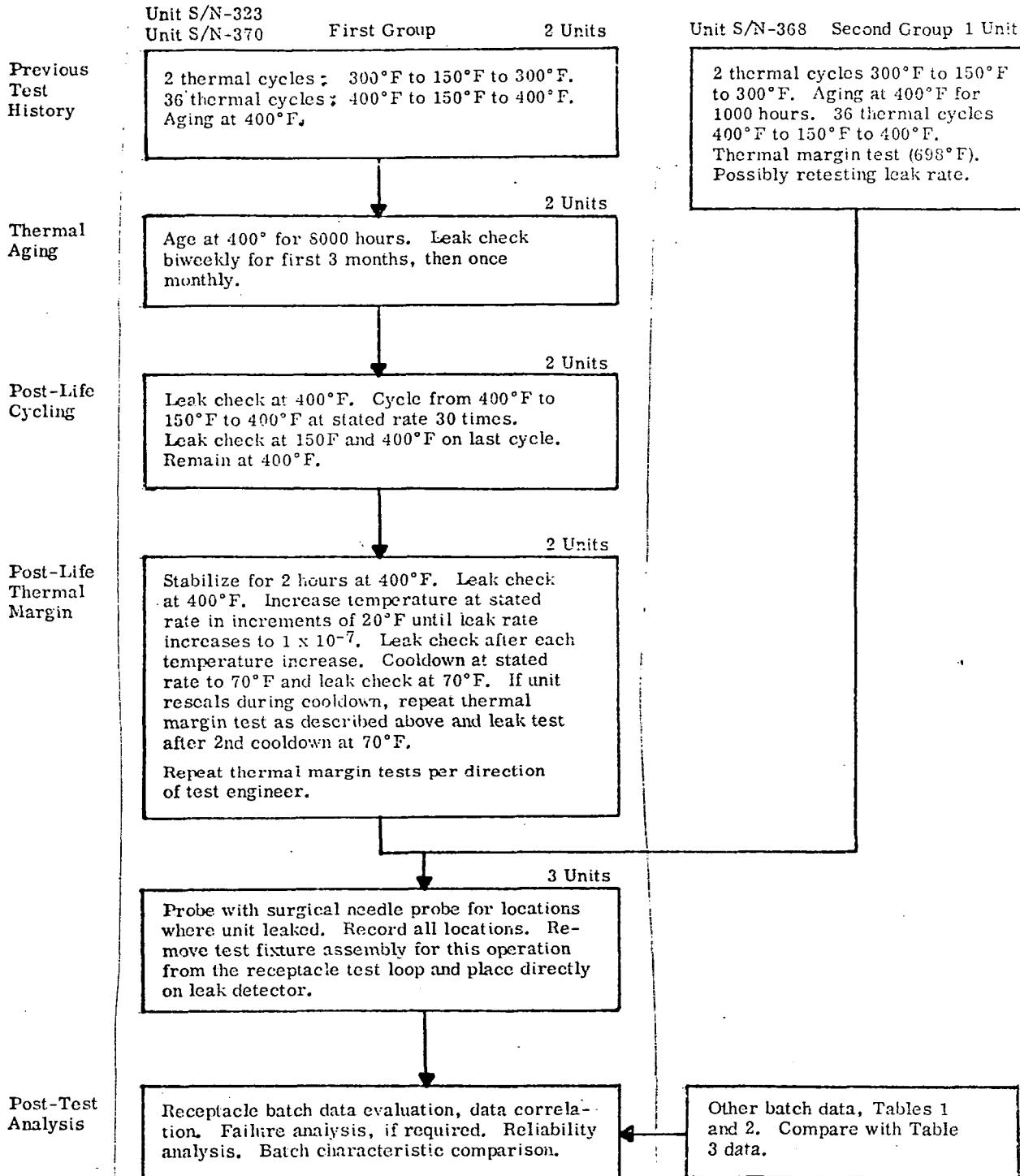


TABLE 4
RECEPTACLE ALLOCATION MATRIX

Item	Steel Shell Receptacle 78033-16-26PN			Remarks
	1st Batch	2nd Batch	Total	
Quantity Procured (new units)	20	40	60	
<u>Requirements (new units)</u>				
ETG S/N-1	5		5	
Other Generators		6	6	
<u>TES Tests (new units)</u>				
Preliminary Thermal Margin	3	3	6	
Group 1: Cycle/Life/Cycle	5	2	7	60 cycles, 8000 hours life
Group 2: Life/Cycle	4	2	6	1000 hours life, 30 cycles
Post-Life Thermal Margin	(4)	(4)	(8)	Units are from groups 1 and 2
Quantity of Test Specimens	12	7	19	Based on 2 manufactured batches of receptacles
<u>Unassigned (new units)</u>	3	27	30	
Current Test Specimens	Receptacles S/N-323, 370, 368		3	Batches were manufactured in 1972
Group 1: Cycle/Life/Cycle	2		2	Tests are now in progress
Group 2: Life/Cycle	1		1	Margin test was completed
Post-Life Thermal Margin	(3)		(3)	Two units are from Groups 1 and 2

**TABLE 5. TES DUMMY STAINLESS STEEL RECEPTACLE
ATTACHMENT DEMONSTRATION TESTS**

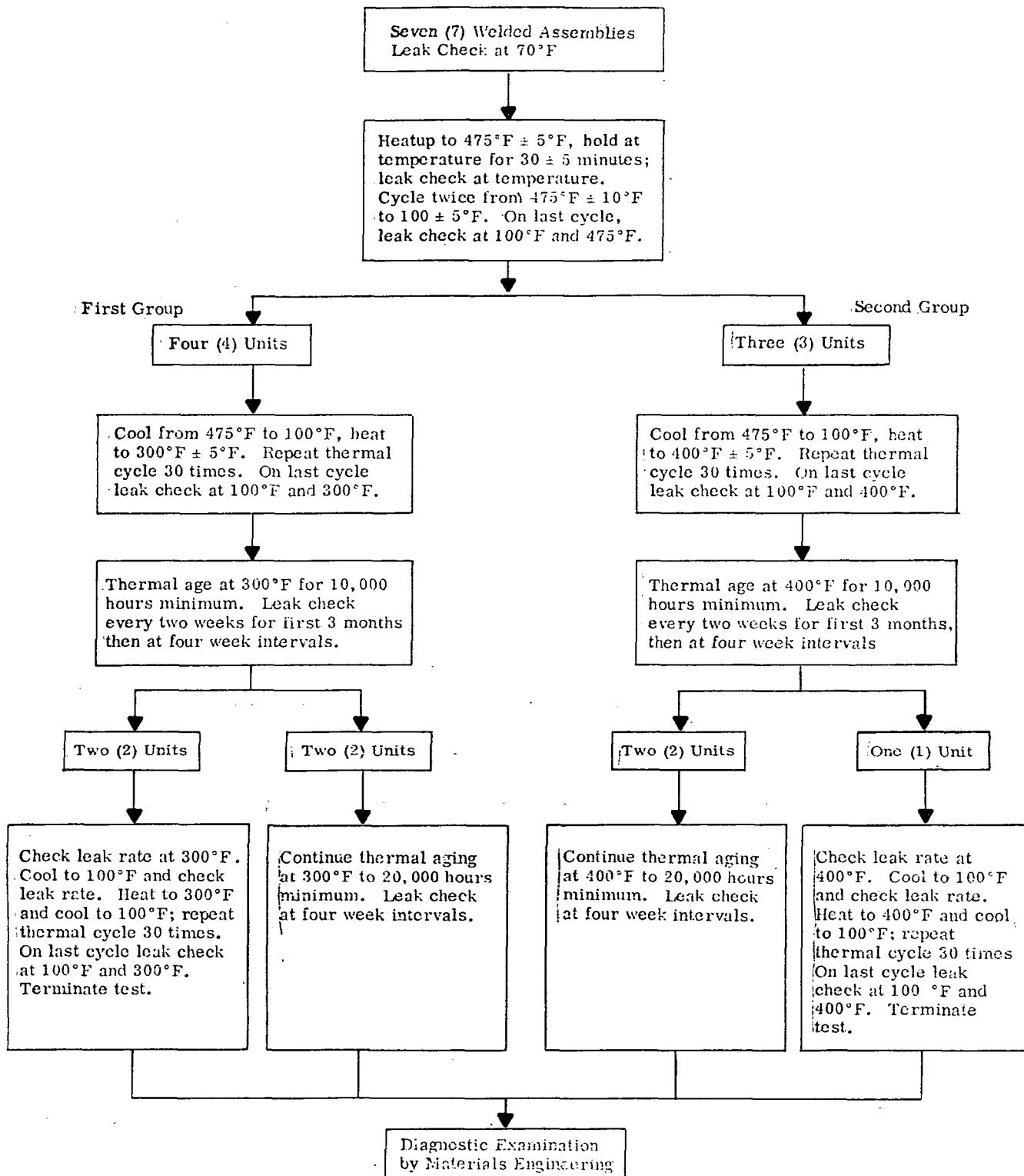


Table 6: Tabulation of TES Hermetic Receptacle Test Programs

Start or Period	Receptacle Model Tested	Programs and Descriptions of Receptacles and Tests
26/10/65	34013	<p>→ 1. <u>SNAP 19 Nimbus Generator Receptacle Test Program</u></p> <p>Manufactured by the Deutsch Company. Hermetic receptacle: Deutsch P/N-34013 TES P/N-CCI-81N2-1</p> <p><u>Receptacle description:</u></p> <p>Size 16 (SS 321) steel shell, O-ring seal, jam-nut type, thread-coupling, 4 x #8 AWG Alloy 52 pins, solid glass hermetic diaphragm.</p> <p>Manufactured by the Deutsch Company. Hermetic receptacle: Deutsch P/N-34014 TES P/N-CCI-81N2-2</p> <p><u>Receptacle description:</u></p> <p>Size 16 (SS 321) steel shell, O-ring seal, jam-nut type, thread-coupling, 6 x #12 AWG and 7 x #20 AWG Alloy 52 pins, solid glass hermetic diaphragm.</p> <p>A large number of units of both models were tested.</p> <p><u>Results:</u> Successful employment of 1 receptacle 34013 and 1 receptacle 34014 on each of 4 SNAP 19 Nimbus space-flight generators on board 2 different Nimbus spacecraft/weather satellites and 1 pair of these receptacles on a laboratory test generator for over 35,000 hours (6 receptacles total).</p>
1964-1968		<p>→ 2. <u>SNAP 29 Generator Receptacle Test Programs</u></p> <p>Large numbers of different types of hermetic electrical feedthroughs and receptacles were tested.</p>
1969-1973	DM5618-19 -7P274	<p>→ 3. <u>SNAP 19 Pioneer Generator Receptacle Test Programs</u></p> <p>Manufactured by the Deutsch Company. Hermetic receptacle: Deutsch P/N-DM5618-19-7P274</p> <p><u>Receptacle description:</u></p> <p>Size 19 (SS 321) steel shell, O-ring seal, push-pull coupling, 7 x 12 AWG Alloy 52 pins, solid glass hermetic diaphragm.</p> <p>Over 50 units were tested.</p> <p>Manufactured by the Deutsch Company.</p> <p><u>Receptacle description:</u></p> <p>Size 19 (SS 321) steel shell, O-ring seal, push-pull coupling, 19 x #20 AWG Alloy 52 pins, solid glass hermetic diaphragm.</p> <p>Over 20 units were tested.</p>
4/23/70	BE7H16A26	<p>Manufactured by Glasseyal Products Co. Hermetic receptacle: Glasseyal P/N-BE7H16A26 TES P/N-CCI-81N11-1</p> <p><u>Receptacle description:</u></p> <p>Size 16 (SS 304) steel shell, O-ring seal, jam-nut type, bayonet-lock, 26 X #20 AWG Alloy 52 pins, solid glass hermetic diaphragm.</p> <p>Over 40 units were tested.</p>

Table 6 (Continued)

Start or Period	Receptacle Model Tested	Programs and Description of Receptacles and Tests
1971-1972	DBA54H16-26 PN	<p>Manufactured by the Deutsch Company. Hermetic receptacle: Deutsch P/N-DBA54H16-26 PN</p> <p><u>Receptacle description:</u></p> <p>Size 16 (SS 321) steel shell, O-ring seal, jam-nut type, bayonet-lock, 26 x #20 AWG gold plated Alloy 52 pins, solid glass hermetic diaphragm.</p> <p>Over 100 units were tested during the SNAP 19 Pioneer and Viking generator programs. Functional receptacle performance tests were conducted.</p> <p><u>Results:</u> Successful employment of 1 receptacle DBA54H16-26 PN with SS 321 steel shell on each of 4 SNAP 19 Pioneer spaceflight generators on board the Pioneer 10/Jupiter spacecraft during a long-term space mission (4 receptacles total).</p>
1972-1973	DBA54H16-26 PN	<p>Manufactured by the Deutsch Company. Hermetic receptacle: Deutsch P/N-DBA54H16-26 PN-Special</p> <p><u>Receptacle description:</u></p> <p>Size 16 (SS 20 EC 3) shell, otherwise the same as description of receptacle DBA54H16-26 PN above.</p> <p>A large number of units were tested and functional performance tests (life, thermal cycle and thermal safety margin) were conducted.</p> <p><u>Results:</u> Successful employment of 1 receptacle DBA54H16-26 PN with SS 20CB3 steel shell on each of 4 SNAP 19 Pioneer spaceflight generators onboard the Pioneer 11/Jupiter spacecraft during a long-term space mission (4 receptacles total).</p> <p>4. <u>HPG 1 Generator Receptacle Test Program</u></p> <p>Manufactured by the Deutsch Company.</p> <p><u>Receptacle description:</u></p> <p>Size 16 (SS 321) steel shell, otherwise the same as description of receptacle DBA54H16-26 PN above.</p> <p>A number of units were tested.</p> <p><u>Results:</u> Successful employment of DBA54H16-26 PN receptacles with SS 321 steel shells on HPG 1 generator for over 13,000 hours.</p> <p>5. <u>HPG 2 Generator Receptacle Test Program</u></p> <p>Manufactured by the Deutsch Company. Hermetic receptacle: Deutsch P/N-DBA54H16-26 PN-Special</p> <p><u>Receptacle description:</u></p> <p>Size 16 (SS 20CB3) steel shell, otherwise the same as description of receptacle DBA54H16-26 PN above.</p> <p>A number of units were tested.</p>

Table 6 (Continued)

Start or Period	Receptacle Model Tested	Programs and Description of Receptacles and Tests
	#7862	<p>Manufactured by Physical Science Corp. (now Gulton Industries). Hermetic receptacle: Gulton P/N-7862 TES P/N-452A81N450-1</p> <p><u>Receptacle description:</u></p> <p>Size 16 (Inconel 750X) steel shell with weld-mount flange, bayonet-lock, 26 x 20 AWG Inconel 750X gold plated regular pins, individual bead hermetic seal for each pin insert.</p> <p>12 units were tested.</p>
	#7863	<p>Manufactured by Gulton Industries. Hermetic receptacle: Gulton P/N-7863 TES P/N-452A81N450-2</p> <p><u>Receptacle description:</u></p> <p>Size 16 (Inconel 750X) steel shell with 14 regular (Inconel 750X) and 6 pairs of Chromel/Alumel T/C pins, otherwise the same as description of receptacle #7862 above.</p> <p>15 units were tested.</p>
	#7864	<p>Manufactured by Gulton Industries. Hermetic receptacle: Gulton P/N-7864 TES P/N-452A81N450-3</p> <p><u>Receptacle description:</u></p> <p>Same as receptacle #7863 above, but with 24 regular and 2 Chromel/Alumel T/C pins.</p> <p>6 units were tested.</p>
1971-1975	DBA54H16-26 PN	<p>Manufactured by Gulton Industries. Hermetic receptacle: Gulton P/N-7868 TES P/N-452A81N450-4</p> <p><u>Receptacle description:</u></p> <p>Same as receptacle #7863 above, but with 13 pairs of Chromel/Alumel T/C pins.</p> <p>2 units were tested.</p> <p><u>Results:</u> Successful employment of 3 Deutsch receptacles DBA54H16-26 PN with SS 20CB3 steel shell and 1 Gulton receptacle #7868 with Chromel/Alumel T/C pins on HPG-2 generator.</p> <p><u>SNAP 19 Viking Generator Receptacle Test Program</u></p> <p>Manufactured by the Deutsch Company. Hermetic receptacle: Deutsch P/N-DBA54H16-26 PN</p> <p><u>Receptacle description:</u></p> <p>Size 16 (SS 321) steel shell, otherwise the same as description of receptacle DBA54H16-26 PN above.</p>

Table 6 (Continued)

Start or Period	Receptacle Model Tested	Programs and Descriptions of Receptacles and Tests
	DBA54H16-26 PN	<p>A large number of units were tested and functional receptacle tests were performed.</p> <p>Manufactured by the Deutsch Company. Hermetic receptacle: Deutsch P/N DBA54H16-26 PN-Special</p> <p><u>Receptacle description:</u></p> <p>Size 16 (SS 20CB3) steel shell, otherwise the same as description of receptacle DBA54H16-26 PN above.</p> <p>A large number of units were tested and functional performance tests (life, thermal cycle and thermal safety margin) were conducted.</p>
4/21/72	PV7H16B-26 PN	<p>Manufactured by ITT/Cannon Electric Company. Hermetic receptacle; ITT/Cannon P/N-PV7H16B26PN</p> <p><u>Receptacle description:</u></p> <p>Size 16, (SS 304) steel shell, otherwise the same as description of Deutsch receptacle DBA54H16-26 PN above.</p> <p>2 units were tested.</p>
	78033-16-26 PN	<p>Manufactured by the Deutsch Company. Hermetic receptacle: Deutsch P/N-78033-16-26 PN TES P/N-452A6000044-001</p> <p><u>Receptacle description:</u></p> <p>Size 16 (SS 20CB3) steel shell with weld-mount flange, bayonet-lock, 26 x #20 AWG gold-plated Alloy 52 pins, solid glass hermetic diaphragm.</p> <p>Over 120 units were tested and functional performance tests (life, thermal cycle and thermal safety margin) were conducted.</p> <p><u>Results:</u> Successful employment of 1 receptacle 78033-16-26 PN with SS 20CB3 steel shell on each of 2 SNAP 19 Viking spaceflight generators onboard each Viking spacecraft Mars Lander 1 and 2 during a long-term mission on the surface of Mars (4 receptacles total).</p>
1975-1979	DBA54H16-26 PN	<p>→ 7. <u>KIPS Receptacle Test Program</u></p> <p>Manufactured by the Deutsch Company. Hermetic receptacle: Deutsch P/N-DBA54H16-26PN-Special</p> <p><u>Receptacle description:</u></p> <p>Size 16 (SS 20CB3) steel shell, otherwise the same as description of receptacle DBA54H16-26 PN above.</p> <p>A large number of units were tested.</p> <p><u>Results:</u> Successful employment of receptacles DBA54H16-26PN with SS 20CB3 steel shell on KIPS equipment units.</p>

