List of known ADDER v. 1.0.1 bugs and design defects

The Advanced Dimensional Depletion for Engineering of Reactors (ADDER) Software is under continued development at Argonne National Laboratory by the Research and Test Reactor (RTR) Department, under the umbrella of the US High Performance Research Reactors (USHPRR) project. In order to satisfy the NQA-1 requirements for the project, ADDER’s development follows a rigorous Software Quality Assurance Plan (SQAP). Rather than being updated every time a modification is made to the software base, the GitHub repository is updated by the developers following a formal release of the software under the SQAP. The timeline of these releases is flexible and is subject to the needs and requirements of the USHPRR project.

The following list is intended to document known bugs and design defects identified by the ADDER users and developers and currently being addressed as part of the **next software release (ADDER v. 1.1.0), planned for end of August 2024 at the time of compiling this list**. The users should be aware of these software issues before using the software in order to avoid unintended erroneous results. If you encounter any bug not listed below, please notify the ADDER development team.

Please send any question or comment to [adder@anl.gov](mailto:adder@anl.gov). Please email us to be added to the list of known ADDER users, so that we can notify of newly found bugs as soon as they are discovered.

# Wrong position used for a geometry\_search operation performed after a transform operation on the same group.

**Type:** error.

**Description:** ADDER utilizes the second-to-last position (instead of the last) after a transform operation as the starting value of a geometry\_search for a given control group. As such, if a control group is moved from position x to position y using a transform operation and then a geometry\_search is performed on that same control group, the starting point for the geometry\_search will be position x rather than position y.

**How to avoid the issue pending corrective action:** users should add an additional transform with a value of 0 before using a geometry\_search. This makes sure that the second-to-last position corresponds to the reference value desired by the user.

# Incorrect Implementation of String Method “strip” in ADDER.

**Type:** error.

**Description:** Due to the incorrect implementation of string method “strip” in ADDER, input from an ADDER or MCNP input file can be incorrectly processed by ADDER. In most cases the incorrect processing will cause ADDER to crash. ADDER can potentially process the following input incorrectly:

* FM cards in MCNP inputs which include parentheses.
* MSR feed materials in ADDER inputs which include parentheses or any of the following characters: material\_

**How to avoid the issue pending corrective action:** If possible, users should modify their input so that FM cards in MCNP inputs do not include parentheses, and so that MSR feed materials in ADDER inputs do not include parentheses or any of the following characters: material\_

# Unexpected behavior of transformed universes after shuffle operations.

**Type:** design defect.

**Description:** The current ADDER manual does not specify how transformations are handled during universe shuffling. In the current version of ADDER (v.1.0.1), when universes are shuffled each universe will take on the transformation that was applied to the universe it is being shuffled into. In other words, if a universe undergoes a transformation (e.g., a rotation), the transformation is applied to the MCNP cell that is filled with that specific universe at the time the [[[transform]]] operation is performed during the calculation. If the universe is then moved to another location via a [[[shuffle]]] operation, the transformation stays with the cell and is not applied to the new location. Consequently, the universe that is shuffled to replace the first one now features the transformation that was applied to the first universe. This behavior may be counterintuitive to users, for example, when universes are associated with fuel elements that are flipped and/or rotated as part of the fuel management strategy. When elements are flipped and rotated and then a new element replaces them in the same core location (e.g., when the fuel is moved into storage), the latter may result in unintended flips or rotations. In complex fuel management strategies, this may result in a core loading that is significantly different than what the user intended.

**How to avoid the issue pending corrective action:** Pending implementation of corrective action, users need to be very deliberate with the management of components identified by universes and may need to adjust their input files to ensure that the universe transformations are being applied as intended. In particular, users performing [[[transform]]] operations on universes should make sure that the universes are transformed back to their unperturbed state (i.e., from the base MCNP input file provided for the run) if they require the new universes taking their place to start in their original configuration. For example, if a fuel element, identified by a universe, is flipped and rotated when in a certain core location, it should be flipped and rotated back before moving it out of that core location. If not, the transformed universe will be reverted back to its original orientation when in its new location, while the second universe that replaces the first will inherit its modified orientation. Users are encouraged to double check all the MCNP transformation cards resulting from combinations of [[[transform]]] and [[[shuffle]]] operations.

