RAMA, RADIATION ANALYSIS MODELING APPLICATION

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ABSTRACT

1. **Program Name and Title:** RAMA, Radiation Analysis Modeling Application.

2. **Computer for Which Program is Designed and Other Machine Versions Available:** RAMA has been developed to be portable to any computing platform that supports the Fortran 90 programming language.

3. **Problem Solved:** RAMA has the modeling capabilities to solve a variety of radiation transport problems in nuclear power plants. The RAMA computer code system is a current state-of-the-art nuclear transport theory program which calculates multi-group neutron fluxes, gamma-ray fluxes and radiation dose rates in three-dimensional space to support radiolysis evaluations.

4. **Method of Solution:** RAMA uses three primary methods to perform accurate radiation dose rate calculations for radiolysis/ECP evaluations:
   - a three-dimensional, integral transport theory calculation based upon the method of characteristics solution methodology. This methodology is particularly well suited to problems that require a large number of solution regions, such as those that generally evolve from standard ex-core applications. It is more precise and produces results faster than the older discrete ordinates and Monte Carlo methods.
   - an accurate anisotropic scattering treatment using up to seven scattering moments with thermal group up-scattering. Scattering moments up to P7 are used to handle the anisotropic scattering effects in the ex-core regions. Up-scatter cross sections are provided in five thermal energy groups below the 5 eV energy boundary. Up-scatter groups significantly improve the thermal neutron flux and gamma-ray flux calculations in the ex-core regions.

- an arbitrary geometry modeling capability coupled with a three-dimensional ray-tracing methodology for accurate plant geometry modeling. The 3-D ray tracing method allows the code to determine accurate transmission probabilities of neutron and gamma-ray particles through material regions.

5. **Restrictions on the Complexity of the Problem:** None noted.

6. **Typical Running Time:** Execution of a two-dimensional model of an eighth core symmetric problem on a current generation workstation takes a few minutes. Execution of a three-dimensional one eighth symmetric model of the reactor system takes several hours.

7. **Unusual Features of the Program:** RAMA provides the following major capabilities:

- A three-dimensional geometry modeling capability based upon combinatorial geometry techniques. Using plant design drawings, a true representation of the reactor can be built.
  - — Accurate representation of straight and curved surfaces are supported providing the capability to describe problem geometries of any symmetrical form including half, quarter and octant symmetry.
  - — Size of the geometry model is virtually unlimited.
- RAMA requires material data, fuel data and plant operating data to perform its calculations. Materials are assigned to all regions of the problem geometry. Material types include solids and liquids.
  - — Pressure vessel, vessel components and structural material data are obtained from mechanical design drawings and material specification sheets.
  - — Fuel material data for the core region is obtained from process computers and/or core follow and core design codes.
  - — Plant operating data is generated to represent a state point condition of the reactor assembly at a given point in the operation of the plant. The operating data provided to RAMA must contain material descriptions and operating state parameters that correspond to the primary material regions of the reactor assembly model. Nuclear data obtained from the reactor engineers and input into the RAMA code includes reactor state point data, core isotopics data and coolant density data.
- RAMA uses a broad-group 47 neutron/20 gamma-ray ENDF/B-VI data library.
- RAMA generates four key output parameters:
  - — Spatial and spectral distributions of neutron fluxes,
  - — Spatial and spectral distributions of gamma-ray fluxes,
  - — Radiation dose rates in multi-group form and
  - — Energy deposition rates for all material regions represented in the model.

8. **Related and Auxiliary Programs:** RAMA provides dose rate data to support hydrogen water chemistry analysis and flux data for use as input to TransWare's RAFTER code. RAFTER calculates nuclide activity levels and both neutron and gamma-ray fluence levels in reactor pressure vessel and internal structural components.

9. **Status:** Beta Version, September 1998.

10. **References:** 1. Dean. Jones, et.al., "Radiation Analysis Modeling Application Computer Code Manual", Volume 2: User Manual, EPRI Research Project B401-02, Draft Report, October 1998.

11. **Hardware Requirements:** A minimum of 32 MB of RAM and 2 GB of free hard disk space is recommended.

12. **Programming Language:** Fortran 90

13. **Operating System:** UNIX and UNIX-compatible systems, including Linux.

14. **Other Programming or Operating Information or Restrictions:** None.

15. **Name and Affiliation of Author or Contributor:** Dean B. Jones and Kenneth E. Watkins, TransWare Enterprises Inc., (408) 227-7700.

16. **Material Available:** Contact EPRI to discuss product availability. Brochures describing the RAMA code and support services are available from TransWare Enterprises Incorporated. Contact TransWare regarding fluence methods, RAFTER, and evolving technologies.

17. **Category:** C and J

    Keywords: Radiation Dose Rate, Radiolysis, ECP, Arbitrary Geometry, Neutron Flux, Gamma-ray Flux, Combinatorial Geometry

18. **Sponsor:** RAMA was developed by TransWare Enterprises Inc. under funding provided by the Boiling Water Reactors Vessel Internals Project (BWRVIP) and EPRI.