Table 6 (Continued)

Start or Period	Receptacle Model Tested	Programs and Descriptions of Receptacles and Tests
1970-1979	DBA54H16-26 PN	<p>→ 8. <u>Sentinel 8S Generator Receptacle Test Program</u></p> <p>Manufactured by the Deutsch Company. Hermetic receptacle: Deutsch P/N-DBA54H16-26 PN-Special</p> <p><u>Receptacle description:</u></p> <p>Size 16 (SS 20CB3) steel shell, otherwise the same as description of receptacle DBA54H16-26 PN above.</p> <p>Over 32 units were tested.</p> <p><u>Results:</u> Successful employment of a number of receptacles DBA54H16-26 PN with SS 20 CB3 steel shell on various Sentinel 8S generators.</p>
1970-1979	5606-3208	<p>→ 9. <u>Sentinel 25 Generator Receptacle Test Program</u></p> <p>Manufactured by Burton Electrical Engineering Company. Hermetic receptacle: Burton P/N-5606-3208-A002</p> <p>A large number of units were tested.</p> <p><u>Results:</u> Successful employment of receptacle 5606-3208 on many Sentinel 25 generators.</p>
1976-1979	DBA54H16-26 PN Custom-made	<p>→ 10. <u>HPG MOD 3 Generator Receptacle Test Program</u></p> <p>Manufactured by the Deutsch Company. Hermetic receptacle: Deutsch P/N-DBA54H16-26 PN-Special</p> <p><u>Receptacle description:</u></p> <p>Size 16, (SS 20CB3) steel shell, otherwise the same as description of receptacle DBA54H16-26 PN above.</p> <p>Over 30 units were tested.</p> <p>Custom-made hermetic receptacle.</p> <p><u>Receptacle description:</u></p> <p>Size 56 stainless steel shell with 6 #6 AWG copper alloy pins, 2 x #16 AWG copper alloy pins and 2 pairs of #16 AWG Chromel/Alumel T/C pins, solid glass hermetic diaphragm.</p> <p>A number of units were tested.</p> <p><u>Results:</u> Successful employment of 3 receptacles DBA54H16-26 PN with SS 20CB3 steel shell and 1 custom-made hermetic receptacle on a number of HPG MOD 3 generators.</p>
1975-1979	J-1	<p>→ 11. <u>SIG/Galileo Generator Receptacle Test Program</u></p> <p>Manufactured by Gulton Industries. Hermetic receptacle J-1: Gulton P/N-111 TES P/N-LCP10017-049 Supplier Source Drawing #9353</p> <p><u>Receptacle description:</u></p> <p>Size 20 (6061) aluminum shell with weld-mount flange, thread-coupling, 41 x #20 AWG gold plated Inconel 750X regular pins, individual bead hermetic seal for each pin insert, polarization normal.</p> <p>8 units were tested.</p>

Table 6 (Continued)

Start or Period	Receptacle Model Tested	Programs and Descriptions of Receptacles and Tests
	J-2	<p>Manufactured by Gulton Industries. Hermetic receptacle J-2: Gulton P/N-222 TES P/N-LCP10017-009 Supplier Source Drawing #9232</p> <p><u>Receptacle description:</u></p> <p>Size 20 (6061) aluminum shell with 21 regular pins and 10 pairs of Pt-10% Rh/Pt type S T/C pins, polarization 6; otherwise the same as description of receptacle J-1 above.</p> <p>8 units were tested.</p>
	J-5	<p>Manufactured by Gulton Industries. Hermetic receptacle J-5: Gulton P/N-888 TES P/N-LCP10017-039 Supplier Source Drawing #9235</p> <p><u>Receptacle description:</u></p> <p>Size 20 (6061) aluminum shell with 21 x # 20 AWG Hoskins* Alloy 203 T/C pins equivalent to type W 3% Re/W 25% Re T/C, polarization 7; otherwise the same as description of receptacle J-1 above.</p> <p>9 units were tested.</p>
	J-40	<p>Manufactured by Gulton Industries. Hermetic receptacle J-40: Gulton P/N-40 TES P/N-LCP10046-009 Supplier Source Drawing #9442</p> <p><u>Receptacle description:</u></p> <p>Size 20 (304L) steel shell with weld-mount flange, thread-coupling, 21 x #20 AWG gold plated inconel 750X regular pins and 10 pairs of Hoskins Alloy 203/225 T/C pins equivalent to type W 3% Re/W 25% Re T/C, individual bead hermetic seal for each pin insert, polarization 6.</p> <p>5 units were tested.</p>
	78033-16-26 PN	<p>Manufactured by the Deutsch Company. Hermetic receptacle: Deutsch P/N-78033-16-26 PN TES P/N-SIG110026-001</p> <p><u>Receptacle description:</u></p> <p>Size 16 (SS 20CE3) steel shell with weld-mount flange, bayonet-lock, 26 x #20 AWG gold plated Alloy 52 pins, solid glass hermetic diaphragm.</p> <p>70 units were tested and functional performance tests (life, thermal cycle and thermal safety margin) were conducted.</p> <p><u>Results:</u> Successful employment of 4 receptacles 78033-16-26 PN with bimetal transition rings on SIG/Galileo GDS-1 generator.</p>

* Alloy 225 and 20 x #20 AWG Hoskins

TES-33009-47

APPENDIX A

BIBLIOGRAPHY AND LISTING OF REFERENCES

BIBLIOGRAPHY AND LISTING OF REFERENCES

- 1) Memo LCHPG-SR-273, dated 9/24/75
Interim Status Report of Task 3.2 Component Development, Electrical Feedthrough Attachment/Survey.
- 2) Memo S19V-SR-212, dated 8/28/72
RFQ Evaluation Board for Viking Pressure Transducers and Generator Receptacles.
- 3) Final Report ESD-2960-64, dated 9/15/72
Final Report, SNAP 19 Viking Generator Electrical Receptacle Study.
- 4) Memo S19V-SR-237, dated 9/19/72
Minutes of RFQ Receptacle Board Meeting.
- 5) Memo S19V-LLR-615, dated 9/2/75
Reliability Analysis and Assessment of Viking RTG/ETG Electrical Receptacles
- 6) Memo S19V-LLR-342A, dated 5/21/74
Deutsch Electrical Receptacle Thermal Acceptance Test Report
- 7) Memo S19V-LLR-519E, dated 12/2/74
Investigation of Viking Receptacle/Seal Ring in Process Leak Rejection
- 8) Memo S19V-LLR-403B, dated 9/11/74
Deutsch Electrical Receptacle Seal Thermal Margin Test Results
- 9) Memo S19V-LLR-337D, dated 7/22/74
Deutsch Electrical Receptacle Test Results
- 10) Memo SN19-SR-169, dated 3/3/70
Preliminary Investigation and Evaluation for SNAP 19 Pioneer RTG Hermetically Sealed Receptacles
- 11) ISA-S-37.1, Standard of ISA
Electrical Transducer Nomenclature and Terminology (ISA)
- 12) NAS-1599, National Aerospace Standard
Connectors, Aerospace Industries Association of America, Inc.

13) Connector Standards

NAS-1652

NAS-1678

NAS-1679

NAS-1682

Standards for Electrical Connectors, Aerospace Industries Association.

14) Military Standards

MS-3113

MIL-C-26482 (USAF)

MIL-C-26500 (USAF)

MIL-C-83723 (USAF)

MIL-C-5015

MIL-C-38999

MIL-C-27599

MIL-C-81511

MIL-C-38300

MIL-C-83725

MIL-C-81703

Military Standard Specifications for Electrical Connectors.

15) Military Standard

MIL-STD-202

Test Method for Electronic and Electrical Component Parts

16) Connector Handbook (Vendor Publication)

Hermetic Connector Handbook, ITT/Canon Electric Company

17) Radiation Effects on Connectors, dated 6/16/63 (Report)

CP63-1182, Radiation Effects on Electrical Insulation for Compact Reactors in Space, Conference Paper, IEEE.

18) Radiation Effects on Connectors, dated 7/5/66 (Report)

Developmental Irradiation Test of SNAP 8 Electrical Components, Atomic International.

19) Technical Connector Handbook, dated 1970 (Vendor Publication)

Soldering Hermetically Sealed Receptacles to Aluminum and Stainless Steel Panels, TRW/Amphenol Co.

20) Bulletin HR65 (Vendor Report)

High Reliability Analysis; Analysis of Reliability Factors of Connectors and Headers, Gulton Industries Connector Division.

21) Previous Receptacle Test Procedures and Fixtures

a) Receptacle Test Procedure, dated 4/19/72

452B5100310 (SNAP 19 Pioneer Program Generator) Quality Control Receptacle Acceptance Test Procedure

b) Receptacle Test Procedure, dated 11/8/72

452A6000312 (SNAP 19 Viking Program Generator) Quality Control Electrical Receptacle Thermal Acceptance Test Procedure

c) Receptacle Test Procedure, dated 2/17/76

HPGA3000312 (HPG MOD 3 Program Generator) Quality Control Electrical Receptacle Thermal Acceptance Test Procedure

d) Receptacle Test Fixture, dated 4/21/72 (Drawing)

452B5140038 (SNAP 19 Pioneer/Viking Program Generator) Electrical Receptacle Test Fixture, Quality Control Acceptance

e) Receptacle Test Fixture, dated 4/10/72 (Drawing)

452A6040016 (SNAP 19 Viking Program Generator) Electrical Receptacle Test Fixture, Quality Control Acceptance

f) Receptacle Leak Rate Test Fixture, dated 1973 (Drawing)

NSK 1226 (SNAP 19 Viking Program Generator) Electrical Receptacle Seal Test Test Fixture

g) Receptacle Leak Rate Test Fixture, dated 1973 (Drawing)

NSK 1207 (SNAP 19 Viking Program Generator) Electrical Receptacle/ Seal Ring/Diffusion Bonded Seal Test Fixture

h) Receptacle Leak Rate Test Fixture, dated 1973 (Drawing)

4 Test Stations, Life Test, Electrical Receptacle/Single O-ring Receptacle Seal Test Fixture (SNAP 19 Viking Program)

i) Receptacle Leak Rate Test Fixture, dated 1973 (Drawing)

Electrical Receptacle/Dual O-ring Receptacle Seal Test Fixture (SNAP 19 Viking Program)

- j) Receptacle Leak Rate Test Fixture, dated 1973 (Drawing)
Electrical Receptacle/Composite (O-ring/Diffusion Bond)
Seal Test Fixture (SNAP 19 Viking Program)
- 22) Hermetic Receptacles Specifications, dated 6/22/72
452A81N450 General Specifications for Ultra-High Reliability Hermetic
Receptacles, TES Specifications
- 23) Memo LCHPG-SR-285, dated 9/15/75
Suitability of 10%Rh/Pt-Pt and Other Types of Thermocouple Material
Pins for LCHPG Receptacle Applications
- 24) Memo LCHPG-SR-273A, dated 9/24/75
Manufacturers of Hermetically Sealed Receptacles:
 - a) The Deutsch Company, Electronic Component Division, Banning,
California 92220
 - b) Gulton Industries (formerly Physical Science Corp.), Connector
Division, Costa Mesa, California 92627
 - c) Glass Products Products Co., Linden, New Jersey 07036
 - d) Hermetic Seal Corp., Rosemead, California 91770
 - e) TRW/Cinch, Connector Division, Minneapolis, Minnesota 55415
 - f) Malco/Microdot Co., South Pasadena, California 91030
 - g) TRW/Amphenol, Connector Division, Broadview, Illinois 60153
 - h) Astro-Seal Inc., South El Monte, California, 91733
 - i) ITT/Canon Electric Division, Phoenix, Arizona, 85039 and Santa
Ana, California 90031
 - j) Bendix Corp., Electronics Component Scintilla Division,
Sidney, New York 13838
 - k) Viking Industries, Inc., Chatsworth, California 91311
 - l) Deteronics Corp., South El Monte, California 91733
 - m) HTC Laboratories, Red Bank, New Jersey

- n) Vacuum Ceramics, Gary, Illinois
- o) Rowe Industries, Toledo, Ohio
- p) Joy Mfg. Co., New Philadelphia, Ohio
- 25) Connector Specifications, dated 12/20/75
MB-C450 Connector, Electric, Hermetic, Circular, Boeing Space Division
- 26) Connector Specifications, dated 10/31/75
LCHPB0170400 General Specifications for High-Reliability Hermetic Receptacles, Bayonet-Lock, Weld-Mount
- 27) Memo LCHPG-SR-331, dated 12/3/75
Tentative Test Plan for GDS/ETG Electrical Feedthrough Receptacles
- 28) Memo LCHPG-SR-352, dated 12/18/75
Status of TES RFQ No. 75-177, Hermetic Receptacles and Recommendations
- 29) Receptacle Specifications, dated 4/27/76
LCP 10012 Connector Assemblies, Electrical Receptacles
- 30) Receptacle Specifications, dated 7/29/76
LCP 10017 Hermetic Receptacles, Aluminum Shell, Weld-Mount, Preliminary Engineering Specifications
- 31) Memo LCHPG-SR-721, dated 1/27/77
Updated Test Plan for GDS/ETG Electrical Feedthrough Receptacles, Subtask 2.1.5
- 32) Receptacle Test Fixture, dated 4/26/76 (Drawing)
LCP 10030 Fixture Assemblies, Adapter and Electrical Connector, Quality Control Acceptance Leak Test
- 33) Receptacle Test Fixture, dated 11/12/76 (Drawing)
LCP 10150 Fixture Assemblies, Electrical Connector Tests
- 34) Receptacle Test Procedure, dated 2/27/77
LCP 10031 Test Procedure, Electrical Receptacles Quality Control Acceptance

- 35) Receptacle Test Procedure, dated 5/3/77
LCP 10032 Test Procedure, Electrical Receptacles Life Tests
- 36) Memo LCHPG-LLR-714, dated 1/13/77
LCHPG Electrical Receptacle Test Program Review, Task 2.1.5
- 37) Memo SIG-LLR-933, dated 7/6/77
Reallocation of SIG Gulton Electrical Receptacle Usage
- 38) Memo SIG-LLR-958, dated 7/26/77
Analysis of Gulton Preproduction Electrical Receptacle Thermal Acceptance Tests
- 39) Memo SIG-LLR-984, dated 8/12/77
SIG Aluminum and Steel Shell Electrical Receptacle Test Program
- 40) Memo SIG-WJB-1007, dated 8/25/77
SIG Receptacle/Cover Boss Weld Configuration: Fillet versus Seal Type Weld
- 41) Memo SIG-SR-983, dated 8/11/77
Revised Aluminum and Steel Shell Receptacle Test Plan, Task 2.1.5
- 42) Receptacle Specifications, dated 7/21/77
LCP 10046 Electrical Receptacles, Hermetic, Stainless Steel Shell, Weld-Mount
- 43) Receptacle/Bimetal Ring Test Fixture, dated 11/16/76 (Drawing)
LCP 10090 Fixture Assemblies-Adaptor and Electrical Connector, Quality Control Acceptance Leak Test
- 44) Receptacle Test Loop Station Installation, dated 2/18/77 (Drawing)
LCP 10042 Plumbing System-Electrical Receptacle Life Test Station
- 45) Memo SIG-LLR-1107, dated 10/24/77
Electrical Receptacle and Bimetal Ring Life Test Data Reduction and Analysis Method
- 46) Memo SIG-LLR-1141, dated 11/9/77
SIG Electrical Receptacle Thermal Margin Leak Test Data Reduction and Analysis
- 47) Memo SIG-LLR-822, dated 3/23/77
SIG Electrical Receptacle Thermal Margin Leak Test Analysis and Assessment

48) Memo S19V-LLR-403A, dated 11/6/73
Deutsch Receptacle Seal Thermal Margin Test Results

49) Deutsch Receptacle Specification Drawing, dated 11/2/72
452A6000044-001 Receptacle, Electrical (See Reference 69)

50) Memo SIG-GWB-1187, dated 12/22/77
GDS-1 T/E Power and Heater Electrical Circuit Failure Mode Analysis

51) Memo LCHPG-TBW-538
Electrical Circuit Single Failure Point Analysis, LCHPG GDS Reference Design LCPS010

52) Memo SIG-GWB-1196, dated 12/28/77
Aluminum Electrical Receptacle Acceptance Test Analysis and Assessment

53) Memo QUA-CWR-877, dated 1/27/78
Report on the Thermal Leak Testing of 10 Deutsch Co., Electrical Receptacles, TES P/N 452A6000044-001

54) Memo SIG-LLR-1218, dated 2/1/78
Allocation of Surplus Viking Receptacles to SIG GDS-1

55) Memo SIG-GWB-1219, dated 2/1/78
Assessment of Viking Deutsch Electronics Electrical Receptacles for Use in GDS-1

56) Memo SIG-WRM-1232, dated 2/10/78
Heater, Receptacle and Bimetal Ring Component Development Tests

57) Memo SIG-SR-1294, dated 3/28/78
Status of Gulton Steel Receptacles

58) Memo SIG-LLR-1238, dated 2/20/78
SIG Electrical Receptacle/Bimetal Seal Ring Component Development and GDS-1 Receptacle Test Program

59) Memo LCHPG-WJB-802, dated 3/11/77
Update of Development and Test Plan for the GDS/ETG Electrical Feedthrough Attachment, Subtask 2.1.4

- 60) Memo LCHPG-WJB-437, dated 4/21/76
Development and Test Plan for the GDS/ETG Electrical Feedthrough Receptacle Attachment, Subtask 2.1.4
- 61) Memo SIG-SR-1439, dated 7/20/78
Receptacle Thermal Margin Test, Task 16.9
- 62) Memo SIG-SR-1438, dated 7/25/78
Receptacle and Bimetal Transition Ring Testing, Task 16.9
- 63) Memo SIG-LLR-1319, dated 4/21/78
Gulton Steel Shell Electrical Receptacle Acceptance Test Analysis-Type J40.
- 64) Memo SIG-GWB-1196, dated 4/21/78
Gulton Aluminum Shell Electrical Receptacle Acceptance Test Analysis and Assessment
- 65) Memo SN19-SM-381, dated 2/16/71
RTG Power Connector Resistance Test
- 66) Memo SIG-SR-1497, dated 8/29/78
Justification for Deutsch Co., Receptacles
- 67) Memo SIG-SR-1543, dated 10/9/78
Steel Shell Receptacle Test Plan, Task 16.9
- 68) Memo SIG-LLR-1653, dated 12/15/78
SIG Hermetically Sealed Electrical Receptacle Thermal Acceptance Test, Task 10.3
- 69) Deutsch Receptacle Specification Drawing, dated 11/13/78
SIG 110026-001 Receptacle, Electrical (see Reference 49)
- 70) Receptacle Test Procedure, dated 11/14/78
SIG 110027 Electrical Receptacle Acceptance Test Procedure
- 71) Receptacle Test Procedure, dated 3/9/79
SIG 115001 Electrical Receptacle Life Test Procedure
- 72) Memo SIG-SR-1183A, dated 12/12/77
Gulton Receptacle Test Summary

73) Memo SIG-SR-1656, dated 12/26/78
Partial Results from Quality Control Inspection of New Deutsch Hermetic Receptacles, Task 16.9

74) Memo SIG-GMG-1636, dated 12/6/78
Deutsch Receptacle Weights

75) Memo SIG-LLR-1691, dated 1/24/79
Analysis and Assessment Program for SIG Hermetic Sealed Electrical Receptacle

76) Memo SIG-SR-1694, dated 1/29/79
Partial Results of 54 Receptacle Leak Tests, Task 16.9

77) Memo SIG-GG-1703, dated 1/31/79
Deutsch Receptacle Weights

78) Final Report IESD-2873, dated June 1973
Final Report, SNAP 19 Pioneer 10 and 11 Generators

79) Final Report TES-3069-54, dated June 1976
Final Report, SNAP 19 Viking Lander 1 and 2 Generators

80) Final Report TES-3081-101, dated February 1978
Final Report, HPG MOD 3 Program Generators

81) Receptacle Test Fixture, dated 7/26/77 (Drawing)
LCP 10120 Leak Check Tool, Electrical Receptacle, Weld Development

82) Receptacle Test Fixture, dated 2/16/78 (Drawing)
LCP 10084 Chill Block, Water Cooled, Welded Receptacle Assembly

83) Dummy Receptacle for Deutsch Receptacle, dated 2/16/78 (Drawing)
LCP 10083 Dummy Connector, Weld Development Detail

84) Bimetal Transition Ring for Deutsch Receptacle, dated 12/22/77 (Drawing)
LCP 10082 Transition Fitting, Bi-Metal, Electrical Receptacle

85) Receptacle/Bimetal Ring Test Procedure, dated 5/18/77
LCP 10065 Life Test Procedure, Bimetal Attachment for Stainless Steel Electrical Receptacle Installation

86) Receptacle Test Loop Station Wiring, dated 3/4/77 (Drawing)
LCP 10036 Electrical Schematic, Electrical Receptacle Test Station System (36 test station).

