# An Integrated Fuel Depletion Calculator for Fuel Cycle Options Analysis

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**Program**: Mission Supporting Fuel Cycle R&D

**ABSTRACT**

Nuclear fuel cycle options analysis relies upon the ability to explore outcomes tied to the viability of fuel cycle strategies from the standpoints of economics, safety, security and/or sustainability in resource utilization and waste management. Specification of the charge and discharge isotopic compositions of reactor fuel offers an example of the challenges inherent in fuel cycle simulation. Existing models for evaluating fuel cycle options define sets of charge/discharge composition vectors, here called 'recipes.' Even for a simple analysis consisting of one reactor type, a large number of recipes would be needed to cover input/output compositions for plausible values of initial enrichment and fuel geometry parameters..

This work shifts the parameterization of reactor modeling for options analysis away from recipes and toward microscopic few energy-group cross sections as functions of burn time and other attributes that shape the neutron energy spectrum. This reactor model interpolates cross sections from pre-computed libraries to determine run-time values for a given state of the core. State-specific cross sections would then be used to calculate the neutron flux spectrum, multiplication factor, fuel burnup, and fuel vector at desired burn times. The research challenge lies in embedding the essential physics governing fuel burnup, the neutron energy spectrum, into the group cross sections in a rigorous but extensible fashion. A secondary challenge arises in formulating a multivariate interpolation algorithm to obtain each cross section from 'nearby' (in the phase space of configurations and initial isotopic compositions) multigroup libraries.

Upon completion, the model would be accessible to all levels of potential users. This will be able to be done from a top-level rich client or web-based interface, by scripting the code itself, or by calling the new pipeline from within another fuel cycle application. Further justification for this model is that interpolation of the cross section *enables* much larger initial parameter sweeps covering a wider array of reactor states. Moreover by collectively varying all inputs of interest, the sensitivity and uncertainty of the reactor parameters may be measured.