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NASA TECH BRIEF

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Computer Modeling of Arc Drivers

A computer program that uses nonlinear circuit analysis provides accurate models of the electrical discharge performance of pulsed-energy-storage and arc-driver systems. The program is particularly useful for computing arc discharge properties as a function of a variety of circuit and arc conditions. The investigation of the effect produced by adding mass to the driver gas has led to the development of a dynamic discharge arc driver by which there can be realized a significant improvement in the generation of strong shock waves by arc drivers. For example, with adequate arc resistance and the proper mass in the driver gas, shock Mach numbers as large as 15 can be generated (in a half-atmosphere of air) for study of hydrometeor/shock interaction phenomena.

The model is generated from a description of the element connections involved in the complete arc network, a list of corresponding circuit element values, a description of the circuit current excitation (i.e., arc-discharge waveform), and a list of the outputs desired. The current that flows in the circuit must be obtained by experimental measurement because its waveform is determined by the structure of the capacitor storage system, the driver geometry, and the preset driver conditions (voltage, type of gas, pressure, trigger wire, etc.).

In a first stage of the program, the voltage across the arc chamber is calculated as required by the measured current waveform. The energies absorbed in the cabling, fuses, and arc chamber as a function of time are also computed. Additionally, various related system parameters of interest can be tabulated or plotted; for example, the effective arc resistance, the temperature rise and resistance increase in the fuses, and the derivative of the circuit current. The first-stage calculations are independent of prior knowledge of the arc resistance or inductance.

The second stage of the program requires the selection of a reasonable distribution of arc inductance as a function of time. Once the impedance has been defined, the corresponding values of arc resistance are obtained, based on the current and the arc voltage. The cut-and-try selection is useful because it provides the designer with the progressive series of variations in circuit response that correspond to changes in arc parameters. Also, destructive excitation can be applied to the modeled circuit, so that there is no risk of damage to an expensive capacitor bank.

Note:

Requests for further information may be directed to:

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