87) Bimetal Transition Ring for Gulton Receptacle, dated 10/11/76 (Drawing)
LCP 10014 Transition Fitting, Bi-Metal, Electrical Receptacle

88) Dummy Receptacle for Gulton Steel Shell Receptacle, dated 3/25/76 (Drawing)
LCP 10007 Dummy Connector Configuration Stainless Steel, Weld Development Details

89) Dummy Receptacle for Gulton Aluminum Shell Receptacle, dated 3/23/76 (Drawing)
LCP 10006 Dummy Connector Configuration Weld Development Details

90) Memo SPP-SR-015, dated 3/12/79
High-Temperature Hermetically Sealed Connectors for Generators.

91) Receptacle Welding Test Procedure, dated 12/1/77
SIG 30022 Aluminum Welding Procedure, Electrical Receptacle Installation

92) Dummy Deutsch Viking Receptacle, dated 5/2/72 (Drawing)
NSK-1193 Dummy Deutsch Receptacle Configuration

93) Memo SIG-SR-1183B, dated 12/16/77
Update of Gulton Receptacle Test Summary

94) Bimetal Ring Chill Block Test Fixture, dated 8/30/76 (Drawing)
LCP 10130 Chill Blocks, Weld Test, Details and Assembly Dummy Receptacle Aluminum/Steel Shell Connector/Boss

95) Bimetal Ring Leak Rate Test Fixture, dated 7/26/76 (Drawing)
LCP 10120 Leak Check Tool for Receptacle Weld Development

96) Deutsch Receptacle/Bimetal Ring Assembly, dated 11/13/78 (Drawing)
SIG 110017 Welded Assembly, Transition Fitting to Receptacle

97) Bimetal Ring for Deutsch Receptacle, dated 11/18/78 (Drawing)
SIG 110062 Transition Fitting, Bimetal, Electrical Receptacle

- 98) Bimetal Ring Test Procedure, dated 11/18/78
SIG 110028 Leak Check Procedure for Transition Fitting, Bimetal, Electrical Receptacle
- 99) Bimetal Ring Ultrasonic Test Procedure, dated 11/13/78
SIG 120032 Ultrasonic Inspection Procedure, 6061 AL/AG/304L Clad Plate Blanks
- 100) TES-3069, dated Sept. 1975
SNAP 19 Viking ETG/RTG Electrical Receptacle Test Report
- 101) TES-33009-51, dated June, 1979
SIG Bimetal Weld Transition Joint, Final Report

TES-33009-47

APPENDIX B-1

DESCRIPTION AND TEST RESULTS OF THERMAL
MARGIN TEST OF DEUTSCH RECEPTACLE
S/N-368/BIMETAL TRANSITION RING ASSEMBLY

APPENDIX B-1DESCRIPTION AND TEST RESULTS OF THERMAL
MARGIN TEST OF DEUTSCH RECEPTACLE
S/N-368/BIMETAL TRANSITION RING ASSEMBLY

References: 62. Memo SIG-SR-1438, Receptacle and Bimetal Transition Ring Testing, Task 16.9, dated July 1978.
 8. Memo S19V-LLR-403B, Deutsch Receptacle Thermal Margin Test Results, dated 9/11/74.
 55. Memo SIG-GWB-1219, Assessment of Deutsch Viking Receptacles, dated 2/1/78.

Objectives: To document results of the thermal margin test of Deutsch receptacle S/N-368 with welded bimetal transition ring and to compare results with previous thermal margin tests of the same model Deutsch receptacle.

Conclusion: The first thermal margin test of a Deutsch receptacle/bimetal transition ring assembly was completed and the test results were good. The receptacle failed at a temperature of 698°F and the bimetal transition ring did not exhibit any leak. The thermal safety margin was about 400°F above the anticipated operational temperature level of a generator receptacle. Previous thermal aging and cycling tests did not show any effects. A comparison of test results with previous data of receptacle thermal margin tests showed that this receptacle exhibited about the same failure characteristic. The data of the test can be used for verification of future procured receptacle lots for the SIG flight system generators.

1.0 Thermal Safety Margin Test Report of Deutsch Receptacle
S/N-368/Bimetal Transition Ring Assembly

Purpose of Thermal Margin Test

The purpose of this report was to document and evaluate the results of the first thermal margin test of a Deutsch receptacle/bimetal transition ring assembly. This test was of singular importance since the test results will be used as base line for future thermal margin tests to be conducted with 9 other test specimens presently undergoing thermal

aging tests (Ref. 62) and for future thermal margin tests of representative samples of new lots of procured receptacles for the SIG/Galileo flight system generators.

The thermal margin test was a destructive type of test and determined the thermal safety margin of the hermetically sealed receptacle above its anticipated operational temperature level. Thermal margin test data can be utilized to:

- a. Establish in combination with the permissible maximum leak rate the thermal rating of a receptacle lot.
- b. Determine failure modes and mechanisms of receptacle lots due to temperature.
- c. Indicate the effects, if any, of thermal aging and/or cycling on the receptacle thermal margin rating.
- d. Enable comparison of receptacle lots manufactured at different times.
- e. Verify that units from one receptacle lot are identical with units from another receptacle lot with respect to their reliability characteristics originally defined with test samples from an earlier receptacle lot.

Basically, the receptacle was rated by its supplier with a maximum allowable seal leak rate of 1.0×10^{-8} std cc He/sec-atm at 392°F (200°C) operational temperature. However, TES testing in the past proved the receptacle thermal margin rating to be much higher (500°F to 700°F temperature level) and the seal leak rate a couple of magnitudes smaller (10^{-9} to 10^{-10} region).

Thermal Margin Test of Deutsch Receptacle S/N-368 with Bimetal Transition Ring

A thermal margin test with Deutsch receptacle S/N-368 with bimetal transition ring was performed on 7/19/78. The test was conducted on station 21 of the SIG program receptacle test loop installation at the TES facility. The receptacle/bimetal ring assembly, welded in a LCP 10 150 receptacle test fixture, was brought up to the test temperatures by first increasing continuously the test station power Variac and then by adding to the thermal insulation of the fixture additional insulation blankets.

A Veeco leak detector, model MS18 was used to read continuously and directly the leak rate of the test specimen. The leak rate reference standard for the leak detector was a standard with a rating of 4.6×10^{-8} std cc He/sec. Test temperatures were monitored continuously with a digital thermometer. Measured leak rate data are given in std cc He/sec-atm. The heatup and cooldown rate was 30°F/minute (Table 7).

2.0 Post-Test Inspections and Analysis

The front end of the welded receptacle was covered and the weld joint of the receptacle/bimetal ring was tested with He. There was no detectable leak on the bimetal ring.

TABLE 7
TEST RESULTS OF THERMAL MARGIN TEST OF RECEPTACLE S/N-368

Temperature °F	Leak Rate	Remarks
397	3.2×10^{-9}	Stable, initial reading
421	3.0×10^{-9}	Stable, 9:20 AM
440	2.95×10^{-9}	
460	2.80×10^{-9}	
483	2.60×10^{-9}	After 5 minutes stabilization, 9:45 AM
490	2.40×10^{-9}	
500	2.40×10^{-9}	
520	2.00×10^{-9}	10:10 AM
530	2.00×10^{-9}	Check calibration of leak detector; leak detector is stable.
530	2.00×10^{-9}	Repeat measurement
540	2.20×10^{-9}	
560	2.00×10^{-9}	10:30 AM
580	2.00×10^{-9}	
600	2.10×10^{-9}	Stabilize temperature, 5 minutes
620	2.30×10^{-9}	
640	2.2×10^{-9}	
660	2.1×10^{-9}	
675	2.3×10^{-9}	
675	1.5×10^{-8}	11:45 AM, undetermined fluctuation in reading
680	3.8×10^{-9}	
690	2.6×10^{-9}	Stable, 5 minutes
698	Wide open	Receptacle leak, rate is $> 3 \times 10^{-6}$
698	Wide open	Temperature stable, rate $> 3 \times 10^{-6}$
627	Wide open	
602	Wide open	12:23 PM
500	Wide open	
400	Wide open	
375	Wide open	2:30, an event takes place: pressure on Veeco increased, looks like test fixture O-ring leaks air.
300	Wide open	
200	Wide open	
		Removed test fixture from test loop; test loop flange O-ring looks round and OK; large test fixture O-ring looks flat and permanently set.
150	Wide open	Mount lower half of test fixture on leak detector and probe joins with surgical needle and He. Leak seems to be on one or more center pins of receptacle.
70	Gross leak ($> 3.0 \times 10^{-6}$)	There is a gross leak on at least 2 or more pins in center of receptacle.

The results of the thermal margin test could be summarized as:

- a. Receptacle S/N-368 failed at 698°F (370°C) temperature during heatup; the unit did not reseal after cooldown (Table 7).
- b. The forced failure mode was operational temperature and the leak occurred in the center of the glass diaphragm near two pins.
- c. The bimetal transition ring of the receptacle withstood the ambient temperature of 698°F and did not exhibit any detectable leak after cooldown.

2.1 Pre-Margin Test History of Receptacle S/N-368

Receptacle S/N-368 was manufactured by the Deutsch Company, Electronics Division, Banning, California in November 1973 (lot #7346, 46th week in 73). The TES initial acceptance test leak rate was 8.7×10^{-10} std cc He/sec-atm at 400°F in 1973. The receptacle was in storage until January 1978 when it was retested for SIG program application. The test was conducted at 400°F and showed no detectable leak rate.

A bimetal transition ring was welded to the receptacle in March 1978 and the unit assembly was successfully leak checked. Therefore, the receptacle/bimetal ring assembly was welded into a LCP10150 receptacle test fixture in preparation for receptacle tests in the SIG program receptacle test loop installation.

The receptacle unit was then subjected to 2 thermal cycles from 300°F to 150°F to 300°F, a 1000 hour life performance (thermal aging) test at 400°F and 30 thermal cycle tests from 150°F to 400°F to 150°F. The leak rate data for these tests were as follows:

5/10/78	initial leak rate	at 81°F = 4.5×10^{-10}
	thermal cycle	at 303°F = 1.9×10^{-9}
	thermal cycle	at 148°F = 6.7×10^{-10}
	thermal cycle	at 302°F = 1.1×10^{-9}
5/30/78	during aging	at 399°F = 1.9×10^{-9}
6/9/78	during aging	at 396°F = 1.4×10^{-9}
6/28/78	end of aging	at 399°F = 1.45×10^{-9}
6/28/78	at start of cycling	at 148°F = 7.8×10^{-10}
	at start of cycling	at 399°F = 1.45×10^{-9}
7/18/78	at end of cycling	at 112°F = 4.2×10^{-10}
	at end of cycling	at 400°F = 9.0×10^{-10}
7/19/78	start of thermal margin	at 397°F = 3.2×10^{-9}

TABLE 8

TEST RESULTS OF THERMAL MARGIN TESTS OF 10 RECEPTACLES

Temperature °F	Leak Rate	Remarks
645	4.4×10^{-9}	<u>Receptacle S/N-201</u>
	Failure occurred	1st heatup
	Failure occurred	2nd heatup
	1.5×10^{-7}	Resealed
605	1.3×10^{-7}	<u>Receptacle S/N-203</u>
	Failure occurred	1st heatup
	Failure occurred	2nd heatup
	Still leaking	Did not reseal
674	2.2×10^{-8}	<u>Receptacle S/N-206</u>
	Failure occurred	1st heatup
	Failure occurred	2nd heatup
	Still leaking	Did not reseal
704	5.2×10^{-8}	<u>Receptacle S/N-209</u>
	Failure occurred	1st heatup
	1.3×10^{-6}	Resealed
674	1.6×10^{-8}	<u>Receptacle S/N-211</u>
	Failure occurred	1st heatup
	Failure occurred	2nd heatup
	8.5×10^{-7}	Resealed
652	1.9×10^{-8}	<u>Receptacle S/N-213</u>
	Failure occurred	1st heatup
	Failure occurred	2nd heatup
	Still leaking	Did not reseal
702	2.0×10^{-8}	<u>Receptacle S/N-210</u>
	Failure occurred	1st heatup
	Failure occurred	2nd heatup
	Still leaking	Did not reseal
632	1.2×10^{-8}	<u>Receptacle S/N-214</u>
	Failure occurred	1st heatup
	Failure occurred	2nd heatup
	1.2×10^{-7}	Resealed
602	1.9×10^{-9}	<u>Receptacle S/N-220</u>
	Failure occurred	1st heatup
	Failure occurred	2nd heatup
	3.5×10^{-7}	Resealed
707	4.0×10^{-8}	<u>Receptacle S/N-221</u>
	Failure occurred	1st heatup
	Failure occurred	2nd heatup
	Still leaking	Did not reseal

Leak rate data on 7/18/78 was measured with a Veeco leak detector, model MS-9 and data on 7/19/78 was measured with a Veeco leak detector, model MS-18.

2.2 Comparison with Previous Thermal Margin Test Data and Discussion

Receptacle S/N-368 failed (leak rate $> 3 \times 10^{-6}$ std cc He/sec-atm) at a temperature of 698°F (370°C) during the thermal margin test. In order to establish a reference, these data were compared with the results of previous thermal margin tests performed by TES during the Pioneer/Viking SNAP 19 generator programs in the 1972 to 1974 period. It should be noted that this receptacle S/N-368 and all the previous hermetically sealed receptacles were identical and the same model Deutsch P/N 78033-16-26PN (Figure 2) and TES P/N 452A6000044-001 (Ref. 49) or P/N SIG110026-001 (Ref. 69). However, the previous receptacles had a different test history than receptacle S/N-368. This test history is stated for each receptacle. It also should be noted that some of the previous tested receptacles resealed during the cooldown after the failure during the first heatup of their thermal margin test. These receptacles were then subjected to a second thermal margin test heatup where they failed at a lower temperature level. This was not the case with receptacle S/N-368 which did not reseal after the first heat up and failure (Ref. 8 and 55).

Two receptacle units from lot S/N-7346, the same lot receptacle S/N-368 came from, were thermal margin tested in 1974 and the results were:

Temperature °F	Leak Rate	Remarks
672	9.0×10^{-9}	<u>Receptacle S/N-346</u>
673	Failure occurred	1st heatup
80	Still leaking	Did not reseal
595	1.9×10^{-9}	<u>Receptacle S/N-352</u>
614	Failure occurred	1st heatup
80	Still leaking	Did not reseal

The test histories of units S/N-346 and S/N-352 were: no thermal aging and only 1 previous thermal cycle. Ten receptacle units from lot S/N-7224 were thermal margin tested in 1974 and the results are presented in Table 8.

