CCA – 101*

1. Name of Code: Monte Carlo Program 15-2 (NMPO No. 648)
2. Computer and Programming System: IBM 7090 and 7094—FAP
3. Nature of Code: Program 15-2 calculates the energy spectrum and angular distribution of gamma rays at a point detector due to single and multiple scattering in air from a monoenergetic, monodirectional point source. The single-scattering contribution to the detector energy-angle distribution is computed by numerical integration. Second- and higher-order scattering is determined using Monte Carlo techniques.

   First-collision points for the Monte Carlo calculation are obtained using systematic sampling. Subsequent collision points are determined randomly. A quota sampling scheme is used to allow a more intensive study of those histories that contribute the most error to the problem. Scoring is done at second- and higher-order collision points using a statistical estimation technique. Optional variance reduction techniques are: biased sampling of the scattering angle from an isotropic distribution with weighting according to the Klein-Nishina relationship; and exponential transformation depending on the energy, position and direction of the gamma ray with respect to the detector.
4. Restrictions: Number of detector energy intervals ≤ 30
   Number of detector polar-angle intervals ≤ 30
   Number of detector azimuthal-angle intervals ≤ 4
   Number of multiple collisions per history ≤ 50
5. Machine Requirements: 32-K core memory, 2 magnetic-tape units.
6. Typical Running Time: Computation times are quoted in DC 60-10-150 for preliminary calculations with an earlier version of this code on an IBM 704.
7. Status: Production. Code package CCC-4 is available from Radiation Shielding Information Center, Oak Ridge National Laboratory, Oak Ridge, Tennessee.
8. *References*:

[1]N. R. Baumgardt, A. Trampus and J. E. MacDonald, "Program 15-2, Monte Carlo Calculation of Gamma Ray Scattering in Air," XDC 61-5-1.

[2]M. A. Capo, "Determination of Suitable Parameters for Compiling Gamma Ray Air Scattering Probabilities," DC 60-10-150, (October, 1960).

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1. Code Name: Point Kernel Programs 14-0, 14-1 and 14-2 (NMPO Nos. 69, 70 and 71)
   Data Check Program 14-3 (NMPO No. 128)
2. Computer and Programming System: IBM 7090 and 7094—FAP
3. Nature of Problem Solved: Programs 14-0, 14-1 and 14-2 evaluate point kernels and integrate trapezoidally over source regions to perform reactor-shield penetration calculations for neutrons and gamma rays. Neutron and gamma-ray fluxes, spectra, and dose and energy absorption rates can be optionally computed by Programs 14-0 and 14-1 for positions in and around complex shields containing multiple sources described in a cylindrical-coordinate system. Program 14-2 can be used for sources described in a rectangular-coordinate system. Reactor-shield weight can also be computed.

   Reactor and shield geometries are described by combinations of regions formed by rotation of rectangles and trapezoids about the reactor-shield axis or parallel axes or by translation of convex quadrilaterals parallel to any axis of the rectangular-coordinate system. Compositions are expressed as volume fractions for each material in the assembly. Source density distributions are described in Program 14-0 by either cosine or exponential functions. Source densities are described in Programs 14-1 and 14-2 by tabular input.

   Program 14-3 performs an extensive check of input data to Programs 14-0, 14-1 and 14-2 for range of values, sign, sequencing and completeness.
4. Method of Solution: A modification of the Albert-Welton theory of neutron attenuation is

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