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APPARENT STRAIN TESTS CONDUCTED
ON MICRODOT WELDABLE STRAIN GAGES

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1. INTRODUCTION

This report summarizes the results of apparent strain tests conducted on both temperature-compensated and uncompensated Microdot weldable strain gages as requested by the Sensor Application Engineering group (Ref: Letter IC-4198, dated May 6, 1965). The purpose of the test was to establish repeatability and absolute apparent strain values for a temperature range of -320°F to +80°F for the gages described in Paragraph 2.

2. BACKGROUND INFORMATION

The following background information is extracted from the above-referenced IC letter:

"The results of the performance tests conducted by Microdot Incorporated on purchase orders 59WG-41654 and 49NG-43378, and the results of WANL testing on mounted strain gages had raised some doubts about the ability of the supplier to accurately predict the apparent strain versus temperature characteristic of these strain gages with a high degree of reliability.

"The present method of compensation consists of heat treatment of the finished gage to obtain a predetermined value of unmounted terminal slope. The terminal slope value is determined by experiment initially. This system is valid for compensation only if the curve between the terminal points is repeatable. According to Microdot this is the case based on their experience with a large number of samples.

"Sensor Application Engineering did not share Microdot's confidence in their own compensating ability and raised the question as a result of the performance test data in which three out of fifteen gages appeared to be improperly compensated for the intended base material. After considerable correspondence and negotiating, Microdot offered to demonstrate to WANL engineering the fact that this type of gage has a consistent temperature characteristic and that it is fully capable of being compensated accurately. This demonstration took place on April 7, 1965 at the South Pasadena Plant of Microdot. The results of this demonstration were inconclusive. After the demonstration, the test piece was given to Sensor Application Engineering for our further evaluation. The test piece consisted of four uncompensated gages selected at random by Microdot and mounted on a piece of type 321 Stainless. Also included is a Chromel Alumel thermocouple for temperature measurement."

The test piece was then given to Reactor Component Sensor Development for further testing and evaluation. In addition, it was requested that a similar test piece be prepared using gages selected at random from those presently in NERVA stores. These gages were to be mounted to a base material and subjected to a temperature range for which they were theoretically compensated. Three 977D741-H03 gages mounted on 7079-T6 aluminum were selected for this purpose. These gages are specified as being compensated for 7079-T6 aluminum over the temperature range of -320°F to $+80^{\circ}\text{F}$.

3. TEST PROCEDURE

The mounted gages were submerged in liquid nitrogen and were then permitted to warm-up gradually. Figure 1 shows the test circuit employed and the various components of the test system. A shunt resistor calibration procedure was employed to calibrate the

X-Y recorder as to vertical or Y-axis deflection. The horizontal axis was driven by a chromel alumel thermocouple. The calibration was performed with the aid of a thermal voltage output table and is based on the linearity of the horizontal amplifier.

Each gage was checked three times for repeatability.

4. TEST RESULTS

Figure 2 shows an average of three curves for each uncompensated gage tested.* The repeatability is fair; the maximum deviation between any point for the three runs was approximately 100 microinches/inch.

Figure 3 indicates the average apparent strain obtained for the 977D741-H03 gages. Here again, the plots show an average of three runs per gage.* Repeatability was fair (within 100 microinches/inch) and maximum apparent strain readings for an arbitrary assigned zero line were as follows:

Gage 1 $\pm$ 200 Microinches/inch

Gage 2 $\pm$ 200 Microinches/inch

Gage 3 $\pm$ 330 Microinches/inch

5. CONCLUSIONS

It is readily apparent from the curves obtained for the compensated gages that none of them met the E-Spec requirement of a maximum apparent strain of $\pm$ 100 microinches/inch. However, these tests were conducted on a limited number of strain gages and it is not possible to determine any meaningful quantitative relationships on the percentage of gages that exceed the apparent strain E-Spec requirement for a given shipment of deliverable hardware.

* Exact curves for all individual runs are available for review by interested persons.

It should be further noted that the amount of acceptable apparent strain is largely dependent upon its intended application on the NERVA reactor. For example, an apparent strain of ± 200 microinches/inch may be quite acceptable for lateral support spring applications where the maximum strains run as high as 4500 microinches/inch, but would present a significant error for tie rod applications where the maximum strains run approximately 1500 microinches/inch. Hence, it is recommended that consideration be given to revising the E-Spec so as to stipulate the amount of apparent strain acceptable for each type of gage.

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FIGURE 3