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SDC - A SHIELDING DESIGN CALCULATION CODE FOR FUEL HANDLING FACILITIES*

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ABSTRACT

SDC is a FORTRAN II code for the IBM-7090 which was written to perform at least 90% of the basic gamma shielding calculations required for chemical processing and fuel handling facilities. This code was designed to eliminate most of the tedium of performing shielding computations by hand without the subsequent substitution of complex instructions for data preparation or machine handling. The simplified data sheet should allow use of this code by almost anyone connected with fuel handling even if he has had little or no shielding or computer experience.

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The code was designed to handle 16 different source geometries shielded by slab shields. An additional six source geometries in which the source is submerged in the shielding material (e.g. fuel elements stored in a canal) are included. Space was allotted for 17 different materials that may be selected for shield, clad, or source. In addition to the material options, three different types of calculations involving laminated shields of up to ten laminations can be performed. Two major options in the code permit calculation of (1) required shield thickness when a dose rate target is specified, or (2) dose rate when the shield thickness is given. Calculation of dose rates from unshielded sources as well as surface intensities for cylinders and spheres is also included. As many as 12 gamma energy groups, covering an energy range of 0.25 to 10 Mev with corresponding source strengths, may be included in the calculation. The source strengths may be varied for a given source-shield geometry by adding new source cards.

Integration of the basic exponential attenuation point kernel over the various geometries was the method chosen to calculate the uncollided gamma flux. The biological dose rate was obtained by multiplying this value of flux by the product of a dose conversion factor and a flux weighted buildup factor to account for all dose point-to-source path lengths. This method of attack was used instead of a more sophisticated model in order to allow incorporation of all 22 geometries in one basic code.

The code supplies many calculational features as built-in data: (1) E and F functions were calculated by special subroutines. (2) Self-absorption coefficients for large distances from source (both cylinders and spheres) were evaluated from the data and fitted to a polynominal by the method of least squares. (3) Self-absorption factors for small distances from the source were obtained from the curves presented in several sources,[1,2,3] the values were tabulated, and a double interpolation subroutine was written to evaluate the self-absorption coefficient. (4) Total linear attenuation coefficients were taken from various sources for the listed material options (linear interpolation is used to find intermediate values from these tables). (5) Dose buildup factors were obtained either directly from the literature or calculated and/or estimated from other data in the literature, with double interpolation used to obtain intermediate values.

The basic makeup of the code consists of (1) a calling program, (2) the calculation subroutines which perform the individual source geometry calculations, (3) standard and special mathematical subroutines, (4) standard and special input-output subroutines, and (5) a double interpolation subroutine to perform table lookup operations. Linear fractional iteration is used to find the required thickness of shield when a dose rate target is given.

This code has been used successfully to evaluate shield thickness and/or dose rates for several design jobs at the Oak Ridge National Laboratory. The average machine time has been less than 0.01 hour per case.

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2. T. Rockwell, "Reactor Shielding Design Manual," TID-7004 (1956).
3. J. Moteff, "Miscellaneous Data for Shielding Calculations," APEX-176 (1954).

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