

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

May 17, 2005

NRC INFORMATION NOTICE 2005-13: POTENTIAL NON-CONSERVATIVE ERROR IN
MODELING GEOMETRIC REGIONS IN THE
KENO-V.A CRITICALITY CODE

ADDRESSEES

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).

PURPOSE

The U.S. Nuclear Regulatory Commission (NRC) is issuing this information notice (IN) to inform recipients of a potential non-conservative error in modeling geometric regions in the Keno-V.a 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 is a Monte Carlo particle tracking code that solves the neutron transport equation in arbitrary three-dimensional geometric configurations. Keno-V.a is part of the SCALE software package.

An ORNL staff member identified a problem while performing a criticality safety benchmark evaluation in which some cases produced 1 to 1.5 percent lower k-effective (k_{eff}) values. This statistically significant difference was brought to the attention of the Keno-V.a code manager at ORNL. ORNL's review of the discrepancy determined that the observed difference in k_{eff} was attributed to round-off error.

ORNL provided diagnostic guidance on its website for SCALE users to determine the impacts of round-off errors on calculated k_{eff} results:

<http://www-rsicc.ornl.gov/rsic-cgi-bin/enote.pl?nb=scale5&action=view&page=56>

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ORNL also provided preventive guidance, for SCALE users, to avoid modeling geometric configurations that were potentially sensitive to numerical round-off errors. Subsequently, ORNL issued a Keno-V.a patch to fix the numerical round-off error in SCALE Version 5. ORNL did not issue a patch for earlier versions of SCALE. NRC informally notified fuel cycle licensees of the existence of the Keno-V.a error.

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

DISCUSSION

Modeling geometric configurations using Keno-V.a is accomplished by defining regions composed of simple geometric shapes. Holes are one type of geometric region that could be used to construct complex geometric configurations. Holes may contain bodies or arrays having any geometric shape. The numerical round-off error only occurs when using the hole option to define geometric regions and the body in the hole is a cylinder or hemi-cylinder. A similar round-off error was previously identified and corrected for holes containing other geometric shapes.

The reported condition arises when the end face of a hole, whose outer boundary is a cylinder or a hemi-cylinder, shares a common flat boundary with another hole, region, or unit. Neutrons crossing the common boundary are incorrectly tracked when the numerical round-off error causes the code to misinterpret which region the neutron is entering. If the tracking failure results in missing absorber material, calculated k_{eff} values could be overestimated. If the tracking failure results in missing fuel, calculated k_{eff} values could be underestimated.

ORNL has recommended that geometric configurations that were modeled using cylindrical/hemi-cylindrical holes be checked for shared boundaries. If shared boundaries exist, ORNL recommends inserting a small gap, larger than potential round-off error [at least 1.0×10^{-5} cm (3.9×10^{-6} in.)], between the boundaries. ORNL has also issued the following patch, for SCALE Version 5, that can be downloaded from the SCALE website: http://www.ornl.gov/sci/scale/download_kenova.htm. This patch is intended to prevent tracking errors in geometric configurations having boundaries. If the patch is installed, the modified Keno-V.a code should be verified by re-running validation cases to ensure the code is working correctly.

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.

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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
04/18/05	RIS-05-06	Reporting Requirements for Gauges Damaged at Temporary Job Sites	All material licensees possessing portable gauges, regulated under 10 CFR Part 30.
04/14/05	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.
02/28/05	RIS-05-003	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).
05/17/05	IN-05-013	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)
05/17/05	IN-05-012	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.
04/07/05	IN-05-010	Changes to 10 CFR Part 71 Packages	All 10 CFR Part 71 licensees and certificate holders.

04/01/05	IN-05-007	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.
03/10/05	IN-05-005	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, <http://www.nrc.gov>, under Electronic Reading Room/Document Collections.