# ADDER incorrectly reports k\_eff uncertainties in the HDF5 results file.

**Type:** error.

**Description:** Rather than reporting the relative statistical uncertainty for k\_eff in the output HDF5 file, ADDER lists the k\_eff values itself twice.

**How to avoid the issue pending corrective action:** Users need to manually inspect the MCNP output files generated during the ADDER execution to access the correct value of k\_eff relative statistical uncertainty, as calculated by MCNP.

# Incorrect rotation matrices in ADDER-generated MCNP input files resulting from [[[transform]]] operations featuring yaw, pitch, and/or roll angles

**Type:** Error

**Description:** The *[[[transform]]]* operation is used to rotate a component by a given angle, defined by the *yaw, pitch, roll,* and/or *matrix* variables. When such an operation is performed, the resulting ADDER-generated MCNP inputs feature rotation matrices that are not consistent with the desired angles. The issue arose from the difference in the format of rotation matrix that the neutron transport software MCNP implements with respect to ADDER. As such, users that think they are rotating a component by a certain angle may end up with a rotation that is significantly different in the simulation. Such a behavior may lead to calculations failing and/or significantly incorrect results. Users who need to rotate components via the [[[transform]]] operation in ADDER should be aware that the ADDER-generated MCNP models may be incorrect.

**How to avoid the issue pending corrective action:** If performing a rotation can't be avoided in the model, users should reach out to the developers (sending an email to adder@anl.gov) to identify alternative incorrect rotation angles and/or matrices that would produce the right tr card and, as such, the right orientation of the components in the ADDER-generated MCNP inputs.

# ADDER exits with an error when neutronics MCNP models includes FM cards attenuators

**Type:** error

**Description:** ADDER incorrectly processes MCNP input files that have any FM cards using attenuator sets. The incorrect processing will cause ADDER to crash. This is not the case of the FM card using the multiplier set, which is handled properly by ADDER.

**How to avoid the issue pending corrective action:** Users are advised to avoid using the attenuator set in the MCNP input file. If the calculation of the attenuator factor is necessary for the purpose of the analysis, users should include other tallies to calculate the attenuator factor in a separate post-processing phase. Further information and guidance will be provided in the future, after further investigation and modification by the software engineers.

# Critical search algorithm fails with too few active kcode cycles

**Type:** error

**Description:** The criticality search operation of ADDER can fail or return nonsensical values if not enough active cycles are run in the neutronics solver MCNP. ADDER automatically calculates the number of active cycles using a combination of the parameters set in the [[[geometry\_search]]] subsubsection in the ADDER input, and the neutron statistics set in the KCODE card of the original MCNP input file (cycles, neutron histories per cycle). In some cases, the calculated number of active cycles is so low that MCNP will not return a combined collision/absorption/track-length keff, which ADDER requires to successfully process neutronics calculations.

**How to avoid the issue pending corrective action:** If encountered, users may be able to avoid this issue by iteratively decreasing the ‘uncertainty\_fraction’ parameter in the [[[geometry\_search]]] subsubsection until ADDER returns sensical values for keff during the criticality search operation. Further information and guidance will be provided in the future, after further investigation and modification by the software engineers.

# Critical search algorithm fails with too few active kcode cycles

**Type:** error

**Description:** In certain cases, ADDER exits with an error (“*Either a power history is used on a fissile-free system (keff = 0) or the recoverable energy from fission contains a floating-point error.”)* due to the average recoverable energy (Q\_rec) for the system being computed by the software as 0.0. This error ends the ADDER depletion calculation for systems that are known to have fissionable regions and – hence – for which a Q\_rec value should in principle be computable. It often occurs in simulation with low statistics, which can be executed by the users and contributors in quick simplified test examples and/or support the development and the debugging of the software.

**How to avoid the issue pending corrective action:** If the error is incurred, users and contributors are advised to increase the neutron statistics of the problem and/or modify the model using a more realistic geometry. Further information and guidance will be provided in the future, after further investigation and modification by the software engineers.