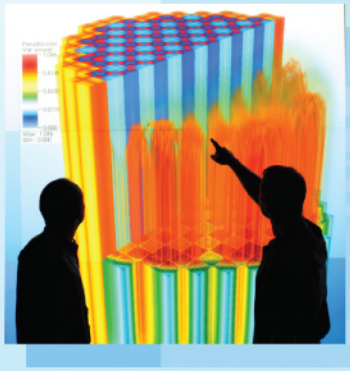
Power uprates
and plant life extension

CASL-U-2014-0028-000-a

Consortium for Advanced Simulation of LWRs



Engineering design
and analysis

Milestone Report L2:VUQ.SAUQ.P5.01

Multi-physics UQ Hybridization Framework Development

Science-enabling
high performance
computing

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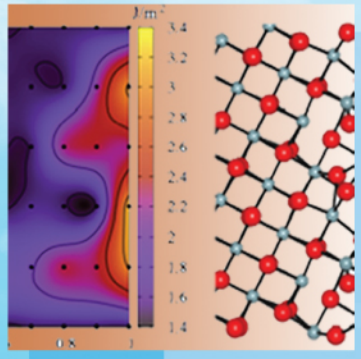
July 11, 2013



Fundamental science

Plant operational data

U.S. DEPARTMENT OF ENERGY | Nuclear Energy

CASL Level 2 (L2) Milestone Definition

Multi-physics UQ Hybridization Framework Development

ID: L L2:VUQ.P5.01	Due Date: 09/30/2012	Owner (Project): Hany Abdel-Khalik

Milestone Description: This milestone will extend a UQ hybridization framework, developed in year 1, to allow its application to multi-physics models. This framework is designed to allow the use of DAKOTA to propagate uncertainties in a model with many input parameters. A reduction methodology, demonstrated in a past milestone, will be employed to propagate uncertainties using minimal number of forward and adjoint code executions. The ultimate goal of this framework is to enable uncertainty quantification through the Denovo-Drekar code system. Initially, we will focus on coupling Denovo neutronics model with depletion calculations. When Drekar becomes available, the framework will be extended to the Drekar model; this is expected to happen in PoR6. In addition to performing UQ, this milestone will support data assimilation efforts focusing on hybridization to enable their use for multi-physics models with many input parameters.

Milestone Execution Responsibility: Dr. Hany Abdel-Khalik will be responsible for the execution of this milestone with the help of his research group.

Milestone Execution Plan: The Denovo code will be acquired from ORNL, and the depletion calculations will be performed using the ORIGEN code. The reduction algorithm will be implemented at various points in depletion to account for isotopics variations. A surrogate model will be developed that calculates to a user-defined accuracy the responses of interest, e.g. few-group cross-sections, pin powers. The surrogate will be then used to propagate cross-sections uncertainties

Milestone Execution Evidence: The deliverables include:

(a) Document describing the hybridization algorithm and the associated theoretical development.

(b) Two examples, including an assembly model and a quarter core model, demonstrating the ability to propagate uncertainties efficiently over a specified range of depletion

Milestone Linkage: This work will be done independently of other development.

Its results however will be linked to the data assimilation project as the reduction algorithm developed here will provide the basis for the multi-physics data assimilation project.

Milestone Completion Criteria: A formal report documenting the details of the implementation will be delivered by the end of the performance period. The uncertainty quantification results generated by existing state-of-the-art techniques will be compared to those generated by the hybrid approach.