

UNITED STATES  
NUCLEAR REGULATORY COMMISSION  
OFFICE OF NUCLEAR REACTOR REGULATION  
OFFICE OF NUCLEAR MATERIAL SAFETY AND SAFEGUARDS  
WASHINGTON, D.C. 20555

November 17, 2005

NRC INFORMATION NOTICE 2005-31: POTENTIAL NON-CONSERVATIVE ERROR IN PREPARING PROBLEM-DEPENDENT CROSS SECTIONS FOR USE WITH THE KENO V.A OR KENO-VI CRITICALITY CODE

### ADDRESSEES

All licensees using the KENO V.a or KENO-VI criticality code module in Version 5 of the Standardized Computer Analyses for Licensing Evaluation (SCALE) software developed by Oak Ridge National Laboratory (ORNL).

### PURPOSE

The U.S. Nuclear Regulatory Commission (NRC) is issuing this information notice (IN) to inform recipients of a potential non-conservative error associated with preparation of problem-dependent cross-sections for use with either the KENO V.a or KENO-VI criticality code. It is expected that recipients will review the information for applicability to their facilities and consider actions, as appropriate, to avoid non-conservative results. However, suggestions contained in this IN are not new NRC requirements; therefore, no specific action nor written response is required.

### DESCRIPTION OF CIRCUMSTANCES

KENO V.a and KENO-VI are Monte Carlo particle-tracking codes that solve the neutron transport equation in arbitrary three-dimensional geometric configurations and give an estimate of effective neutron multiplication ( $k_{\text{eff}}$ ). KENO V.a and KENO-VI are part of the SCALE software package.

An ORNL staff member identified a programming error in a rarely used lattice cell cross-section processing option known as asymmetric slab cell (ASYMSLABCELL) in SCALE 5. In test cases with materials test reactor (MTR) plate fuel, this error resulted in non-conservative calculated  $k_{\text{eff}}$  values, which ranged from 4 percent lower (for high-enriched uranium) to 15 percent lower (for low-enriched uranium) calculated  $k_{\text{eff}}$  values. ORNL's review of the discrepancy determined that the observed difference in  $k_{\text{eff}}$  was attributed to errors in the calculation of dimensions for slab cells in cross-section processing. These errors cause an inaccurate Dancoff factor calculation. Note that the Dancoff factor is a calculated adjustment factor, applied in the resonance self-shielding of cross-sections, to account for geometrical effects (e.g., lattices). Accurate Dancoff factors are required to calculate  $k_{\text{eff}}$  in multigroup codes such as KENO.

**ML053060039**

ORNL provided diagnostic guidance on its website for SCALE users to determine the impact of the programming error on calculated  $k_{\text{eff}}$  results:

<http://www-rsicc.ornl.gov/rsic-cgi-bin/enote.pl?nb=scale5&action=view&page=84>

ORNL also provided preventive guidance, for SCALE users, to determine whether cases are subject to the error and how to modify the associated input files to avoid the error. Because the programming error, as discussed below, is associated with a code option that is seldom used, ORNL plans to incorporate the fix in the next version of SCALE 5 expected in March 2006.

NRC is continuing to evaluate the extent of the error. If relevant new information is obtained, NRC will provide the information in a future communication.

## DISCUSSION

Programming errors in the SCALE 5 LATTICECELL geometry option can cause erroneously calculated Dancoff factors to be propagated into a non-conservative KENO  $k_{\text{eff}}$  calculation when the ASYMSLABCELL input option is selected using the new SCALE 5 input format (keywords "READ COMP"). If a SCALE 5 control sequence is executed using input files developed with the SCALE 4 format, the input file will not properly convert to a SCALE 5 input format, and a fatal error will result before any calculations are performed.

The impact of an erroneous Dancoff factor calculation on a calculated  $k_{\text{eff}}$  value is problem-dependent. Analyses performed at ORNL indicate that the error in  $k_{\text{eff}}$  can be potentially significant if the ASYMSLABCELL option is used. The impact of the error on  $k_{\text{eff}}$  is relatively minor for cases where the symmetric slab cell (SYMMSLABCELL) option is used (results of test cases were slightly conservative). Plate-type fuel is one use for the slab cell option in SCALE. Lower-enriched systems will tend to demonstrate larger errors because of the greater importance of the Dancoff factor in these cases. ORNL used an infinite system of 20 percent enriched MTR fuel as a sample test. ORNL's results showed that the erroneous Dancoff factor could lower  $k_{\text{eff}}$  by as much as 4 percent for higher-enriched uranium and by as much as 15 percent from the predicted value for lower-enriched uranium.

ORNL has recommended that input files using the LATTICECELL geometry option, in conjunction with either the ASYMSLABCELL or SYMMSLABCELL keywords and the SCALE 5 input format, be replaced with an equivalent MULTIREGION geometry specification and a SLAB input option. Tests at ORNL have confirmed that the MULTIREGION specification with the SLAB option will produce the correct prediction of  $k_{\text{eff}}$ .

## CONTACT

This IN requires no specific action nor written response. If you have any questions about the information in this notice, please contact the technical contact listed below.

**/RA/**

Michael J. Case, Director  
Division of Inspection & Regional Support  
Office of Nuclear Reactor Regulation

**/RA/**

Robert C. Pierson, Director  
Division of Fuel Cycle Safety  
and Safeguards  
Office of Nuclear Material Safety  
and Safeguards

Technical Contact: Lawrence Berg, NMSS  
301-415-6215  
E-mail: [ljb2@nrc.gov](mailto:ljb2@nrc.gov)

Attachment: List of Recently Issued NMSS Generic Communications

Note: NRC generic communications may be found on the NRC public Web site, <http://www.nrc.gov>, under Electronic Reading Room/Document Collections.