2.3 Discussion of Test Results of 10 Thermal Margin Tests

The test results showed that the forced receptacle failures during the thermal margin tests occurred between 722°F and 610°F during the first heatup and between 661°F and 392°F during the second heatup. Tabulating the test data for further evaluation, the following factors became apparent:

Receptacle SN-	1st Heatup Failure °F	2nd Heatup Failure °F	Failure ΔT °F	Resealed after Cooldown
201	669	500	119	Yes
203	610	500	110	No
206	707	648	59	No
209	722	—	—	Yes
211	704	647	57	Yes
213	672	661	11	No
210	707	392	315	No
214	668	645	23	Yes
220	634	534	100	Yes
221	717	392	325	No

The average level of the forced failure temperature during the thermal margin tests of the 10 hermetically sealed receptacles was 681°F (361°C). In evaluating these data with the failure temperature of 698°F during the thermal margin test of receptacle/bimetal ring assembly S/N-368, it was mandatory to take into account the previous test histories (prior to margin tests) of these 10 receptacles and compare these data with unit S/N-368. The test histories compared as follows:

Receptacle S/N	Thermal Rating °F	Thermal Aging Cumulative Hours	Thermal Cycling Number of Cycles
201	669	5,828	1220
203	610	5,828	1220
206	707	5,523	1103
209	722	5,544	1159
211	704	5,042	1019
213	672	5,281	1076
210	707	14,547	1015
214	668	14,502	1011
220	634	14,426	1047
221	717	14,597	1015
346	673	—	1
352	614	—	1
368	698	1,635	30

2.4 Conclusions from Test Results of 13 Thermal Margin Tests

The following conclusions from the test results of 13 thermal safety margin tests with the Deutsch hermetically sealed receptacle P/N 78033-16-26PN were derived from these 1974 and 1978 data:

- (a) The average of the forced seal failure of the 13 receptacles occurred on the first heatup of their thermal margin tests at about 676°F (358°C).
- (b) The average of the thermal ratings of 10 receptacles (S/N-201 through S/N-221) was 681°F (361°C). Seal failure in the 1974 thermal margin tests during the SNAP 19 Viking receptacle test program was defined as a gross leak rate of 1.0×10^{-4} std cc He/sec-atm or greater.
- (c) The average of the thermal ratings of 2 receptacles (S/N-346 and S/N-352) was 644°F (340°C). Seal failure in these 1974 thermal margin tests during the SNAP 19 Viking receptacle test program was also defined as a gross leak rate of 1.0×10^{-4} std cc He/sec-atm or greater.
- (d) The thermal rating of receptacle S/N-368 was 698°F (370°C). Seal failure in this 1978 thermal margin test during the SIG/Galileo receptacle test program was defined as a gross leak rate of 1.0×10^{-7} std cc He/sec-atm or greater. Comparing the data of receptacle S/N-368 with data of the previous 1974 thermal margin tests of (a) through (c) above, it could be seen that receptacle S/N-368 exhibited about the same characteristics for the thermal margin.
- (e) Previous life performance tests (thermal aging at 400°F) as well as the different time durations of these tests which varied between, 0, 1600, 5000 and 14,600 hours did not show any noticeable effects on a thermal margin rating of a receptacle.
- (f) Previous temperature cycle tests (400°F to 100°F to 400°F) as well as the quantities of these cycle tests which varied in numbers between 1, 30, 1000 and 1200 did not show any noticeable effects on a thermal rating of a receptacle.
- (g) The combinations of life performance and temperature cycle tests or only temperature cycle tests without life performance tests did not show any noticeable effect on a thermal margin rating of a receptacle.
- (h) The attachment of receptacle S/N-368 to a bimetal transition ring did not show any effect on the thermal rating of this receptacle.

Figures 25 through 29 illustrate the trend of the leak rate versus temperature characteristics of 8 Deutsch steel (SS20CB3) shell receptacles respectively. These test results were obtained during the receptacle test program of the SNAP 19 Viking generator program over the 1972 to 1975 period (Ref. 5 through 9 and 48). These trend data compared closely with those of receptacle S/N-368.

3.0 Further Testing of Receptacle S/N-368 and Other New Thermal Margin Test Samples with Dye Penetration Tests

It was contemplated to remove the Deutsch receptacle/bimetal ring assembly S/N-368 from the LCP10150 test fixture and conduct a dye penetration test. This type of receptacle test was expected to clarify how many and exactly which pins failed in its thermal margin test. Dye penetrant was also to be applied to the welded joint of the bimetal transition ring to verify that no leak occurred at this location. These dye penetration tests of receptacle S/N-368 were to be performed together with 6 other test samples from the new batch of 60 Deutsch receptacles after their thermal margin tests were completed.

TES-33009-47

APPENDIX B-2

DESCRIPTION AND TEST RESULTS OF LIFE PERFORMANCE AND
TEMPERATURE CYCLING TESTS OF DEUTSCH RECEPTACLE/
BIMETAL TRANSITION RING AND DUMMY RECEPTACLE/BIMETAL
TRANSITION RING ASSEMBLIES

**DESCRIPTION AND TEST RESULTS OF LIFE PERFORMANCE AND
TEMPERATURE CYCLING TESTS OF DEUTSCH RECEPTACLE/
BIMETAL TRANSITION RING AND DUMMY RECEPTACLE/BIMETAL
TRANSITION RING ASSEMBLIES.**

References: 35.a) LCP 10032 Test Procedure, Electrical Receptacles Life Tests

 35.b) Test Data Record Sheets, Tables III and IV of LCP 10032 Deutsch Receptacle/Bimetal Ring Assembly Test Procedure

 85.a) LCP 10065 Life Test Procedure, Bimetal Attachment for Stainless Steel Shell Electrical Receptacle Installation

 85.b) Test Data Record Sheets, Tables II and III, of LCP 10065 Dummy Receptacle/Bimetal Ring Assembly Test Procedure

Objectives: To document results of life performance and temperature cycling tests of 3 Deutsch receptacle/bimetal transition ring and 7 dummy receptacle/bimetal transition ring assemblies over the period May 1978 to June 1979.

Conclusion: Functional receptacle and bimetal ring performance tests were successfully conducted with 3 test samples of Deutsch receptacle/bimetal transition ring and 7 dummy receptacle/bimetal transition ring assemblies for over 9360 hours. No receptacle leak rate failures occurred. The leak rate of all test samples remained in the 10^{-10} to the 10^{-9} std cc He/sec-atm regions.

1. Test Report of 10 Receptacle/Bimetal Ring Assemblies

Life performance (thermal aging at defined elevated temperature levels) and miscellaneous temperature cycling tests with 10 test specimens were performed in the receptacle test loop installation at the TES facilities. The test specimens were 3 hermetic Deutsch receptacle/bimetal transition ring and 7 solid steel dummy receptacle/bimetal ring assemblies. One thermal margin test was conducted with one hermetic Deutsch receptacle/bimetal transition ring assembly to establish thermal ratings of the burnt-in hermetic receptacle as well as its burnt-in bimetal ring. This ring was welded to the weld-mount flange of the receptacle. The results of this thermal margin test are described in Appendix B-1.

All tests were performed according to the outlines of the receptacle test plan and test procedures of References 35 and 85; the steps of these procedures are listed in details on Tables 1 through 5. The heatup and cooldown temperature rate for all test operations was about 30° F per minute with exception of the thermal margin test.

A facility power outage occurred once during one night when the life performance tests were in progress for about 1000 hours. The power interruption of the test fixture heaters lasted about 4 hours. This event was not considered as a fast thermal shock to the test samples but rather as an additional temperature cycle from elevated to room to elevated temperature. The reason for this evaluation of this event was the large heat sink mass of the solid aluminum block of the LCP 10150 test fixture (Figure 11). All test samples were leak tested at 150°F and 400°F the following day and no detrimental effects were detected.

Leak rate checks of the test samples were performed periodically according to procedure instructions. These checks are also shown on Tables 1 through 5. Test temperatures were monitored continuously. The test results of the 10 samples are shown in Tables 9 through 18.

2. Discussion of Test Results from 3 Deutsch Receptacle/Bimetal Ring and 7 Dummy Receptacle/Bimetal Ring Assemblies

Table 19 summarizes the test results of all 10 test samples. A comparison of the initial pre-testing leak rate of each test sample with its leak rate value after approximately 8000 hours of thermal aging at elevated temperatures indicates no significant effects were caused by this aging test. Another evaluation of Tables 9 through 18 shows good stabilities of leak rate values even with progressing life tests at elevated temperatures.

The test results showed that the sequence of life and temperature cycling tests had no effects on the performance characteristics of any of the test samples. The same type Deutsch hermetic receptacle, P/N 78033-16-26PN with SS20CB3 steel shell and weld-mount flange, was tested extensively during the SNAP 19 Viking receptacle test program (Table 6).

Comparisons of these 1978 test results with those obtained over the 1972 to 1975 period (Tables 27 through 38) show basically the same characteristics of the tested units in both receptacle programs. Figure 30 illustrates probability curves for no-leak failures for 3 different leak rate/temperature levels. These data were derived from test results of the SNAP 19 Viking receptacle test program. An analysis of the test results of the 10 samples of the SIG receptacle test program indicated that the reliability prediction curves of Figure 30 apply also for these 10 test samples.

Tables 28, 29 and 36 show typical stabilities of receptacle leak rates before and after life performance (thermal aging), cycle and pressure tests in helium, ambient air, vacuum and CO₂ and Tables 31 and 32 illustrate leak rate stabilities before and after welding operations of Magnesium-Thorium to Magnesium-Thorium/Steel rings diffusion-bonded to Viking Deutsch steel shell receptacles.

Tables 33, 34, 37 and 38 list some of the test hours, test operations and reliability analyses of the Viking Program Deutsch receptacles. All these data can be directly correlated with the results of the receptacle test samples of the SIG/Galileo receptacle test program.

Notes for Test Results of Tables 9 through 18

1. Initial leak rate value of test sample prior to start of functional tests.
2. Leak rate data taken after 2 temperature cycles from 400°F to 150° to 400°F.
3. Test sample in burn-in at 400°F for 450 hours.
4. Leak rate data taken at start of 36 temperature cycle tests from 400°F to 150°F to 400°F.
5. Leak rate data taken after 36 temperature cycles from 400°F to 150°F to 400°F.
6. Leak rate data taken during life performance test (thermal aging at 400°F).
7. Leak rate data taken at start of 30 temperature cycle tests from 400°F to 150°F to 400°F.
8. Leak rate data taken after 30 temperature cycles from 400°F to 150°F to 400°F.
9. Leak rate data taken after 2 temperature cycles from 475°F to 100°F to 475°F.
10. Leak rate data taken after 30 temperature cycle tests from 400°F to 100°F to 400°F.
11. Leak rate data taken after 30 temperature cycle tests from 300°F to 100°F to 300°F.
12. Leak rate data taken during life performance test (thermal aging at 300°F).

TABLE 9

Test Results of Deutsch Receptacle/Bimetal Ring Assembly S/N - 323 (Test Station 19)

Test Sample S/N 323 Notes*	Cumulative Hours of Aging at 400°F	Test Date	Test Result	Temperature (°F)	Leak Rate Std. cc He/sec - atm
1		5/10/78	Good	81	3.9×10^{-10}
1		5/11/78	↑	302	2.6×10^{-9}
2		5/11/78		152	6.6×10^{-10}
2	48	5/11/78		297	1.15×10^{-9}
3	498				
4	498	5/31/78		146	7.4×10^{-10}
4	498	5/31/78		400	1.1×10^{-9}
5	936	6/19/78		152	9.5×10^{-10}
5	936	6/19/78		400	9.0×10^{-10}
6	1272	7/3/78		397	1.1×10^{-9}
6	1608	7/17/78		400	1.2×10^{-9}
6	1944	7/31/78		400	2.0×10^{-9}
6	2208	8/11/78		400	1.7×10^{-9}
6	2616	8/28/78		400	7.9×10^{-10}
6	2952	9/11/78		400	1.1×10^{-9}
6	3648	10/10/78		400	1.45×10^{-9}
6	4320	11/7/78		400	1.2×10^{-9}
6	4968	12/4/78		400	1.45×10^{-9}
6	6192	1/24/79		400	2.0×10^{-9}
6	6480	2/7/79		400	1.8×10^{-9}
6	6176	3/8/79		400	1.5×10^{-9}
6	7800	4/2/79		400	1.3×10^{-9}
6	8664	5/9/79	↓	400	1.6×10^{-9}
6	9360	6/7/79	Good	400	1.75×10^{-9}

*See Notes on page B-2-3.

TES-33009-47

B-2-4

TABLE 10

Test Results of Deutsch Receptacle/Bimetal Ring Assembly S/N - 370 (Test Station 20)

Test Sample S/N 370 Notes*	Cumulative Hours of Aging at 400° F	Test Date	Test Result	Temperature (° F)	Leak Rate	
					Std. cc He/sec - atm	
1		5/10/78	Good	81	4.4×10^{-10}	
1		5/11/78	↑	305		3.5×10^{-9}
2		5/11/78		150	7.4×10^{-10}	
2	48	5/11/78		302		1.1×10^{-9}
3	498	---				
4	498	5/31/78		147	8.2×10^{-10}	
4	498	5/31/78		396		1.7×10^{-9}
5	936	6/19/78		153	1.1×10^{-9}	
5	936	6/19/78		397		1.25×10^{-9}
6	1272	7/3/78		398		1.3×10^{-9}
6	1608	7/17/78		400		1.4×10^{-9}
6	1944	7/31/78		400		1.8×10^{-9}
6	2208	8/11/78		400		1.1×10^{-9}
6	2616	8/28/78		400		9.7×10^{-10}
6	2952	8/11/78		400		1.4×10^{-9}
6	3648	10/10/78		400		1.48×10^{-9}
6	4320	11/7/78		400		1.2×10^{-9}
6	4968	12/4/78		400		1.2×10^{-9}
6	6192	1/24/79		400		2.2×10^{-9}
6	6480	2/7/79		400		1.9×10^{-9}
6	7176	3/8/79		400		1.6×10^{-9}
6	7800	4/3/79		400		1.4×10^{-9}
6	8664	5/9/79	↓	400		1.4×10^{-9}
6	9360	6/7/79	Good	400		1.6×10^{-9}

*See Notes on page B-2-3.

TABLE 11Test Results of Deutsch Receptacle/Bimetal Ring Assembly S/N - 368 (Test Station 21)

Test Sample S/N 368 Notes **)	Cumulative Hours of Aging at 400°F	Test Date	Test Result	Temperature (°F)	Leak Rate Std. cc He/sec - atm	
1		5/10/78	Good	81	4.5×10^{-10}	
1		5/11/78		303		1.9×10^{-9}
2		5/11/78		148	6.7×10^{-10}	
2	48	5/11/78		302		1.1×10^{-9}
6	474	5/30/78		399		1.9×10^{-9}
6	714	6/9/78		396		1.4×10^{-9}
6	1170	6/28/78		399		1.45×10^{-9}
7	1170	6/28/78		399		1.45×10^{-9}
7	1170	6/28/78		148	7.8×10^{-10}	
8	1635	7/18/78		112	4.2×10^{-10}	
8	1635	7/18/78		400		9.0×10^{-10}
*)	1635	7/19/78	Good	400		3.2×10^{-9}

*) Followed by a thermal margin test (Appendix B-1).

**) See Notes on page B-2-3.

TABLE 12

Test Results of Dummy Receptacle/Bimetal Ring Assembly S/N-B0701(Test Station 22)

Test Sample S/N B0701 Notes *	Cumulative Hours of Aging at 400°F	Test Date	Test Result	Temperature (°F)	Leak Rate Std. cc He/sec - atm
1		5/25/78	Good	83	3.6×10^{-10}
1	120	5/30/78		478	1.7×10^{-9}
9		6/1/78		91	7.9×10^{-10}
9	124	6/1/78		473	1.3×10^{-9}
10	694	6/26/78		84	4.8×10^{-10}
10	694	6/28/78		401	9.0×10^{-10}
6	1054	7/13/78		398	7.3×10^{-10}
6	1366	7/26/78		400	1.6×10^{-9}
6	1678	8/9/78		400	6.6×10^{-10}
6	2134	8/28/78		400	6.2×10^{-10}
6	2422	9/6/78		400	8.0×10^{-10}
6	2758	9/20/78		400	6.2×10^{-10}
6	3430	10/18/78		400	1.1×10^{-9}
6	3958	11/8/78		400	8.0×10^{-10}
6	4990	12/21/78		400	1.3×10^{-9}
6	5734	1/25/79		400	1.7×10^{-9}
6	6070	2/8/79		400	1.6×10^{-9}
6	6742	3/8/79		400	1.2×10^{-9}
6	7366	4/3/79		400	9.0×10^{-10}
6	8230	5/9/79		400	9.6×10^{-10}
6	8926	6/7/79	Good	400	1.3×10^{-9}

*See Notes on page B-2-3.

TABLE 13

Test Results of Dummy Receptacle/Bimetal Ring Assembly S/N B0702 (Test Station 23)

Test Sample S/N B0702 Notes *	Cumulative Hours of Aging at 400°F	Test Date	Test Result	Temperature (°F)		Leak Rate Std. cc He/sec - atm	
1		5/25/78	Good	80		4.4×10^{-10}	
1	120	5/30/78	▲	478		1.45×10^{-9}	
9		6/1/78		79		8.4×10^{-10}	
9	124	6/2/78		473		9.0×10^{-10}	
10	694	6/26/78		82		4.1×10^{-10}	
10	694	6/28/78		400		7.6×10^{-10}	
6	1054	7/13/78		400		1.0×10^{-9}	
6	1366	7/26/78		400		1.3×10^{-9}	
6	1678	8/9/78		400		7.8×10^{-10}	
6	2134	8/28/78		400		7.2×10^{-10}	
6	2422	9/6/78		400		6.4×10^{-10}	
6	2758	9/20/78		400		4.5×10^{-10}	
6	3430	10/18/78		400		9.2×10^{-10}	
6	3958	11/8/78		400		9.0×10^{-10}	
6	4990	12/21/78		400		1.5×10^{-9}	
6	5734	1/24/79		400		1.75×10^{-9}	
6	6070	2/9/79		400		1.40×10^{-9}	
6	6742	3/7/79		400		1.1×10^{-9}	
6	7366	4/3/79		400		1.3×10^{-9}	
6	8230	5/9/79	▼	400		9.9×10^{-10}	
6	8926	6/7/79	Good	400		1.2×10^{-9}	

*See Notes on page B-2-3.

TABLE 14

Test Results of Dummy Receptacle/Bimetal Ring Assembly S/N-B0703(Test Station 24)

Test Sample S/N B0703 Notes *	Cumulative Hours of Aging at 400°F	Test Date	Test Result	Temperature (°F)	Leak Rate Std. cc He/sec - atm
1		5/25/78	Good	81	3.8×10^{-10}
1	120	5/30/78	↑	476	5.0×10^{-10}
9		6/1/78		78	7.8×10^{-10}
9	124	6/2/78		471	8.2×10^{-10}
10	694	6/26/78		81	3.0×10^{-10}
10	694	6/28/78		400	4.8×10^{-10}
6	1054	7/13/78		400	4.4×10^{-10}
6	1366	7/26/78		400	6.9×10^{-10}
6	1678	8/9/78		400	4.9×10^{-10}
6	2134	8/28/78		400	5.3×10^{-10}
6	2422	9/6/78		400	5.0×10^{-10}
6	2758	9/20/78		400	4.0×10^{-10}
6	3430	10/18/78		400	7.4×10^{-10}
6	3958	11/8/78		400	4.9×10^{-10}
6	4990	12/21/78		400	8.0×10^{-10}
6	5734	1/24/79		400	8.2×10^{-10}
6	6070	2/9/79		400	6.8×10^{-10}
6	6742	3/7/79		400	6.5×10^{-10}
6	7366	4/4/79		400	5.2×10^{-10}
6	8254	5/10/79	↓	400	5.8×10^{-10}
6	8950	6/8/79	Good	400	5.0×10^{-10}

*See Notes on page B-2-3.

