RADIATION ACTIVITY AND FLUENCE TRENDING EVALUATIONS FOR REACTOR SYSTEMS (RAFTER)

K. E. Watkins, S. P. Baker and M. E. Lujan
TransWare Enterprises Inc., 5450 Thornwood Dr., Suite M, San Jose CA 95123
kwatkins@twe.com, (408) 227-7700

ABSTRACT

1. **Program Name and Title:** RAFTER, Radiation Activity and Fluence Trending Evaluations for Reactor Systems.

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

3. **Problem Solved:** RAFTER determines nuclide activation and both neutron and gamma-ray fluence levels in reactor pressure vessel and internal structural components. These analytically determined nuclide activity levels can then be compared to surveillance capsule, flux wire and coolant measurements as a means of calibrating the results to measured plant activation samples.

4. **Method of Solution:** RAFTER is an activation and fluence analysis tool which calculates nuclide activity levels from fundamental activation cross section data and neutron fluxes. RAFTER uses activation cross section data derived from the ENDF/B-VI nuclear data library. Activation reactions, neutron fluxes and time interval data are primary inputs to the code. Neutron flux data is derived from plant operating histories for all operating cycles of interest to the time of activation analysis. RAFTER calculates integrated nuclide activities over several operating state points of a reactor operating cycle and over multiple operating cycles. RAFTER accounts for the changes in mass of irradiated materials by using sophisticated isotopic depletion equations. It calculates the activation of nuclides due to the bombardment of neutrons on the material and the subsequent decay of activated nuclides due to the radioactive half-life of the nuclides.

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

6.	**Typical Running Time:** Execution of a typical RAFTER problem will take one to two minutes.

7.	**Unusual Features of the Program:** RAFTER provides the following major capabilities:
   - Calculates nuclide activity levels from fundamental activation cross section data and neutron fluxes.
   - Supports direct comparisons to measured activity levels of flux wires, surveillance capsule specimens, and coolant samples.
   - Provides a more precise determination of neutron and gamma-ray fluences in pressure vessels and internal components.
   - Uses easy to prepare inputs and is geometry independent. The user may specify the activation reactions of interest, the time of irradiation, and the neutron flux levels in the regions of interest.
   - Tracks nuclide activity levels for 32 unique nuclide reactions, including Fe-54 (n,p), Mn-54, Cu-63 (n,alpha), and Co-60, found in pressure vessel and internal component materials.
   - Outputs a table of activity factors for desired activation nuclides at each time step in the calculation.
   - Acts as a standalone computer code module, but may be easily interfaced or integrated into utility flux calculation codes, such as BWRVIP/EPRI's RAMA code system, RSICC's DOT/DORT/TORT code systems, or any other vendor or utility radiation analysis code package.
   - Supports a convenient restart capability which allows an on-going evaluation of nuclide activity evaluations as new operating data becomes available.
   - Supports utility in-service inspection decisions and tech spec (p/T curve) limits evaluations.

8.	**Related and Auxiliary Programs:** RAFTER uses flux data from flux calculation codes such as BWRVIP/EPRI's RAMA and RSICC's DOT/DORT/TORT.

9.	**Status:** RAFTER Version 1.00, November 1998 has been developed and tested on UNIX workstations using the Linux operating system (DEC Alpha and Intel systems), and on computer systems operating with the WINDOWS 98 operating system.

10.	**References:** None.

11.	**Hardware Requirements:** A UNIX workstation with a minimum 16 MB of RAM and 2 GB of free hard disk space is recommended.

12.	**Programming Language:** Fortran 90

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

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

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

16. **Material Available:** RAFTER code and brochures are available from TransWare Enterprises Inc.

17. **Category:** B and C

   Keywords: Neutron Fluence, Gamma-ray Fluence, Nuclide Activation, Neutron Flux, Radiation Analysis.

18. **Sponsor:** TransWare Enterprises Inc.