Computer Code Abstract

BMC-I: The Battelle Monte Carlo Code

1. Name: BMC-I (Battelle Monte Carlo Code).
2. Computer: The BMC Code is designed to operate on the UNIVAC 1108 computer system. Approximately 65K words of core are required.
3. Problem Solved: The BMC code is a general purpose neutronic Monte Carlo Code. The code was developed primarily for use in solving some of the more complex problems encountered in predicting the neutronic characteristics of thermal reactors. Some of the problems which the BMC code has been used to solve are: lattice cell parameters such as resonance escape, thermal utilization, and cross-section averaging, criticality problems, power distributions, shielding problems, and first flight collision probabilities.

   The BMC code is flexible as to the size and type of problem solved and the cross section and geometry detail which may be used. The neutron fluxes and reaction rates in the energy range from 0 to 10 MeV are calculated in one, two, or three space dimensions. Statistical confidence limits are assigned to the results. The cross sections utilized in the BMC code are processed from data in the ENDF/B format.
4. Method of Solution: Analog Monte Carlo techniques are used to determine neutron histories. The neutron fluxes, reaction rates, and leakage are obtained from the histories by using an exponential track length estimator. Variance reduction techniques such as absorption weight ratioing, importance weighting, and Russian Roulette are also available.

   The reactions which are treated are fission, capture, anisotropic, isotropic, and thermal elastic scattering, and inelastic $n - n'$ and $n - 2n$ reactions. Thermal scattering makes use of the ideal gas model with a corrective technique to account for thermal binding effects.

   The cross sections are defined using micro-group averaged cross sections. The resonance cross sections can also be treated at each energy using the Doppler broadened Breit-Wigner resonance formulas.

   The geometry is defined using regions enclosed by planes, cylinders, spheres, or boundaries of the form $A(X - X_0)^2 + B(Y - Y_0)^2 + C(Z - Z_0)^2 - K = 0$. Provisions are made for voids and for reflecting symmetry boundaries. A general source routine is available for starting the neutrons. For eigenvalue problems, the fission neutrons are used as the source. Statistics are obtained on all calculated quantities by processing batches and taking a standard deviation of the results from each batch. A special geometry routine is included for a square array of clad fuel rods. The fuel in each rod may be different.

   The BMC code contains restart capability so that the results can be examined at a number of steps in the calculation.
5. Restrictions on the Complexity of the Problem: The BMC code was designed to make it easy to change the dimensions and, hence, make it available for a large range of problem types. A typical problem might have 5 materials, 30 geometry regions, 10 tally regions, and 190 energy groups with 60 energy groups below 1.0 eV. However, problems have been run with 2 materials, 132 geometry and 132 tally regions, and 96 energy groups; and with 10 materials, 60 geometry and 40 tally regions, and 190 energy groups.

   Another restriction is imposed by the approximate model used for the thermal scattering. It has been developed for light and heavy water at 293°K. To use it at other temperatures or for other moderators requires special cross-section preparation.
6. Typical Running Time: As with all Monte Carlo Codes, the running time for the BMC code is very dependent on the complexity of the problem. The time varies from 2 to 10 min for the simplest problems up to several hours for the more complex problems. Typical times for single rod lattice cells would be in the range of 2 to 20 min while that for a power distribution in a fuel bundle would be in the range of $\frac{1}{2}$ to $1\frac{1}{2}$ h.
7. Unusual Features of the Program: The BMC code uses data in the ENDF/B format so use can be made of the ENDF/B data files. Also, the BMC code does a complete energy calculation from fast to thermal.
8. Related and Auxiliary Programs: The BMC code is an update of the Monte Carlo part of the RBU code which was coded in machine language for the IBM-7090-7094 computer system. The BMC code package consists of three codes: BMC, BMCLIB, and LIBR. BMC is the Monte Carlo code. The BMCLIB code is used to process cross sections from the ENDF/B format and prepare a cross-section library for the BMC code. The LIBR code can be used to make corrections to or listings of the BMC cross-section tape. The LIBR code makes use of the generalized input routine, NAMELIST.
9. Status: The BMC code is in production use on the UNIVAC-1108 computer at Pacific Northwest Laboratory, Richland, Washington.
10. Machine Requirements: Approximately 65K words of directly addressable core storage are required by the program. Approximately 1 000 000 decimal words of scratch drum space are needed. Three tapes are needed in addition to the card reader and printer. A Calcomp plotter is required to exercise the plotting options of the code.

11. Programming Language Used: The program is coded primarily in Fortran-V (95%) and SLEUTH (5%).

12. Operating System: UNIVAC 1108 computer with Fortran-V compiler and CSCX operating system. The Calcomp plotter model 763 is used for the plotting options.

13. Program Information: The BMC code and the BMCLIB code each consist of approximately 50 subroutines. They make use of overlay links to conserve on memory requirements. The LIBR code is a smaller code of approximately 12 subroutines. The entire code package is contained on about 14 000 cards.

14. User Information: The BMC code and report may be obtained either from the Argonne Code Center at Argonne National Laboratory or from Pacific Northwest Laboratory in Richland, Washington.

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16. *References:*

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