TABLE 15

Test Results of Dummy Receptacle/Bimetal Ring Assembly S/N-B0704 (Test Station 25)

Test Sample S/N B0704 Notes *	Cumulative Hours of Aging at 300°F	Test Date	Test Result	Temperature (°F)	Leak Rate Std. cc He/sec - atm
1		5/25/78	Good	80	3.4×10^{-10}
1	120	5/30/78		476	9.4×10^{-10}
9		6/1/78		79	4.8×10^{-10}
9	124	6/2/78		470	1.0×10^{-9}
11	694	6/26/78		82	4.4×10^{-10}
11	694	6/28/78		301	1.4×10^{-9}
12	1054	7/13/78		300	1.0×10^{-9}
12	1366	7/26/78		300	1.7×10^{-9}
12	1678	8/9/78		300	9.2×10^{-10}
12	2134	8/28/78		300	8.6×10^{-10}
12	2422	9/6/78		300	5.9×10^{-10}
12	2758	9/20/78		300	4.0×10^{-10}
12	3430	10/18/78		300	9.0×10^{-10}
12	3958	11/9/78		300	8.7×10^{-10}
12	4990	12/21/78		300	1.7×10^{-9}
12	5734	1/25/79		300	1.9×10^{-9}
12	6070	2/4/79		300	1.4×10^{-9}
12	6742	3/7/79		300	1.1×10^{-9}
12	7366	4/4/79		300	1.3×10^{-9}
12	8254	5/10/79		300	1.2×10^{-9}
12	8950	6/8/79	Good	300	8.6×10^{-10}

*See Notes on page B-2-3.

TABLE 16

Test Results of Dummy Receptacle/Bimetal Ring Assembly S/N-B0706(Test Station 26)

Test Sample S/N B0706 Notes *	Cumulative Hours of Aging at 300°F	Test Date	Test Result	Temperature (°F)	Leak Rate Std. cc He/sec - atm
1		5/25/78	Good	81	
1	120	5/30/78	▲	473	2.7×10^{-10} 1.7×10^{-9}
9		6/1/78		79	8.8×10^{-10}
9	124	6/2/78		479	1.5×10^{-9}
11	694	6/26/78		82	5.1×10^{-10}
11	694	6/28/78		301	1.8×10^{-9}
12	1150	7/17/78		300	2.7×10^{-10}
12	1366	7/26/78		300	1.8×10^{-9}
12	1678	8/9/78		300	7.0×10^{-10}
12	2134	8/28/78		300	1.3×10^{-9}
12	2422	9/6/78		300	4.0×10^{-10}
12	2758	9/20/78		300	6.4×10^{-10}
12	3430	10/18/78		300	8.9×10^{-10}
12	3958	11/9/78		300	7.1×10^{-10}
12	4990	12/22/78		300	1.3×10^{-9}
12	5734	1/25/79		300	1.6×10^{-9}
12	6070	2/9/79		300	9.4×10^{-10}
12	6742	3/7/79		300	1.0×10^{-9}
12	7366	4/4/79		300	1.3×10^{-9}
12	8254	5/10/79		300	1.1×10^{-9}
12	8950	6/8/79	Good	300	8.1×10^{-10}

*See Notes on page B-2-3.

TABLE 17

Test Results of Dummy Receptacle/Bimetal Ring Assembly S/N-B0801(Test Station 27)

Test Sample S/N B0801 Notes *	Cumulative Hours of Aging at 300°F	Test Date	Test Result	Temperature (°F)	Leak Rate Std. cc He/sec - atm
1		5/25/78	Good	81	2.7×10^{-10}
1	120	5/30/78	↑	473	1.6×10^{-9}
9		6/1/78		82	5.1×10^{-10}
9	124	6/2/78		469	1.5×10^{-9}
11	694	6/26/78		84	4.8×10^{-10}
11	694	6/28/78		300	1.4×10^{-9}
12	1150	7/17/78		300	3.44×10^{-10}
12	1366	7/26/78		300	1.9×10^{-9}
12	1678	8/9/78		300	1.0×10^{-9}
12	2134	8/29/78		300	9.6×10^{-10}
12	2422	9/6/78		300	5.2×10^{-10}
12	2758	9/20/78		300	5.0×10^{-10}
12	3430	10/18/78		300	9.5×10^{-10}
12	3958	11/9/78		300	8.3×10^{-10}
12	4990	12/22/78		300	1.2×10^{-9}
12	5734	1/25/79		300	1.6×10^{-9}
12	6070	2/9/79		300	1.12×10^{-9}
12	6742	3/6/79		300	1.1×10^{-9}
12	7366	4/4/79		300	1.1×10^{-9}
12	8254	5/10/79	↓	300	1.2×10^{-9}
12	8950	6/8/79	Good	300	1.2×10^{-9}

*See Notes on page B-2-3.

TABLE 18

Test Results of Dummy Receptacle/Bimetal Ring Assembly S/N-A1205 (Test Station 28)

Test Sample S/N A1205 Notes *	Cumulative Hours of Aging at 300°F	Test Date	Test Result	Temperature (°F)	Leak Rate Std. cc He/sec - atm
1		5/25/78	Good	80	2.0×10^{-10}
1	120	5/30/78	▲	469	2.6×10^{-9}
9		6/1/78		81	9.2×10^{-10}
9	124	6/2/78		469	7.8×10^{-10}
11	694	6/26/78		83	4.0×10^{-10}
11	694	6/28/78		298	1.2×10^{-9}
12	1150	7/17/78		300	3.6×10^{-10}
12	1366	7/26/78		300	1.5×10^{-9}
12	1678	8/9/78		300	4.4×10^{-10}
12	2134	8/29/78		300	4.8×10^{-10}
12	2422	9/6/78		300	6.5×10^{-10}
12	2758	9/20/78		300	3.8×10^{-10}
12	3430	10/18/78		300	7.9×10^{-10}
12	3958	11/9/78		300	8.6×10^{-10}
12	4990	12/22/78		300	1.22×10^{-10}
12	5734	1/25/79		300	9.9×10^{-10}
12	6070	2/9/79		300	1.4×10^{-10}
12	6742	3/6/79		300	8.6×10^{-10}
12	7366	4/4/79		300	9.9×10^{-10}
12	8254	5/10/79	▼	300	8.6×10^{-10}
12	8950	6/8/79	Good	300	9.1×10^{-10}

*See Notes on page B-2-3.

TABLE 19

Summary Tabulation of Test Results From Functional Receptacle/Bimetal Ring Tests

Test Specimen S/N-	Leak Rate in Std cc He/sec-atm				Cumulative Hours of Thermal Aging at 400°F (300°F*)
	at 70°F		at 400°F (300°F*)		
	Pre-Test	Post-Test	Pre-Test	Post-Test	
323	3.9×10^{-10}	N/A	$*)2.6 \times 10^{-9}$	1.6×10^{-9}	8664
370	4.4×10^{-10}		$*)3.5 \times 10^{-9}$	1.4×10^{-9}	8664
368	4.5×10^{-10}		$*)1.9 \times 10^{-9}$	3.2×10^{-9}	1635
B0701	3.6×10^{-10}		1.7×10^{-9}	9.6×10^{-10}	8230
B0702	4.4×10^{-10}		1.45×10^{-9}	9.9×10^{-10}	8230
B0703	3.8×10^{-10}		5.0×10^{-10}	5.8×10^{-10}	8254
B0704	3.4×10^{-10}		9.4×10^{-10}	$*)1.2 \times 10^{-9}$	8254*)
B0706	2.7×10^{-10}		1.7×10^{-9}	$*)1.1 \times 10^{-9}$	8254*)
B0801	2.7×10^{-10}		1.6×10^{-9}	$*)1.2 \times 10^{-9}$	8254*)
A1205	2.0×10^{-10}	N/A	2.6×10^{-9}	$*)8.6 \times 10^{-10}$	8254*)

TES-33009-47

APPENDIX C

DESCRIPTION AND TEST RESULTS OF TES QUALITY CONTROL
LEAK RATE ACCEPTANCE TESTS OF GULTON HERMETICALLY
SEALED ALUMINUM AND STEEL SHELL RECEPTACLES.

DESCRIPTION AND TEST RESULTS OF TES QUALITY CONTROL
LEAK RATE ACCEPTANCE TESTS OF GULTON HERMETICALLY
SEALED ALUMINUM AND STEEL SHELL RECEPTACLES.

References: 30) Aluminum Shell Receptacle Specifications for Gulton Receptacles, LCP 10017 Hermetic Receptacles, Aluminum Shell, Weld-Mount, Engineering Specifications
42) Steel Shell Receptacle Specifications for Gulton Receptacles, LCP 10046, Electric Receptacles, Hermetic, Stainless Steel Shell, Weld-Mount
32) LCP 10030 Fixture Assemblies, Electrical Receptacle, Quality Control Acceptance
34) LCP 10031 Test Procedure, Electrical Receptacles Quality Control Acceptance

Objectives: To document results of TES Quality Control leak rate acceptance tests of 25 aluminum shell and 5 steel shell hermetically sealed receptacles manufactured by Gulton Industries, Costa Mesa, California.

Conclusion: Both types of hermetically sealed receptacles were not suitable as generator flight hardware since their leak rate characteristics did not meet the hermetic seal requirements of References 30 and 42.

1. Test Report of Gulton Hermetic Receptacles

Leak rate acceptance tests were conducted by TES Quality Control with 30 hermetically sealed receptacles upon delivery from Gulton Industries, Costa Mesa, California. The different types of receptacles were as follows:

- a) 8 units of model J-2 with aluminum shell and 21 regular pins and 10 pairs of Pt-10% Rh/Pt type S T/C pins
- b) 9 units of model J-5 with aluminum shell and 41 W/Re T/C pins
- c) 8 units of model J-1 with aluminum shell and 41 Inconel 750 regular pins
- d) 5 units of model J-40 with steel shell and 21 Inconel 750 regular pins and 20 pairs of W/Re T/C pins.

All receptacles had individual glass/ceramic bead inserts as hermetic seal for each pin. Three units from the 8 J-2 type and 2 units from the 8 J-1 type passed the Quality Control acceptance tests. Six of the remaining 25 units were tested twice with the same failure results which were consistent with respect to failure temperatures as well as resealing of these units after cooldown. The acceptance/reject criteria for these tests were leak rate specifications for aluminum shell receptacles of $\leq 1 \times 10^{-9}$ std cc He/sec-atm at 70°F and 300°F and for steel shell receptacles of $\leq 1 \times 10^{-9}$ std cc He/sec-atm at 70°F and 400°F temperatures. The test results of the 25 aluminum shell receptacles and the 5 steel shell receptacles are shown in Tables 20 through 23 respectively.

2. Discussion of Test Results from 25 Aluminum Shell and 5 Steel Shell Gulton Receptacles

The test results of the receptacle leak rate acceptance tests proved that hermetically sealed receptacles with aluminum shells and different types of thermocouple pin inserts are feasible within the present state-of-the-art, since 5 of these units passed the criterion of this test. However, the low test yield made a hardware application impossible. The failure of all steel shell receptacles with thermocouple pins indicated that further development for this type of receptacle would be required to obtain a higher temperature rating.

Tables 24 and 25 summarize the test results of both receptacle types. In analyzing these data, it became apparent that the actual thermal rating of the aluminum shell receptacles was in the order of 200°F to 220°F and the thermal rating of the steel shell receptacle was about 150°F. Figures 17 through 23 demonstrate the trend of the leak rate versus temperature characteristics of 7 tested Gulton receptacles.

TABLE 20

TEST RESULTS OF LEAK RATE ACCEPTANCE TESTS OF GULTON ALUMINUM SHELL RECEPTACLES TYPE J-2

Receptacle S/N-	Weight (grams)	Test Date	Accepted Q. C.	Temperature (°F)	Leak Rate Std. cc He/sec-gtm	
002	42.493	12/6/77	No	76		$<1 \times 10^{-10}$
				177		1×10^{-10}
				246		2.0×10^{-10}
				250		$>3 \times 10^{-6}$
				275		$>3 \times 10^{-6}$
				258		8.0×10^{-9}
				230		3.0×10^{-9}
				263		6.0×10^{-7}
				266		1.0×10^{-6}
				272		$>3 \times 10^{-6}$
002		12/6/77	No	250		3×10^{-9}
				234		5.0×10^{-10}
003		12/6/77	No	173		2.0×10^{-10}
				127		1.0×10^{-10}
				80		$<1 \times 10^{-10}$
				245		1.5×10^{-9}
				266		$>3.0 \times 10^{-6}$
				259		10×10^{-9}
				240		1.8×10^{-9}
				217		1.0×10^{-9}
				187		6.0×10^{-10}
				99		2.0×10^{-10}
004	42.766	12/7/77	Yes	73		$<1 \times 10^{-10}$
				244		1.0×10^{-10}
				278		1.0×10^{-10}
				291		1.0×10^{-10}
				113		$<1.0 \times 10^{-10}$
005	42.842	12/7/77	No	76		$<1.0 \times 10^{-10}$
				120		1.0×10^{-10}
				176		2.0×10^{-10}
				219		$>3 \times 10^{-6}$
				190		5.0×10^{-8}
				142		2.5×10^{-9}
				76		8.0×10^{-10}
				75		7.0×10^{-10}
006		12/2/77	Yes	77		$<1.0 \times 10^{-10}$
				151		1.0×10^{-10}
				233		2.0×10^{-9}
				286		2.0×10^{-10}
				296		6.0×10^{-10}
				194		1.0×10^{-10}
006		12/2/77	Yes	86		3.0×10^{-10}

TABLE 20 (Cont.)

Receptacle S/N-	Weight (grams)	Test Date	Accepted Q. C.	Temperature (°F)		Leak Rate Std. cc He/sec-atm	
007		12/14/77	No	70		1.0×10^{-7}	$<1 \times 10^{-10}$
				227	263		$>3.0 \times 10^{-6}$
				239		4.0×10^{-8}	
				218		1.2×10^{-8}	
				192		8.0×10^{-10}	
				148		1.0×10^{-10}	
				128			$<1 \times 10^{-10}$
008		12/14/77	No	86		1.0×10^{-7}	$<1 \times 10^{-10}$
				228	249		$>3.0 \times 10^{-6}$
				233		2.5×10^{-7}	
				211		1.2×10^{-9}	
				202		8.0×10^{-10}	
				160			2.0×10^{-10}
009		12/7/77	Yes	72		3.0×10^{-10}	$<1 \times 10^{-10}$
				147	291		6.0×10^{-10}
				91			5.0×10^{-10}

TABLE 21

TEST RESULTS OF LEAK RATE ACCEPTANCE TESTS OF GULTON ALUMINUM SHELL RECEPTACLES TYPE J-5

Receptacle S/N	Weight (grams)	Test Date	Accepted Q. C.	Temperature (°F)	Leak Rate Std. cc He/sec-atm
051	38.977	12/2/77	No	75	1.2×10^{-6}
051				104	$>3.0 \times 10^{-6}$
051					1.4×10^{-6}
052	39.069	12/2/77	No	77	2.0×10^{-9}
				101	1.2×10^{-8}
				190	5.0×10^{-7}
				220	$>3.0 \times 10^{-6}$
				198	3.6×10^{-6}
				175	1.0×10^{-7}
				154	5.0×10^{-8}
052				77	2.2×10^{-8}
053		12/2/77	No	74	$<1 \times 10^{-10}$
				72	
				85	8.0×10^{-10}
				163	1.0×10^{-9}
				182	4.0×10^{-8}
				198	5.0×10^{-7}
053			No	163	$>3.0 \times 10^{-6}$
				83	7.0×10^{-9}
				78	1.3×10^{-9}
054	39.069	12/19/77	No	76	$<1 \times 10^{-10}$
				133	1.4×10^{-8}
				143	1.4×10^{-7}
				170	3.0×10^{-6}
				148	3.8×10^{-7}
				126	6.0×10^{-8}
054				91	8.6×10^{-9}
055		12/19/77	No	78	$<1 \times 10^{-10}$
				100	1.8×10^{-9}
				146	6.0×10^{-7}
				156	$>3 \times 10^{-6}$
055				143	4.5×10^{-7}
				119	2.9×10^{-8}
				80	5.8×10^{-9}
057		12/16/77	No	78	1.4×10^{-8}
				184	$>3.0 \times 10^{-6}$
				223	3.8×10^{-8}
				185	7.2×10^{-7}
				130	6.0×10^{-8}
057				93	

TABLE 21 (Cont.)

Receptacle S/N	Weight (grams)	Test Date	Accepted Q.C.	Temperature (°F)	Leak Rate Std. cc He/sec-atm	
058		12/19/77	No	75		8.0×10^{-9}
				97		3.5×10^{-8}
				142		1.4×10^{-7}
				187	212	1.3×10^{-6}
				180		1.5×10^{-7}
				136		7.5×10^{-8}
				99		3.0×10^{-8}
059		12/19/77	No	84		1.8×10^{-8}
				154		3.0×10^{-7}
				188	198	3.0×10^{-6}
				179		4.5×10^{-7}
				99		9.6×10^{-8}
060		12/19/77	No	86		2.0×10^{-8}
				159		2.3×10^{-7}
				184	203	1.3×10^{-6}
				183		7.0×10^{-7}
				80		4.4×10^{-8}

TABLE 22

TEST RESULTS OF LEAK RATE ACCEPTANCE TESTS OF GULTON ALUMINUM RECEPTACLES TYPE J-1

Receptacle S/N	Weight (grams)	Test Date	Accepted Q.C.	Temperature (°F)		Leak Rate Std. cc He/sec-atm	
061		12/13/77	No	77		1.0×10^{-9}	1×10^{-10}
				196	229	5.0×10^{-7}	3.0×10^{-6}
				204		5.0×10^{-8}	
				156			
				83			1.2×10^{-8}
062		12/13/77	Yes	75			$<1 \times 10^{-10}$
				121	296		1.0×10^{-10}
							$<1 \times 10^{-10}$
063		12/14/77	No	97		1.4×10^{-9}	$<1 \times 10^{-10}$
				227	242	1.6×10^{-6}	$>3.0 \times 10^{-6}$
				227	250	3.0×10^{-7}	
				208		2.0×10^{-8}	
				191		4.0×10^{-9}	
064		12/15/77	No	127			8.0×10^{-10}
				78			1×10^{-10}
				219		1×10^{-9}	
				234	239	3.0×10^{-6}	$>3.0 \times 10^{-6}$
				201		7.0×10^{-7}	
065		12/15/77	No	170		7.0×10^{-8}	
				109			1.1×10^{-8}
				80			4.0×10^{-8}
				93			
				211	239	1.6×10^{-8}	$>3.0 \times 10^{-6}$
066		12/15/77	No	219		3.8×10^{-7}	
				176		3.8×10^{-8}	
				100			1.1×10^{-8}
				79			$<1 \times 10^{-10}$
				205	246	4.0×10^{-10}	$>3.0 \times 10^{-6}$
067		12/15/77	Yes	195		8.0×10^{-7}	
				167		8.0×10^{-8}	
				91			8.5×10^{-9}
067				79			$<1 \times 10^{-10}$
067				129	296		$<1 \times 10^{-10}$
067							$<1 \times 10^{-10}$

TABLE 22 (Cont.)

