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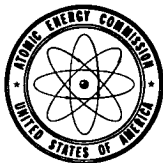
AEC-NASA TECH BRIEF

SOC-DS Computer Code Provides Tool for Design Evaluation of Homogeneous Two-Material Nuclear Shield

The problem:

To develop a simple and inexpensive method to select a nuclear shield material of optimum volume, weight, or cost to meet the requirements of a given radiation dose rate or energy transmission constraint. Selection of shield materials previously required costly computer runs, using transport, point kernel, or other applicable codes. Plotting and data reduction from such codes were tedious and time consuming operations.

The solution:

The SOC-DS Code (Shield Optimization Code— Direct Search), which is applicable to evaluating neutron and gamma ray shields for fixed station, mobile, or space reactors.

How it's done:

A shielding-materials comparison and optimization method has been developed which determines the amount or thickness of any two materials that will result in a minimum shield weight, volume, or cost. The method has been automated in the SOC–DS that provides an economical survey tool for finding the optimum volume fraction for minimum weight, volume, or cost for a homogeneous two-material shield to meet a given radiation dose rate or energy transmission constraint. The code considers the attenuation of fast and thermal neutrons and gamma rays incident on the shield as well as leakage of neutrons slowed down and secondary gamma rays produced in the shield.

The radiation attenuation model is basically exponential for the incident neutrons and gamma rays with a simplified age approximation for determining the slowed-down neutron component. Secondary gamma rays produced in the shield by incident thermal and slowed-down neutrons are treated in two groups. The optimization method employed is an alternating pattern and exploratory search routine which contains simple acceleration and deceleration parameters for performing search moves.

The optimization code finds the optimum volume fractions for minimum weight of a homogenized mixture of neutron and gamma ray shielding materials. The code may be constrained in emergent dose rate, energy, or volume fraction and will find a minimum mass, volume, or material cost to satisfy the constraint. If both dose rates and volume fraction are constrained, the code will find the required thickness or volume. This output may be automatically plotted as well as printed.

This method has been used to compare over 50 combinations of shielding materials as an aid in selecting lightweight shields for detail evaluation. When compared to more rigorous neutron and photon S_n transport analysis, which included a coupled routine for generating secondary gamma ray sources, SOC-DS (1) correctly predicted the order of the various materials when arranged by weight for a given attenuation and (2) found the optimum volume fraction of the two materials. These computations generally resulted in a conservative (overestimated) shield thickness.

Some of the important features of the method are:
1. consideration of shield secondary gamma rays,
2. consideration of neutron slowing down in the shield,
3. allowance to adjust for potential energy release of neutrons escaping the shield,

(continued overleaf)

4. plot of data for evaluation of off-optimum volume fractions, and
5. very little computer time.

Notes:

1. This program is written in Fortran IV and MAP for use on the IBM 7094 computer.
2. Inquiries concerning this program may be made to:

> COSMIC
> Computer Center
> University of Georgia
> Athens, Georgia 30601
> Reference: B67-10537

Patent status:

No patent action is contemplated by AEC or NASA.