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NASA TECH BRIEF

Minimum Permissible Leakage Resistance Established for Instrumentation Systems

The problem:

When an instrumentation system has been exposed to the elements, its leakage resistance to ground is appreciably affected to the detriment of system precision. Previously, such exposed systems have been dried out until leakage resistance to ground approaches infinity. This often far exceeds the precision/frequency requirements of a given system and thus results in a waste of time and money.

The solution:

Mathematical formulas are used to determine if, and to what extent, a given system should be dried out to restore minimum permissible leakage resistance.

How it's done:

One example is a system that uses transducers associated with a strain gage bridge network. The power supply minus lead of the bridge network is grounded at the test stand. Leakage from one of the bridge output leads to the stand ground unbalances the bridge. If the amount of leakage during a test changes sufficiently, the test data is invalid. Invalid data is readily identified by a significant zero shift and significant difference between post-test and pre-test electrical unbalance.

In a pressure measuring system that measures one megohm leakage to ground, system precision must not deteriorate by as much as 20%, i.e., 0.0005 (0.2 × 0.0025). To determine whether the system should be dried out or the test run without this precaution, the following formula is employed:

$$\Delta R = \frac{(10^6)^2\Omega}{10^6 + \dfrac{0.8(35{,}000)}{0.0005}}$$

$$\Delta R = 17{,}550\,\Omega$$

Where: ΔR = Change in leakage resistance during test.

This example shows that if the leakage resistance increased or decreased 17,550 ohms from the initial value of 1 megohm during test, system precision would deteriorate 0.05%. Because 17,550 ohms represents only a 1.755% change, it is likely that the leakage resistance would change by this amount. In this case, the system would be dried out before running the test.

Assuming the system dried out so that leakage to ground measures 10 megohms, the question of whether to further dry out the system or run the test is resolved by the following:

$$\Delta R = \frac{(10^7)^2\Omega}{10^7 + \dfrac{0.8(35{,}000)}{0.0005}}$$

$$\Delta R = 1.5\text{M}\Omega \text{ or } 15\% \text{ change.}$$

In this case the test would be run without further drying since it is unlikely the leakage resistance would change as much as 15% during test.

When it is assumed the leakage resistance will not change more than 20% during a test, and that a deterioration in precision of 20% of the precision classification of the system can be tolerated, the following determines the minimum permissible leakage resistance:

$$R_L = \frac{R_c}{NP}$$

Where: R_L = Minimum permissible leakage resistance; R_c = Resistance of electrical unbalance resistor for 80% deflection; N = Number of electrical unbalance resistors; P = System precision classification (0.0025, 0.005, 0.01, 0.02, etc.).

(continued overleaf)

Notes:

1. Formulas may be derived to be used for an indeterminate number of instrumentation systems that are exposed to moisture penetration.
2. Inquiries concerning this innovation may be directed to:

   Technology Utilization Officer
   Marshall Space Flight Center
   Huntsville, Alabama 35812
   Reference: B66-10397

Patent status:

No patent action is contemplated by NASA.

Source: J. L. Perrin
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