Receptacle S/N	Weight (grams)	Test Date	Accepted Q.C.	Temperature (°F)	Leak Rate Std. cc He/sec-atm	
068		12/15/77	No	85	1.0 x 10 ⁻⁹	4.0 x 10 ⁻¹⁰
				124		
				182		
				221		
				226	1.0 x 10 ⁻⁷	> 3.0 x 10 ⁻⁶
				183	9.0 x 10 ⁻⁷	
				94	7.6 x 10 ⁻⁸	
						1.0 x 10 ⁻⁸

TABLE 23

TEST RESULTS OF LEAK RATE ACCEPTANCE TESTS OF GULTON STEEL SHELL RECEPTACLES TYPE J-40

Receptacle S/N	Weight (grams)	Test Date	Accepted Q. C.	Temperature (°F)		Leak Rate Std. cc He/sec-atm						
				70	104	131	161	194	2 x 10 ⁻⁸	7 x 10 ⁻⁷	1 x 10 ⁻⁶	<1 x 10 ⁻¹⁰
003		4/12/78	No	159	119	89			2.9 x 10 ⁻⁶	6.0 x 10 ⁻⁷		>3.0 x 10 ⁻⁶
003												3.0 x 10 ⁻⁸
004		4/14/78	No	Leaked on 3 pins.								
005		4/14/78	No	73	165	200	151	215	1.4 x 10 ⁻⁹	2.0 x 10 ⁻⁶	1.0 x 10 ⁻⁹	<1 x 10 ⁻¹⁰
005				139	122				4.0 x 10 ⁻¹⁰			>3.0 x 10 ⁻⁶
006		4/17/78	No	76	157	180	188	196	1.2 x 10 ⁻⁹	5.0 x 10 ⁻⁸	1.0 x 10 ⁻⁶	<1 x 10 ⁻¹⁰
006				170	145	137	109		2.0 x 10 ⁻⁷	1.0 x 10 ⁻⁹	6.0 x 10 ⁻¹⁰	>3.0 x 10 ⁻⁶
008		4/18/78	No	71	113	169	155	182	1.2 x 10 ⁻⁷	1.2 x 10 ⁻⁶	2.7 x 10 ⁻⁶	1.0 x 10 ⁻⁸
008				104	85	105			4.0 x 10 ⁻⁷		5.5 x 10 ⁻⁹	>3.0 x 10 ⁻⁶
								125				1.6 x 10 ⁻⁹

TABLE 24

SUMMARY TABULATION OF TEST RESULTS FROM LEAK RATE ACCEPTANCE
TESTS OF GULTON ALUMINUM SHELL RECEPTACLES

Receptacle Type & S/N	Leak Rate in std cc He/sec-atm			Determined Thermal Rating (°F)	After Cooldown Resealed	Remarks
	Pre-Test at 70°F	Failed at °F	Leak Rate Prior to Failure			
J-2,-002	$<1 \times 10^{-10}$	250	2.0×10^{-10}	≈ 240	Yes	
	$<1 \times 10^{-10}$	266	1.5×10^{-9}		Yes	
	$<1 \times 10^{-10}$	---	---		---	Passed
	$<1 \times 10^{-10}$	219	2.0×10^{-10}		≈ 190	Yes
	$<1 \times 10^{-10}$	---	---		Above 300	
	$<1 \times 10^{-10}$	---	---		Above 300	
	$<1 \times 10^{-10}$	263	1.0×10^{-7}		≈ 240	Yes
	$<1 \times 10^{-10}$	249	1.0×10^{-7}		≈ 220	Yes
	$<1 \times 10^{-10}$	---	---		Above 300	
J-5,-051	1.2×10^{-6}	136	1.2×10^{-6}	≈ 190	Yes	
	2.0×10^{-9}	220	5.0×10^{-7}		Yes	
	$<1 \times 10^{-10}$	198	5.0×10^{-7}		≈ 160	Yes
	$<1 \times 10^{-10}$	170	1.4×10^{-7}		≈ 140	Yes
	$<1 \times 10^{-10}$	156	6.0×10^{-7}		≈ 140	Yes
	1.4×10^{-8}	223	8.2×10^{-7}		≈ 180	Yes
	8.0×10^{-9}	187	1.4×10^{-7}		≈ 140	Yes
	1.8×10^{-8}	188	3.0×10^{-7}		≈ 170	Yes
	2.0×10^{-8}	184	2.3×10^{-7}		≈ 160	Yes
	1×10^{-10}	229	1.0×10^{-9}		≈ 190	Yes
	$<1 \times 10^{-10}$	---	---		Above 300	
	$<1 \times 10^{-10}$	250	1.4×10^{-9}		≈ 220	Yes
	1×10^{-10}	239	1×10^{-9}		≈ 220	Yes
J-1,-061	4.0×10^{-8}	239	1.6×10^{-8}	≈ 220	Yes	
	$<1 \times 10^{-10}$	246	4.0×10^{-10}		≈ 200	Yes
	$<1 \times 10^{-10}$	---	---		Above 300	
	$<1 \times 10^{-10}$	247	1.0×10^{-7}		≈ 220	Yes
	4.0×10^{-10}	---	---		Passed	
	4.0×10^{-10}	---	---		Passed	

TABLE 25
 SUMMARY TABULATION OF TEST RESULTS FROM LEAK RATE ACCEPTANCE
 TESTS OF GULTON STEEL SHELL RECEPTACLES

Receptacle Type & S/N-	Leak Rate in std. cc H ₂ /sec-atm			Determined Thermal Rating (°F)	After Cooldown Rescaled	Remarks
	Pre-Test. at 70° F	Failed at °F	Leak Rate Prior to Failure			
J-40,-003	$<1 \times 10^{-10}$	194	1×10^{-6}	≈150	Yes	
-004	Gross Leak					
-005	$<1 \times 10^{-10}$	215	2.0×10^{-6}	≈190	Yes	
-006	$<1 \times 10^{-10}$	196	1.0×10^{-6}	≈170	Yes	
-008	1.0×10^{-8}	182	1.2×10^{-6}	≈150	Yes	

TES-33009-47

APPENDIX D

DESCRIPTION AND TEST RESULTS OF TES QUALITY CONTROL LEAK
RATE ACCEPTANCE TESTS OF THE DEUTSCH HERMETICALLY
SEALED STEEL SHELL RECEPTACLES.

DESCRIPTION AND TEST RESULTS OF TES QUALITY CONTROL LEAK
RATE ACCEPTANCE TESTS OF THE DEUTSCH HERMETICALLY
SEALED STEEL SHELL RECEPTACLES.

References: 69) Specifications for Deutsch Receptacle, SIG 110026, Receptacle, Electrical

32) LCP 10030 Fixture Assemblies, Electrical Receptacle, Quality Control Acceptance

34) SIG 110027, Electrical Receptacle Acceptance Test Procedure

Objectives: To document results of TES Quality Control leak rate acceptance tests of 60 new hermetically sealed receptacles manufactured by the Deutsch Company, Banning, California.

Conclusion: Units from the new batch of Deutsch receptacles were qualified as generator flight hardware, based on the excellent leak rate characteristics of 59 units. Twenty of these units were assigned for further testing with functional performance tests.

1. Test Report of Deutsch Receptacles

Reference 69 defined specifications for the maximum allowable leak rate for the Deutsch receptacles as $\leq 1 \times 10^{-8}$ std cc He/sec-atm over a temperature range from -67°F (-89°C) to $+392^{\circ}\text{F}$ ($+200^{\circ}\text{C}$) as the accept/reject criterion. TES Quality Control acceptance procedures required leak rate checks at room and 400°F temperatures for each receptacle unit (100% screening).

Most units showed, for all practical purposes, NDL (no detectable leak rate) and these data were tabulated in Table 26 as $< 1 \times 10^{-10}$ std cc He/sec-atm. Referring to Table 26, one receptacle unit, S/N -807, did not pass the acceptance tests. This unit measured 7×10^{-9} std cc He/sec-atm at 396°F and 7.2×10^{-9} at 361°F and 126°F during cooldown. These measurements were leak rates in helium. If converted for equivalent leak rates in air, the value for 7.2×10^{-9} at 361°F would have been 1.9×10^{-8} std cc He/sec-atm. Therefore, this particular unit was not suitable for hardware application.

Minor variations in leak rate stability occurred with units S/N-801, 805, 811, 825, 830, 836, 839, 843, 847 and 857 during heatup or cooldown. However, these variations were of no significance. Receptacle temperature and leak rate were measured continuously during the tests.

2. Discussion of Test Results from 60 New Deutsch Receptacles

The test results from leak rate measurements of the new Deutsch receptacles were very good and compared favorably with test data of previous receptacle units used as flight hardware for the SNAP 19 Pioneer and Viking program flight generators. The long-

term reliability under thermal aging and temperature cycling still had to be established. For this reason, 20 units of the new batch of receptacles were assigned as representative test samples.

The identical receptacle model, TES P/N 452A6000044-001 (Reference 49) or updated TES P/N SIG 110026-001 (Reference 69) and Deutsch Company P/N 78033-16-26PN, was extensively tested during the SNAP 19 Pioneer and Viking generator receptacle test programs (Table 6). In order to conduct a preliminary analysis of the test results of the 60 new units (Table 26), a comparison is made with the test results of leak rate acceptance tests from these previous test programs during the 1972 to 1975 period.

Figure 24 presents a histogram at 392°F of 127 Viking Deutsch receptacles compiled from results of their thermal leak rate acceptance test. These 127 receptacles were from 7 different batches of receptacles. A comparison with Figure 24 shows a lower leak rate characteristic/distribution for the batch of the 60 new Deutsch receptacles.

Other results of former leak rate acceptance tests are presented in Table 27 (10 Viking Deutsch receptacle units), Table 28 (8 units), Table 31 (8 units), Table 32 (7 units) and Table 36 (20 units). Here again, in this comparison, the 60 new units exhibit a lower leak rate characteristic.

TABLE 26: TEST RESULTS OF LEAK RATE ACCEPTANCE
TESTS OF NEW DEUTSCH STREL SHELL RECEPPIACLES

Receptacle S/N-	Weight (grams)	Test Date	Accepted Q.C.	Temperature °F	Leak Rate std cc He/sec-atm
801 801	38.9942	11/13/78	Yes	75 132	2×10^{-10} 2×10^{-10} 2×10^{-10}
802 802	38.7815	11/13/78	Yes	71 94	1×10^{-10} 1×10^{-10} $<1 \times 10^{-10}$
803 803	38.9641	11/14/78	Yes	72 96	$<1 \times 10^{-10}$ $<1 \times 10^{-10}$ $<1 \times 10^{-10}$
804 804	38.8935	11/15/78	Yes	74 100	$<1 \times 10^{-10}$ $<1 \times 10^{-10}$ $<1 \times 10^{-10}$
805 805	38.7515	11/21/78	Yes	74 135 360 105	1×10^{-10} 2×10^{-10} 2×10^{-10} 2×10^{-10} $<1 \times 10^{-10}$
806 806	39.1185	11/21/78	Yes	77 107	$<1 \times 10^{-10}$ $<1 \times 10^{-10}$ $<1 \times 10^{-10}$
807 807	38.9773	11/22/78	No	74 374 386 388 396 361 126	4.5×10^{-9} 5.1×10^{-9} 5.6×10^{-9} 6.0×10^{-9} 7.0×10^{-9} 7.2×10^{-9} 7.2×10^{-9}
808 808	38.0410	12/1/78	Yes	73 110	$<1 \times 10^{-10}$ $<1 \times 10^{-10}$ $<1 \times 10^{-10}$
809 809	36.8509	12/4/78	Yes	78 151	$<1 \times 10^{-10}$ $<1 \times 10^{-10}$ $<1 \times 10^{-10}$
810 610	36.5312	12/4/78	Yes	79 103	$<1 \times 10^{-10}$ $<1 \times 10^{-10}$ $<1 \times 10^{-10}$
811 811	38.9258	12/4/78	Yes	78 280 322 385 389 367 325 105	$<1 \times 10^{-10}$ 1×10^{-10} 2.0×10^{-10} 1.0×10^{-10} 1×10^{-10} 1.0×10^{-10} $<1 \times 10^{-10}$ $<1 \times 10^{-10}$

TABLE 26: TEST RESULTS OF NEW DEUTSCH RECEPTACLES (CONTINUED)

Receptacle S/N	Weight (grams)	Test Date	Accepted Q.C.	Temperature °F	Leak Rate std cc HE/sec-atm
811 811	38.9258	12/4/78	Yes	78 280 322 385 367 325 105	<1 x 10 ⁻¹⁰ 1 x 10 ⁻¹⁰ 2.0 x 10 ⁻¹⁰ 1.0 x 10 ⁻¹⁰ <1 x 10 ⁻¹⁰ 1.0 x 10 ⁻¹⁰ <1 x 10 ⁻¹⁰ <1 x 10 ⁻¹⁰
812 812	39.0156	12/4/78	Yes	78 135	<1 x 10 ⁻¹⁰ <1 x 10 ⁻¹⁰ <1 x 10 ⁻¹⁰
813 813	39.0158	12/5/78	Yes	73 136	<1 x 10 ⁻¹⁰ <1 x 10 ⁻¹⁰ <1 x 10 ⁻¹⁰
814 814	39.0283	12/5/78	Yes	78 106	<1 x 10 ⁻¹⁰ <1 x 10 ⁻¹⁰ <1 x 10 ⁻¹⁰
815 815	38.9253	12/5/78	Yes	79 392 102	<1 x 10 ⁻¹⁰ <1 x 10 ⁻¹⁰ <1 x 10 ⁻¹⁰
816 816	38.7517	12/6/78	Yes	71 103	<1 x 10 ⁻¹⁰ <1 x 10 ⁻¹⁰ <1 x 10 ⁻¹⁰
817 817	38.9192	12/6/78	Yes	75 102	<1 x 10 ⁻¹⁰ <1 x 10 ⁻¹⁰ <1 x 10 ⁻¹⁰
818 818	38.8805	12/7/78	Yes	74 107	<1 x 10 ⁻¹⁰ <1 x 10 ⁻¹⁰ <1 x 10 ⁻¹⁰
819 819	39.3941	12/7/78	Yes	75 104	<1 x 10 ⁻¹⁰ <1 x 10 ⁻¹⁰ <1 x 10 ⁻¹⁰
820 820	39.0710	12/8/78	Yes	74 97	<1 x 10 ⁻¹⁰ <1 x 10 ⁻¹⁰ <1 x 10 ⁻¹⁰
821 821	38.7224	12/8/78	Yes	74 97	<1 x 10 ⁻¹⁰ <1 x 10 ⁻¹⁰ <1 x 10 ⁻¹⁰
822 822	38.9458	12/11/78	Yes	73 102	<1 x 10 ⁻¹⁰ <1 x 10 ⁻¹⁰

TABLE 26: TEST RESULTS OF NEW DEUTSCH RECEPTACLES (CONTINUED)

Receptacle S/N	Weight (grams)	Test Date	Accepted U.S.	Temperature °F	Leak Rate std cc He/sec-atm
823	38.8748	12/11/78	Yes	77 102	$<1 \times 10^{-10}$ $<1 \times 10^{-10}$ $<1 \times 10^{-10}$
823					
824	38.9248	12/12/78	Yes	74 99	$<1 \times 10^{-10}$ $<1 \times 10^{-10}$ $<1 \times 10^{-10}$
824					
825	38.8799	12/12/78	Yes	74 154 197 258 271 384 371 330 286 239 99	$<1 \times 10^{-10}$ 1×10^{-10} 2×10^{-10} 3×10^{-10} 4.0×10^{-10} 3.0×10^{-10} 2.0×10^{-10} 6.0×10^{-10} 2.0×10^{-10} 1.0×10^{-10} $<1 \times 10^{-10}$ $<1 \times 10^{-10}$
825					
826	38.9602	12/13/78	Yes	72 96	$<1 \times 10^{-10}$ $<1 \times 10^{-10}$ $<1 \times 10^{-10}$
826					
827	39.1220	1/2/79	Yes	75 94	$<1 \times 10^{-10}$ $<1 \times 10^{-10}$ $<1 \times 10^{-10}$
827					
828	38.9774	1/4/79	Yes	72 90	$<1 \times 10^{-10}$ $<1 \times 10^{-10}$ $<1 \times 10^{-10}$
828					
829	38.9420	1/4/79	Yes	75 88	$<1 \times 10^{-10}$ $<1 \times 10^{-10}$ $<1 \times 10^{-10}$
829					
830	38.9867	1/5/79	Yes	72 193 331 293 97	$<1 \times 10^{-10}$ 2.0×10^{-10} 2.0×10^{-10} $<1 \times 10^{-10}$ $<1 \times 10^{-10}$
830					
831	38.7450	1/5/79	Yes	71 94	$<1 \times 10^{-10}$ $<1 \times 10^{-10}$ $<1 \times 10^{-10}$
831					
832	38.9677	1/6/79	Yes	72 96	$<1 \times 10^{-10}$ $<1 \times 10^{-10}$ $<1 \times 10^{-10}$
832					
833	38.6222	1/8/79	Yes	72 94	$<1 \times 10^{-10}$ $<1 \times 10^{-10}$
833					

TABLE 26: TEST RESULTS OF NEW DEUTSCH RECEPTACLES (CONTINUED)

Receptacle S/N-	Weight (grams)	Test Date	Accepted Q.C.	Temperature °F	Leak Rate std cc He/sec-atm
834 834	39.0133	1/9/79	Yes	72 97	$<1 \times 10^{-10}$ $<1 \times 10^{-10}$ $<1 \times 10^{-10}$
835 835	38.6925	1/9/79	Yes	73 96	$<1 \times 10^{-10}$ $<1 \times 10^{-10}$ $<1 \times 10^{-10}$
836 836	38.9544	1/10/79	Yes	74 302 340 375 99	$<1 \times 10^{-10}$ 2.0×10^{-10} 2.0×10^{-10} 1.0×10^{-10} $<1 \times 10^{-10}$ $<1 \times 10^{-10}$
837 837	38.8271	1/11/79	Yes	74 94	$<1 \times 10^{-10}$ $<1 \times 10^{-10}$ $<1 \times 10^{-10}$
838 838	38.8701	1/11/79	Yes	74 95	$<1 \times 10^{-10}$ $<1 \times 10^{-10}$ $<1 \times 10^{-10}$
839 839	38.8701	1/12/79	Yes	75 227 265 298 91	$<1 \times 10^{-10}$ 2.0×10^{-10} 2.0×10^{-10} $<1 \times 10^{-10}$ $<1 \times 10^{-10}$
840 840	39.0418	1/12/79	Yes	70 91	$<1 \times 10^{-10}$ $<1 \times 10^{-10}$ $<1 \times 10^{-10}$
841 841	39.8560	1/15/79	Yes	75 93	$<1 \times 10^{-10}$ $<1 \times 10^{-10}$ $<1 \times 10^{-10}$
842 842	38.7893	1/15/79	Yes	76 90	$<1 \times 10^{-10}$ $<1 \times 10^{-10}$ $<1 \times 10^{-10}$
843 843	38.6669	1/16/79	Yes	70 190 291 325 357 387 148	$<1 \times 10^{-10}$ 2.0×10^{-10} 2.0×10^{-10} 5.0×10^{-10} 2.0×10^{-10} $<1 \times 10^{-10}$ $<1 \times 10^{-10}$
844 844	39.0305	1/16/79	Yes	72 95	$<1 \times 10^{-10}$ $<1 \times 10^{-10}$ $<1 \times 10^{-10}$

