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NASA TECH BRIEF

Lewis Research Center

Computer Program Optimizes Design of Nuclear Radiation Shields

A revised computer program, OPEX II, optimizes the design of nuclear radiation shields by determining the minimum weight, volume, or cost for the shield. The original program, OPEX, used the steepest-descent method but was limited to slab geometry. The new program incorporates improved coding, simplified data input, the use of spherical geometry, an expanded output, and the capability of altering the dose-thickness relationship when a shield layer has been removed.

When radiation components are not independent, which is generally the case for secondary gammas generated by neutron absorptions and inelastic scatters throughout the shield, numerical iterative methods must be employed to optimize radiation shield designs. OPEX II uses a technique called the method of steepest-descent.

The method assumes an empirical analytical expression, called the dose-thickness relationship, which relates the radiation dose at some reference detector point to all thicknesses of material present. The parameters in this expression are obtained by fitting them to some accurate, detailed radiation-transport calculations of dose for a given base configuration and perturbations of that configuration. The geometry and material thickness determine the weight and the derivative of the weight with respect to thickness. Using the first derivative of the weight and the dose with respect to thickness as determined from the dose-thickness relationship, the optimization procedure alters the base configuration to obtain a set of thicknesses corresponding to a minimum weight configuration for a given dose constraint.

Notes:

1. Program documentation includes a complete description of how to obtain the necessary input data for OPEX II from other radiation transport calculations. Data-input instructions, FORTRAN IV coding, and a sample problem for optimizing a seven-layer shield of tungsten and lithium hydride in a space power reactor are also included.
2. This program is written in FORTRAN IV for use on the IBM 7094-2.
3. Requests for further information may be directed to:

   COSMIC
   112 Barrow Hall
   University of Georgia
   Athens, Georgia 30601
   Reference: B71-10400

Patent status:

No patent action is contemplated by NASA.

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Category 09