**Recently Issued NMSS Generic Communications**

Date	GC No.	Subject	Addressees
2/11/05	BL-05-01	Material Control and Accounting at Reactors and Wet Spent Fuel Storage Facilities	All holders of operating licenses for nuclear power reactors, decommissioning nuclear power reactor sites storing spent fuel in a pool, and wet spent fuel storage sites.
11/08/05	RIS-05-27	NRC Timeliness Goals, Prioritization of Incoming License Applications and Voluntary Submittal of Schedule for Future Actions for NRC Review	All 10 CFR Parts 71 and 72 licensees and certificate holders.
10/28/05	RIS-05-22	Requirements for the Physical Protection During Transportation of Special Nuclear Material of Moderate and Low Strategic Significance: 10 CFR Part 72 vs. Regulatory Guide 5.59 (1983)	All holders of licenses for the possession of special nuclear material (SNM) that ship Category II and III quantities of this material.
9/27/05	RIS-04-17, Rev. 1	Revised Decay-in-Storage Provisions for the Storage of Radioactive Waste Containing Byproduct Material	All licensees regulated under 10 CFR Parts 30, 32, 33, 35, 39, and 50.
8/25/05	RIS-05-18	Guidance for Establishing and Maintaining a Safety Conscious Work Environment	All licensees, applicants for licenses, holders of certificates of compliance, and their contractors subject to NRC authority
8/10/05	RIS-05-16	Issuance of NRC Management Directive 8.17, "Licensee Complaints Against NRC Employees"	All licensees and certificate holders.
8/3/05	RIS-05-15	Reporting Requirements for Damaged Industrial Radiographic Equipment	All material licensees possessing industrial radiographic equipment, regulated under 10 CFR Part 34.
7/13/05	RIS-05-13	NRC Incident Response and the National Response Plan	All licensees and certificate holders.
7/11/05	RIS-05-12	Transportation of Radioactive Material Quantities of Concern NRC Threat Advisory and Protective Measures System	Licensees authorized to possess radioactive material that equals or exceeds the threshold values in the Additional Security Measures (ASM) for transportation of Radioactive Material Quantities of Concern (RAMQC) under their 10 CFR Part 30, 32, 50, 70, and 71 licenses and Agreement State licensees similarly authorized to possess such material in such quantities under their Agreement State licenses.

Date	GC No.	Subject	Addressees
7/11/05	RIS-05-11	Requirements for Power Reactor Licensees in Possession of Devices Subject to the General License Requirements of 10 CFR 31.5	All holders of operating licenses for nuclear power reactors and generally licensed device vendors.
6/10/05	RIS-05-10	Performance-Based Approach for Associated Equipment in 10 CFR 34.20	All industrial radiography licensees and manufacturers and distributors of industrial radiography equipment.
4/18/05	RIS-05-06	Reporting Requirements for Gauges Damaged at Temporary Job Sites	All material licensees possessing portable gauges, regulated under 10 CFR Part 30.
4/14/05	RIS-05-04	Guidance on the Protection of Unattended Openings that Intersect a Security Boundary or Area	All holders of operating licenses or construction permits for nuclear power reactors, research and test reactors, decommissioning reactors with fuel on site, Category 1 fuel cycle facilities, critical mass facilities, uranium conversion facility, independent spent fuel storage installations, gaseous diffusion plants, and certain other material licensees.
2/28/05	RIS-05-03	10 CFR Part 40 Exemptions for Uranium Contained in Aircraft Counterweights - Storage and Repair	All persons possessing aircraft counterweights containing uranium under the exemption in 10 CFR 40.13(c)(5).
10/31/05	IN-05-28	Inadequate Test Procedure Fails to Detect Inoperable Criticality Accident Alarm Horns	All licensees authorized to possess a critical mass of special nuclear material.
10/07/05	IN-05-27	Low Dose-Rate Manual Brachytherapy Equipment Related Medical Events	All medical licensees.
7/29/05	IN-05-22	Inadequate Criticality Safety Analysis of Ventilation Systems at Fuel Cycle Facilities	All licensees authorized to possess a critical mass of special nuclear material.
6/23/05	IN-05-17	Manual Brachytherapy Source Jamming	All medical licensees authorized to possess a Mick applicator.
5/17/05	IN-05-13	Potential Non-conservative Error in Modeling Geometric Regions in the Keno-v.a Criticality Code	All licensees using the Keno-V.a criticality code module in Standardized Computer Analyses for Licensing Evaluation (SCALE) software developed by Oak Ridge National Laboratory (ORNL)
5/17/05	IN-05-12	Excessively Large Criticality Safety Limits Fail to Provide Double Contingency at Fuel Cycle Facility	All licensees authorized to possess a critical mass of special nuclear material.

Date	GC No.	Subject	Addressees
4/7/05	IN-05-10	Changes to 10 CFR Part 71 Packages	All 10 CFR Part 71 licensees and certificate holders.
4/1/05	IN-05-07	Results of HEMYC Electrical Raceway Fire Barrier System Full Scale Fire Testing	All holders of operating licenses for nuclear power reactors, except those who have permanently ceased operations and have certified that fuel has been permanently removed from the reactor vessel, and fuel facilities licensees.
3/10/05	IN-05-05	Improving Material Control and Accountability Interface with Criticality Safety Activities at Fuel Cycle Facilities	All licensees authorized to possess a critical mass of special nuclear material.

Note: NRC generic communications may be found on the NRC public website at <http://www.nrc.gov>, under Electronic Reading Room/Document Collections.