TABLE 26: TEST RESULTS OF NEW DEUTSCH RECEPTACLES (CONTINUED)

Receptacle S/N-	Weight (grams)	Test Date	Accepted Q.C.	Temperature °F		Leak Rate std cc H ₂ /sec-atm
845 845	38.3983	1/17/79	Yes	73 147	393	$<1 \times 10^{-10}$
						$<1 \times 10^{-10}$
846 846	38.9295	1/17/79	Yes	70 97	394	$<1 \times 10^{-10}$
						$<1 \times 10^{-10}$
847 847	38.8908	1/18/79	Yes	71 239 274 224 84	394	$<1 \times 10^{-10}$
						2.0×10^{-10}
						2.0×10^{-10}
						$<1 \times 10^{-10}$
848 848	38.8850	1/18/79	Yes	70 84	394	$<1 \times 10^{-10}$
						$<1 \times 10^{-10}$
849 849	39.1432	1/19/79	Yes	71 95	395	$<1 \times 10^{-10}$
						$<1 \times 10^{-10}$
850 850	38.9743	1/19/79	Yes	71 110	395	$<1 \times 10^{-10}$
						$<1 \times 10^{-10}$
851 851	39.1387	1/22/79	Yes	73 88	394	$<1 \times 10^{-10}$
						$<1 \times 10^{-10}$
852 852	38.3413	1/22/79	Yes	71 85	395	$<1 \times 10^{-10}$
						$<1 \times 10^{-10}$
853 853	39.0280	1/23/79	Yes	71 87	395	$<1 \times 10^{-10}$
						$<1 \times 10^{-10}$
854 854	38.8990	1/23/79	Yes	71 87	394	$<1 \times 10^{-10}$
						$<1 \times 10^{-10}$
855 855	38.4996	1/30/79	Yes	72 89	398	$<1 \times 10^{-10}$
						$<1 \times 10^{-10}$
856 856	38.5696	1/30/79	Yes	71 88	395	$<1 \times 10^{-10}$
						$<1 \times 10^{-10}$

TABLE 26: TEST RESULTS OF NEW DEUTSCH RECEPTACLES (CONTINUED)

Receptacle S/N	Weight (grams)	Test Date	Accepted Q.C.	Temperature °F	Leak Rate std cc He/sec-atm			
857	39.0778	1/31/79	Yes	74	$<1 \times 10^{-10}$			
				289	1.0×10^{-9}			
				326	8.0×10^{-10}			
				395	7.0×10^{-10}			
				392	6.0×10^{-10}			
				143	6.0×10^{-10}			
857				90	5.0×10^{-10}			
858	39.0400	1/31/79	Yes	71	$<1 \times 10^{-10}$			
				84	$<1 \times 10^{-10}$			
858					$<1 \times 10^{-10}$			
859	38.2353	2/1/79	Yes	73	$<1 \times 10^{-10}$			
				126	$<1 \times 10^{-10}$			
859					$<1 \times 10^{-10}$			
860	38.8716	2/1/79	Yes	69	$<1 \times 10^{-10}$			
				134	$<1 \times 10^{-10}$			
860					$<1 \times 10^{-10}$			

TABLE 27: VIKING SURPLUS ELECTRICAL RECEPTACLE HISTORICAL DATA

Receptacle Data			Lot Data			
Recpt. S/N	1973 Acceptance Leak Rate @400°F scc he/sec-atm	1978 Acceptance Retest SIG-EWO-181 Leak Rate @400°F scc he/sec-atm	Lot S/N	°F	Thermal Rating scc he/sec-atm	Remarks
337	1.9×10^{-10}	1.0×10^{-10}	7304		Not tested	Lot procured for and used in HPG S/N 2
362	1.6×10^{-10}	2.0×10^{-10}				
363	1.7×10^{-10}	0.0	7314		Not tested	Only receptacle in this lot
364	9.9×10^{-10}	0.0	7346	672	9.0×10^{-9} (S/N 346)	1) Lot used in Viking flight RTG's S/N 111, 112, 113, 114 and 115 2) S/N-364,365,366 and 367 used in SIG/Galileo GDS-1 generator
365	7.6×10^{-10}	0.0				
366	1.5×10^{-10}	0.0		595	1.9×10^{-9} (S/N 353)	
367	1.2×10^{-9}	0.0				
368*	8.7×10^{-10}	0.0		621	7.9×10^{-9} (S/N 322)	Lot used in Viking ETG's S/N 100,103,105 and 106
370*	3.4×10^{-10}	1.0×10^{-10}				
323*	1.5×10^{-9}	2.0×10^{-10}	7250	621	7.9×10^{-9} (S/N 322)	

*Used in SIG/Galileo Receptacle Test Program

TABLE 28: EFFECT OF THERMAL AGING & CYCLE TESTS ON VIKING
DEUTSCH RECEPTACLE LEAK RATE (4/2/74)

(Leak Rate $\times 10^{-10}$ scc he/(sec-atm) @392°F)

LIFE TEST

Receptacle S/N	Pre-Test	Environment	Post-Test
<u>Group 1</u>			
200	13.0*	9826 hrs/2534 cyc	6.3
201	13.0	5828/1220	2.8
202	12.0	9765/2473	8.4
203	4.5	5828/1220	2.9
<u>Group 3</u>			
206	33.0	5523/1076	12.6
209	11.0	5281/1159	12.9
211	3.8	5042/1103	6.0
213	11.0	5281/1159	5.6

THERMAL MARGIN TEST

201	15.0	669°F	42,000**
206	4.0	707°F	6,100
213	5.0	672°F	3,300

*Denotes Leak rate = 1.3×10^{-9} std cc He/sec-atm

**Denotes Leak rate = 4.2×10^{-6} std cc He/sec-atm

TABLE 29: RELIABILITY DEMONSTRATION DIFFUSION BONDED/WELDED VIKING DEUTSCH ELECTRICAL RECEPTACLE (7/8/74)

Recetp. S/N - Fixture Number	Leak Rate After Five Slow Thermal Cycles (scc He/sec-atm)	Thermal Aging Hours in Air @ 370°F	Leak Rate After Air Aging (scc He/sec-atm)	Leak Rate After Five Fast Thermal Cycles (scc He/sec-atm)	Thermal Aging Hrs. in Vacuum @ 370°F	Leak Rate After Aging (scc He/sec-atm)	Thermal Cycles in CO ₂ 150-370-150°F	Leak Rate After Cycling (scc He/sec-atm)	Final Leak Rate (scc He/sec-atm) 392°F	Final Leak Rate 75°F
19 R-4-1 S/N 214	1.4×10^{-9}	1018	6.4×10^{-10}	3.2×10^{-10}	10481	1.9×10^{-10}	1001	8.4×10^{-10}	8.0×10^{-10}	NDL
20 R-7-1 S/N 218	2.9×10^{-9}	1006	2.0×10^{-9}	2.2×10^{-9}	10000	1.5×10^{-9}	1001	7.0×10^{-10}	7.4×10^{-10}	NDL
21 R-5-2 S/N 215	1.3×10^{-9}	1032	1.3×10^{-9}	9.4×10^{-10}	10498	2.0×10^{-10}	1036	7.0×10^{-10}	7.0×10^{-10}	NDL
22 R-5-1 S/N 212	7.8×10^{-9}	1004	9.5×10^{-10}	3.0×10^{-9}	10548	3.0×10^{-10}	1036	3.0×10^{-10}	3.0×10^{-10}	NDL
23 R-7-2 S/N 217	6.8×10^{-10}	1030	8.3×10^{-10}	3.4×10^{-10}	10474	4.9×10^{-10}	1036	9.0×10^{-10}	1.2×10^{-9}	NDL
24 R-6-1 S/N 216	1.4×10^{-9}	1003	9.9×10^{-10}	2.7×10^{-9}	10455	2.1×10^{-10}	1036	6.0×10^{-10}	6.0×10^{-10}	NDL
25 R-3-1 S/N 208	7.8×10^{-10}	1028	9.8×10^{-10}	3.4×10^{-10}	10474	7.8×10^{-10}	1036	8.0×10^{-10}	5.0×10^{-10}	NDL
26 R-8-1 S/N 221	4.0×10^{-10}	1147	8.2×10^{-10}	7.5×10^{-10}	10435	1.9×10^{-10}	1005	2.4×10^{-10}	2.5×10^{-10}	NDL
27 R-3-2 S/N 210	3.1×10^{-9}	1061	3.3×10^{-9}	5.8×10^{-9}	10471	5.1×10^{-10}	1005	5.7×10^{-10}	8.0×10^{-10}	NDL
28 R-6-2 S/N 217	1.6×10^{-9}	1098	1.1×10^{-9}	4.7×10^{-10}	10432	2.9×10^{-10}	1005	5.1×10^{-10}	5.0×10^{-10}	NDL
10 R-1-8 S/N 220	1.0×10^{-9}	1007	1.1×10^{-9}	9.4×10^{-10}	10308	3.5×10^{-10}	1037	3.0×10^{-10}	1.3×10^{-9}	NDL
13 R-9-1 S/N 223	1.5×10^{-9}	1008	6.9×10^{-10}	2.4×10^{-9}	10338	6.3×10^{-10}	1037	7.5×10^{-10}	4.7×10^{-10}	NDL

NOTES:

1. Status as of 7/8/74.
2. NDL - less than 1×10^{-10} .
3. Refer to 452A6000315, Figure 4, for test procedure sequence details.
4. All leak rates measured at 370°F unless otherwise noted.

TABLE 30: VIKING DEUTSCH ELECTRICAL RECEPTACLE APPLICATIONS BY LOT NUMBER (10/8/74)

TES-33009-47

Application	Lot Number				
	O-Ring Flange 7221	Weld Flange			
		7224	7250	7304	7346
<u>TESTS</u>					
Single O-Ring Fixtures 5 and 6	8				
Qualification and Reliability Groups 1, 3, 4 and RX		22			
Pressure Test Assembly		2	2		
Composite Seal Fixtures 2, 3 and 4				3	
Dual O-Ring Fixtures 1-5			4	1	
<u>GENERATORS</u>					
Pioneer "G" RTG's S/N 49-53	5				
HPG ETG S/N 02				3	
Viking Test ETG/RTG's S/N 100, 103-109		1	5	8	
Viking Flight RTG's S/N 111-115	13	25	14	12	5

TABLE 31: VIKING DEUTSCH RECEPTACLE LEAK RATE TEST RESULTS (10/15/74)

(FIRST FLIGHT LOT SET) (sec He/sec-atm)

Identity		Electrical Receptacle			Receptacle / Seal Ring Assembly			Remarks
		Receiving Inspection		Probe	Post-Welding			
Serial No.	Lot No.	≈ 75°F	≈ 392°F	≈ 75°F	≈ 75°F	≈ 392°F	≈ 75°F	
<u>CONTROL SAMPLE</u>								
322	7250	1.6-10 ^{*)}	7.0-10	3.2-10	< 1.0-09	5.4-10	4.9-10	2.0-10
<u>FIRST FLIGHT LOT SET</u>								
342	7346	1.3-10	1.3-10	1.5-10	< 1.0-09	2.7-08	3.6-07	3.9-07
343	7346	1.5-10	2.7-10	1.3-10	< 1.0-09	6.9-10	1.5-09	6.2-10
344	7346	1.9-10	1.3-10	1.3-10	< 1.0-09	4.0-10	8.7-10	3.6-10
345	7346	1.3-10	1.3-10	1.3-10	< 1.0-09	3.1-10	1.5-09	4.4-10
347	7346	1.3-10	1.3-10	1.3-10	≈ 4.7-07	1.1-07	3.1-07	4.3-07
349	7346	1.3-10	6.7-10	1.3-10	≈ 2.9-07	1.2-07	2.5-07	2.7-07
350	7346	1.5-10	6.3-10	1.3-10	< 1.0-09	----- No Test -----		
								RS 7121 Weld defect

*) Denotes leak rate = 1.6×10^{-10} std cc He/sec-atm

TABLE 32: VIKING DEUTSCH RECEPTACLE SEAL LEAK RATE TEST RESULTS (10/15/74)

Viking RTG's S/N 111-115 Receptacle Lot 7346

(Leak Rate in scc He/sec-atm)

Identity	Electrical Receptacle					Receptacle/Seal Ring Assembly			
	Receiving Inspection			Cup Tinning		Post-Welding			Wiring
	≈75°F	≈392°F	≈75°F	Pre≈75°F	Post≈75°F	≈75°F	≈392°F	≈75°F	Post≈75°F
348	1.3-10 *	6.3-10	2.5-10	1.7-10	1.7-10	1.3-09	2.8-09	2.8-09	4.3-10
351	1.3-10	1.1-10	3.9-10	1.7-10	1.7-10	4.5-10	4.2-09	1.8-09	3.1-10
352	1.3-10	6.4-10	6.2-09	1.7-10	1.7-10	1.2-09	7.5-09	1.2-09	9.5-10
354	1.5-09	7.8-10	1.3-10	1.7-10	1.8-10	1.0-09	2.9-09	6.5-10	5.6-10
355	1.3-10	6.5-10	1.3-10	1.7-10	1.8-10	3.3-10	1.8-09	2.3-10	5.6-10
356	1.5-09	5.4-09	1.3-10	1.7-10	1.8-10				
357	1.5-09	1.4-09	7.6-10	1.7-10	1.8-10				

*) Denotes leak rate = 1.3×10^{-10} std cc He/sec-atm

TABLE 33: VIKING DEUTSCH ELECTRICAL RECEPTACLE ASSESSMENT DATA (10/15/74)

	Quantity	≈ Heated Hours		≈ Thermal Cycles	
		300-360°F	365-400°F	Number	Range °F
<u>System Level</u>					
● Viking ETG/RTG	14	32,570		96	360-150
● Pioneer "G" RTG	5	75,150		—	
● High Performance Generator	3	18,990		—	
<u>Subsystem Level</u>					
● Pressure Test Assembly (Thermal Cycle and Pressure)	4	—		68	(100-370°F @ 15 psia)
				12	(100-370°F @ 100 psia)
				8	(15-100 psia @ 70°F)
				6	(15-100 psia @ 370°F)
<u>Component Level</u>					
● Single O-ring Seal	8		130,100	840 *	370-150
● Diffusion Bond Seal Gr 3, Gr 4, Gr RX	18		201,710	16,788 *	370-150
● Composite Seal	3		3,900	160 *	370-150
● Dual O-ring Seal	5		51,260	1,020 *	370-150
<u>Part Level</u>					
● Qualification, Gr 1	4		31,250	7,400 *	370-150
● Thermal Acceptance	129 **		—	129	392-80

* Includes 5 to 20 cycles 370-80°F

** One reject

TABLE 34: VIKING DEUTSCH ELECTRICAL RECEPTACLE ASSESSMENT TEST DATA (10/15/74)

Code No.	Test Identity	Test Procedure	Test Conditions or Criteria	Test Report	Test Qty.	No. Failed	Total Hours	Cycles	Remarks
A. PART LEVEL - RECEPTACLE									
1.	Supplier Qualification	-	1×10^{-8} scc/sec @ 400°F	TR28060	6	0	-	-	Deutsch Electronics
2.	Qualification (Gr. 1)	452A6000315	1×10^{-7} scc/sec @ 370°F	S19V-TW-337	4	0	31237	7447	Fixtures 1-4
3.	Thermal acceptance	452A6000312	1×10^{-8} scc/sec @ 392°F	S19V-LLR-342	129	1	-	-	Receiving inspection
4.	Thermal margin	EWO 6248, 6381	-	S19V-LLR-403	14	*	-	-	Test to failure
B. COMPONENT LEVEL - RECEPTACLE/SEAL ASSEMBLY									
1.	In-process tests								
(a)	Recept/diff. bond	-	Gross	S19V-TW-341	2	0	-	-	S/N 100*
(b)	Recept/composite	452A6000320	1×10^{-7} scc/sec @ 370°F	S19V-MK-325	2	0	-	-	S/N 103
(c)	Recept/dual O-ring	452A6000322	1×10^{-7} scc/sec @ 70°F	S19V-LLR-368	10	0	-	-	S/N 104-109
(d)	Recept/seal ring	452A6000325	1×10^{-8} scc/sec @ 392°F	S19V-LLR-519	25	3	-	8	Post seal ring weld leak test
2.	Engineering tests								
(a)	Recept/diff. bond seal	452A6000315	1×10^{-7} scc/sec @ 370°F	S19V-TW-337	18	0	201710	16788	Fixtures 10, 12-28
(b)	Recept/composite seal	S19V-MK-321	1×10^{-7} scc/sec @ 370°F	-	3	0	3921	161	Evaluation test. Fixtures 1-4
(c)	Recept/O-ring seal	452A6000324	370°F soak	S19V-TW-336	8	0	130108	840	Verification test. Fixtures 5 & 6
(d)	Recept/dual O-ring seal	452A6000324	Cycle + 370°F soak	S19V-MK-385	5	0	51266	1020	Verification test. Fixtures 1-5
C. SUB-SYSTEM LEVEL - PRESSURE TEST ASSEMBLY (1/2 HOUSING)									
1.	Recept/diff. bond seal	NSK 1297	End cooler thermal cycle Pressure 100 psi @ 370°F	S19V-STC-301	2	0	-	24	12 thermal cycles 600°F/hr rising, 300°F/hr falling @ 15 psia. 5 pressure cycles 15 psia to 100 psia, 2 @ 70°F and 3 @ 370°F
2.	Recept/composite seal	S19V-MK-318	End cooler thermal cycle	S19V-MK-365	4	0	-	56	14 thermal cycles 600°F/hr rising, 300°F/hr falling-11 @ 15 psia & 3 @ 100 psia
D. SYSTEM LEVEL - ETG/RTG									
1.	Pioneer 11								
(a)	Flight (4)	-	Launch, staging and space cruise	ESD-TW-3456	4	0	75150	-	Operational mission S/N 49, 51, 52, 53
(b)	Backup (1)	-	-	ESD-TW-3456	1	0	5400	-	Pioneer G backup S/N 50 - defueled
2.	Viking ETG/RTG	-	-	ESD-TW-3456	14	0	32575	96	S/N 100, 103-109
3.	Viking-shock	452A6000410	Pyrotechnic and Mars landing shock	ESD-2960-94	3	0	-	-	Qualification level - S/N 100, 105
4.	Viking-vibration	452A6000414	Random and sine wave vibration	ESD-2960-94	3	0	-	-	Qualification level - S/N 100, 105
5.	High Performance ETG S/N 102	-	-	ESD-TW-3456	3	0	18990	-	
Total					260	4	550,357	26,440	

*Denotes generator serial number.

TABLE 35: SUMMARY VIKING DEUTSCH ELECTRICAL RECEPTACLE THERMAL MARGIN TEST RESULTS (11/9/74)

Part Identity		Test Identity		Test Experience		Leak Rate in sec-He/sec-Atm				Post Test Failure Verification
Serial No.	Lot No.	Procedure EWO	Fixture Type	Total Hours	Total Cycles	Initial Heat-up Deg. F	Leak Rate	Second Heat-up Deg. F	Leak Rate	
<u>Group 1 - Receptacle Qualification</u>										
201	7224	6248	QC-1	5828	1220	645	4.4×10^{-9}	≈ 500	not measured	Pin D, E
						669	failure	80	1.5×10^{-7}	
203	7224	6248	QC-1	5828	1220	605	1.3×10^{-7}	≈ 500	not measured	Pin D
						610	failure	80	failure	
<u>Group 3 - Receptacle/Diffusion Bond Qualification</u>										
206	7224	6381	Lab-16	5523	1103	674	2.2×10^{-8}	648	failure	Pin A
						707	failure	75	failure	
209	7224	6381	Lab-18	5644	1159	704	5.2×10^{-8}	86	1.3×10^{-6}	Pin W
						722	failure			
211	7224	6381	Lab-15	5042	1019	674	1.6×10^{-8}	647	failure	Pin A
						704	failure	105	8.5×10^{-7}	
213	7224	6381	Lab-17	5281	1076	652	1.9×10^{-8}	661	failure	Pin A
						672	failure	80	failure	
<u>Group 4 - Receptacle/Diffusion Bond Reliability</u>										
210	7224	6896	Lab-27	14547	1015	702	2.0×10^{-8}	392	failure	Pins T, S, A
						707	failure	74	failure	
214	7224	6896	Lab-19	14502	1011	632	1.2×10^{-8}	645	failure	Specific location
						668	failure	74	1.2×10^{-7}	
220	7224	6896	Lab-14	14426	1047	602	1.9×10^{-9}	534	failure	Not identifiable
						634	failure	74	3.5×10^{-7}	
221	7224	6896	Lab-26	14597	1015	707	4.0×10^{-8}	392	failure	Pins M, Z
						717	failure	74	failure	
<u>Receptacle Flight Lot "Qualification"</u>										
346	7346	7017	QC-1	≈ 0	1	672	9.0×10^{-9}			Pin c
						673	failure	80	failure	
352	7346	7017	QC-1	≈ 0	1	595	1.9×10^{-9}			Pins R, A, B
						614	failure	80	failure	

TABLE 36: VIKING DEUTSCH ELECTRICAL RECEPTACLE SEAL LEAK RATES (1975)
(10^{-10} scc He/sec-atm)

Identity			Pre-Test	Reliability Test					Post Test
Test Group	Lab Fixture	Receptacle & Seal S/N	Thermal Acceptance (392°F)	After 5 or 10 Slow Cycles (370°F)	After 1000 Hr's Air Soak (370°F)	After 5 or 10 Fast Cycles (370°F)	After 1,000 or 10,000 Hrs Vacuum soak (370°F)	After 1,000 or 2,000 cycles in CO ₂ (370°F)	(392°F)
1.			Receptacle Seal Qualification Test						
	1	200	13.0 *	7.6	4.7	17.0	1.4	3.7	
	2	201	13.0	20.0	13.0	11.0	6.4	1.9	
	3	202	12.0	18.0	7.9	32.0	1.9	6.0	
	4	203	4.5	21.0	7.3	15.0	3.9	1.8	6.2
3.			Diffusion Bonded/Welded Receptacle Qualification Test						
	15	211	3.8	7.7	2.1	2.2	5.2	4.0	2.5
	16	206	33.0	26.0	9.9	16.0	9.5	2.2	6.4
	17	213	11.0	15.0	34.0	40.0	12.0	3.6	4.7
	18	209	11.0	16.0	4.0	39.0	9.4	2.2	9.2
4.			Diffusion Bonded/Welded Receptacle Reliability Test						
	10/14	220	10.0	10.0	11.0	9.4	3.5	3.0	4.7
	13	223	7.0	15.0	6.9	24.0	5.3	7.5	13.0
	19	214	28.0	14.0	6.4	3.2	1.9	8.4	8.0
	20	218	3.8	29.0	20.0	22.0	15.0	7.0	7.4
	21	215	10.0	13.0	13.0	9.4	2.0	7.0	7.0
	22	212	9.6	78.0	9.5	30.0	3.0	3.0	3.0
	23	219	5.8	6.8	8.3	3.4	4.9	9.0	12.0
	24	216	10.0	14.0	9.9	27.0	2.1	5.0	6.0
	25	208	7.0	7.8	9.8	3.4	7.8	8.0	5.0
	26	221	5.1	4.0	8.2	7.5	1.9	2.4	2.5
	27	210	5.0	31.0	33.0	58.0	5.1	5.7	8.0
	28	217	3.8	15.0	11.0	4.7	2.9	5.1	5.0
Statistics									
No. Samples	N=		20	20	20	20	20	20	18
Mean	X=		10.32	18.44	11.49	16.91	5.26	4.83	8.03
Standard Deviation	s=		7.63	15.82	8.42	14.65	3.76	2.37	7.09
Coefficient of Variance %	COV% =		73.9	85.8	73.3	86.6	71.5	49.1	88.3

*Denotes leak rate = 1.3×10^{-9} std cc He/sec-atm.

TABLE 37: VIKING INDIVIDUAL RECEPTACLE/WELD HOURS AND THERMAL CYCLES (1975)

Test Group	Fixture	Recept. S/N Identity	Hours			Thermal Cycles			Remarks
			Recept.	Weld	Weld	Recept.	Weld	Weld	
			Glass-to-Metal	Mg Th-Mg Th	NI 201-20CB3/321	Glass-to-Metal	Mg Th-Mg Th	NI 201-20CB3/321	
1.	Receptacle Seal Qualification Test								
1	200	9816	NA	NA	2534	NA	NA	NA	Receptacle test only
2	201	5828			1220				
3	202	9765			2473				
4	203	5828			1220				
	Sub-total	31237	NA	NA	7447	NA	NA	NA	
2.	Diffusion Bonded/Welded Dummy Receptacle Qualification Test								
6	D20CB3-13	NA	5140	5140	NA	1050	1050	1050	Dummy Receptacle
8	D20CB3-12		6832	6832		1428	1428	1428	
9	D20CB3-11		5741	5741		1174	1174	1174	
5	D321-10		5421	5421		1145	1145	1145	
7	D321-9		6721	6721		1406	1406	1406	
11	D321-7	NA	3804	3804	NA	542	542	542	
	Sub-total		33659	33659		6745	6745	6745	
3.	Diffusion Bonded/Welded Receptacle Qualification Test								
15	211	5042	5042	5042	1019	1019	1019	1019	
16	206	5523	5523	5523	1103	1103	1103	1103	
17	213	5281	5281	5281	1076	1076	1076	1076	
18	209	5644	5644	5644	1159	1159	1159	1159	
	Sub-total	21490	21490	21490	4357	4357	4357	4357	
4.	Diffusion Bonded/Welded Receptacle Reliability Test								
10/14	220	14426	14426	14426	1047	1047	1047	1047	
13	223	14457	14457	14457	1047	1047	1047	1047	
19	214	14502	14502	14502	1011	1011	1011	1011	
20	218	14009	14009	14009	1011	1011	1011	1011	
21	215	14638	14638	14638	1046	1046	1046	1046	
22	212	14660	14660	14660	1046	1046	1046	1046	
23	219	14612	14612	14612	1046	1046	1046	1046	
24	216	14566	14566	14566	1046	1046	1046	1046	
25	208	14610	14610	14610	1046	1046	1046	1046	
26	221	14597	14597	14597	1015	1015	1015	1015	
27	210	14597	14597	14597	1015	1015	1015	1015	
28	217	14545	14545	14545	1015	1015	1015	1015	
	Sub-total	174169	174169	174169	12391	12391	12391	12391	
	Grand total	226896	229318	229318	24195	23493	23493	23493	

TABLE 38: VIKING ETG/RTG DEUTSCH ELECTRICAL RECEPTACLE RELIABILITY ASSESSMENT SUMMARY (3/20/75)

TES-33009-47

Test Condition	Mission Criterion	Test Type	Test Results	Math Model	Reliability 50% CI	Remarks
Elevated temperature design rating	$M_c = 360^{\circ}\text{F}$ (maximum)	Thermal margin (test-to-failure)	$\bar{x} = 673.3^{\circ}\text{F}$ $s = 37.5^{\circ}\text{F}$ $n = 13$	$SM = \frac{\bar{x} - M_c}{s}$	≥ 0.99999	Leak failures occurred between 595 and 706°F
	1.0×10^{-5} sec He/sec-atm at 337°F		2.3×10^{-10} sec He/sec-atm at 337°F	--	--	
Pressure differential	~ 20 psia at 360°F maximum	Qualification (pressure test assembly)	68 cycles at 15 psia and 12 cycles at 100 psia between 100°F and 370°F on four receptacles - no failures	--	--	
			Eight cycles at 70°F and six at 370°F between 15 and 100 psia on four receptacles - no failures	--	--	
Thermal cycle	One cycle between 370-70-370°F at a 600°F/hour rate	Isothermal and thermal cycle life	Five to 10 cycles on 37 receptacles for a total of 217 cycles - no failures	$R = \exp(-x_{.5,2}^2 c/2C)$	≥ 0.9968	
	360 cycles between 370-150-370°F at a 150°F/hour rate		1000 to 2500 cycles on 33 receptacles for a total of 37,511 cycles - no failures		≥ 0.9933	
Thermal aging	18,980 hours (maximum) at 360°F (maximum) including thermal cycles	Isothermal and thermal cycle life	1800 to 20,000 hours on 38 receptacles for a total of 550,430 hours - no failures	$R = \exp(-x_{.5,2}^2 t/2T)$	≥ 0.9761	Hours accumulating at a rate of -10,000 per month
Field operation		Ground and space environment	155,200 heated hours on 28 receptacles in Pioneer 11, Viking and IIPG ETG/RTG's - no failures		≥ 0.9194	
Dynamic	Pyrotechnic and Mars landing shock and Sine and random vibration	Qualification at generator level acceptance at generator level	Two Viking ETG S/N 100 and RTG S/N 103 for qualification level Five Pioneer 11 RTG's and 13 Viking ETG/RTG's at acceptance level no failures			

D-20

TABLE 39: SIG STEEL SHELL ELECTRICAL RECEPTACLE/BIMETAL SEAL RING TEST MATRIX (RELIABILITY ASSESSMENT DATA BASE)

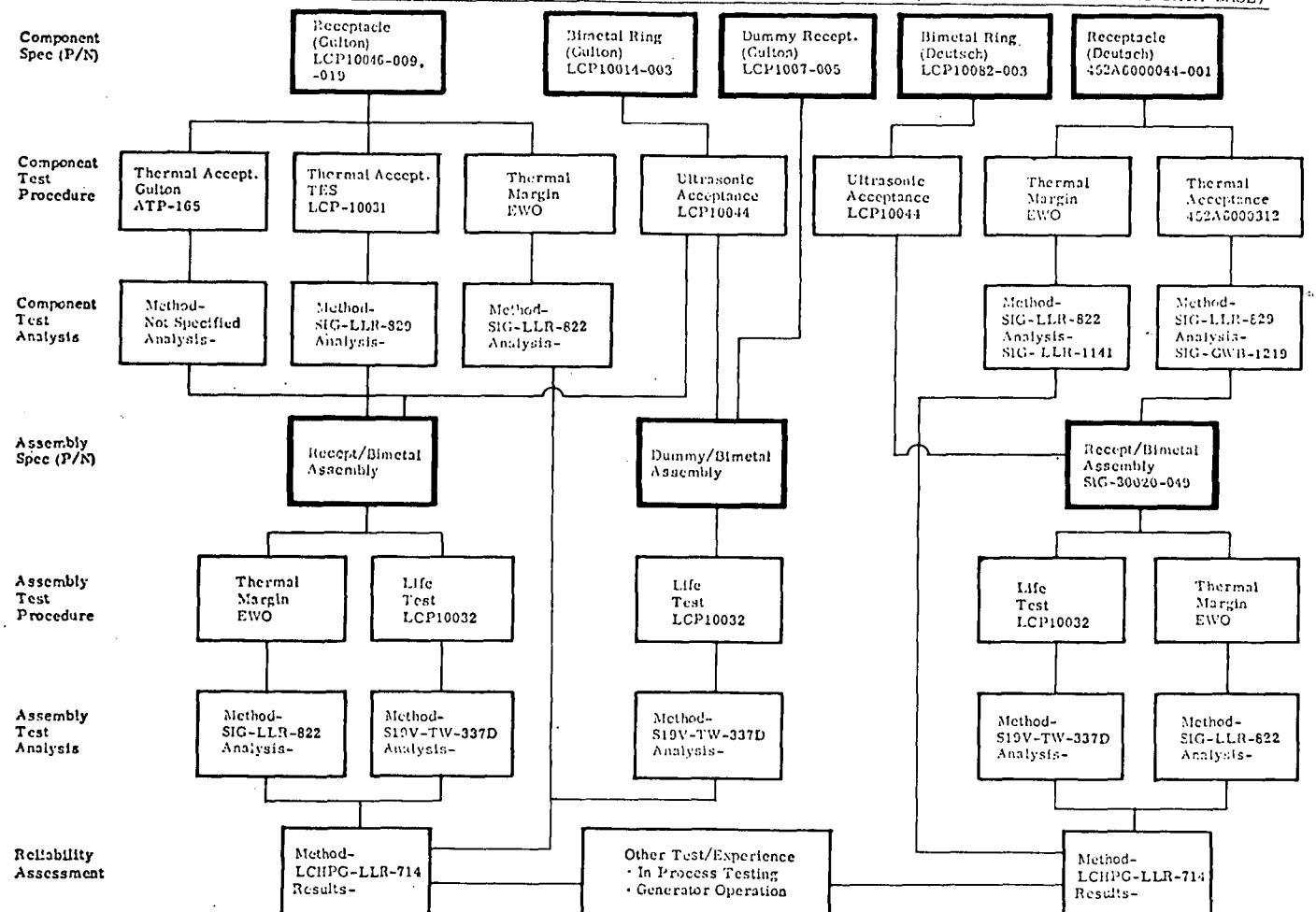


TABLE 40: SIG RECEPTACLE RELIABILITY ASSESSMENT MATRIX

COMPONENT	MISSION OR TEST CRITERIA	TEST DESCRIPTION	SAMPLE QTY	REMARKS
<u>RECEPTACLE-HERMETIC VIKING DATA BASE</u>				
• THERMAL ACCEPTANCE	LEAK RATE $\leq 1.0 \times 10^{-6}$ SCC He/Sec-atm AT 337°F FOR 18,000 HOURS FOLLOWED BY 360 MINIMUM CYCLES BETWEEN 150/360°F AT A MAXIMUM 8 P OF 20 psi.	INSPECTION ACCEPTANCE	129	AV. 2.3×10^{-10} SCC He/Sec-atm AT 400°F
• THERMAL RATING		THERMAL MARGIN (DESTRUCTIVE)	12	GROSS LEAK AT 673°F AV.
• THERMAL AGING		LIFE 18,000 HR. AT 360-400°F	38	TOTAL 550,000 HRS. (1,800-20,000 HRS/UNIT)
• THERMAL CYCLES		LIFE 360 CYCLES 360/150°F	33	TOTAL 37,500 CYCLES (1,000-2,500/UNIT)
• PRESSURE		QUALIFICATION	4	6 CYCLES 15-100 PSID AT 370°F AND 12 CYCLES 100-370°F AT 100 PSID
• FLIGHT EXPERIENCE		PIONEER 11 VIKING 1 AND 2	4 2 EA.	~ 200,000 OPERATING (SPACE) HOURS ~ 110,000 OPERATING (SPACE) HOURS
<u>SIG DATA BASE</u>	LEAK RATE, AT 0.95 PROBABILITY AT 50% CONFIDENCE LEVEL, OF $\leq 1.0 \times 10^{-9}$ SCC He/Sec-atm AT 257°F FOR 8,760 HOURS MAXIMUM AT A MAXIMUM 8 P OF 24 psi AND < 10 THERMAL CYCLES.	INSPECTION ACCEPTANCE	60	AV. 1.5×10^{-10} SCC He/Sec-atm AT 400°F ON FIRST (4) UNITS TESTED.
• THERMAL ACCEPTANCE		THERMAL MARGIN (DESTRUCTIVE)	14	
• THERMAL RATING		LIFE TEST UP TO 8,000 HOURS AT 300°F AND 400°F WITH THERMAL CYCLES TO 150°F	13	
<u>BIMETAL SEAL RING</u>				
• THERMAL AGING	LEAK RATE $\leq 1.0 \times 10^{-9}$ SCC He/Sec-atm AT 257°F FOR 8,760 HOURS MAXIMUM AT A MAXIMUM 8 P OF 24 psi AND A LOW TBD	ACCELERATED TEMPERATURE - TIME KINETIC PROPERTIES OF BOND ZONE DIFFUSION INTERACTION	48	TEN YEARS USEFUL LIFE PREDICTED AT OPERATING TEMPERATURE OF 257°F.
• STRUCTURAL STRENGTH	STRENGTH FOR 7 YEARS AT 257°F MAXIMUM	BOND TENSILE STRENGTH VERSUS AGING TEMPERATURE AND TIME PROPERTIES	20	ULTIMATE TENSILE STRENGTH 48ksi AFTER AGING AT 300°F FOR 24 HOURS.
• THERMAL AGING WITH CYCLES		LIFE TEST UP TO 10,000 HOURS AT 300°F AND 400°F WITH THERMAL CYCLES TO 150°F	23	TOTAL OF 30,000 HOURS AT 300-400°F AND 300 CYCLES BETWEEN 300/150°F AND 400/150°F FOR TEN UNITS ON TEST.