

SCALE Training: ORIGIN Fuel Depletion, Activation, and Source Term Analysis

Oak Ridge National Laboratory

Training summary:

This is a hands-on training course that covers the use of ORIGIN for depletion and decay analysis, nuclide inventories, decay heat, and radiation emissions and spectra calculations.

The goal is to enable all participants to:

- **Understand what ORIGIN is:** ORIGIN's capabilities for depletion and decay analysis, type and role of nuclear data and nuclear data libraries, capabilities of other modules in the ORIGIN family (ORIGAMI, OBIWAN, OPUS, ARP).
- **Gain confidence** in creating, validating, and running input with SCALE's graphical user interface, Fulcrum.
- **Learn best practices** for determining nuclide inventories, decay heat, and radiation emissions and spectra in spent nuclear fuel and activated materials.
- **Gain hands-on experience** through interactive tutorials and challenging real-world workshop problems: perform typical calculations with ORIGIN and ORIGAMI; determine nuclide inventories, decay heat, radiation emissions; generate ORIGIN reactor libraries using TRITON; generate and apply ORIGIN activation libraries; post-process, view, and analyze results.

Note:

This training will be presented using SCALE 6.3. No prior knowledge of SCALE is required.

Day 1

Introduction to SCALE and ORIGEN

- (01) Welcome, introductions, logistics, training overview
- (02) SCALE overview
- (03) How does SCALE work?
- (04) Summary of depletion/decay modules/sequences/files in SCALE
- (05) Introduction to ORIGEN
 - ORIGEN overview
 - Tutorial: hands-on introduction to Fulcrum for ORIGEN – simple decay problem
- (06) Nuclear data for ORIGEN
 - Description of nuclear data for ORIGEN
 - ORIGEN nuclear data visualization with Fulcrum

ORIGEN decay calculations

- (07) ORIGEN decay calculations basics
 - Fundamentals: ORIGEN input components & syntax
 - ORIGEN decay with F71 input
 - Workshop
 - (08) Post-processing of ORIGEN binary concentration file (F71)
 - OPUS post-processing utility for ORIGEN: fundamentals, tutorial
 - OBIWAN command line interface to view F71 files: fundamentals, tutorial
 - (09) ORIGEN decay for radiation emission and spectra calculations
 - Fundamentals: ORIGEN input for radiation emissions
 - Tutorial: neutron emission and spectra
 - Workshop
- Retrospective Day 1

Day 2

Creating and applying ORIGEN activation libraries

- (10) ORIGEN activation libraries
 - Fundamentals: multi-group nuclear data processing basics; introduction to ORIGEN Library Builder input; activation calculations with ORIGEN
 - Tutorial: creating ORIGEN activation libraries
 - Workshop

ORIGAMI for easy spent fuel calculations**(11) ORIGEN reactor libraries**

- Fundamentals: ORIGEN reactor libraries in SCALE; viewing ORIGEN reactor library file contents using OBIWAN
- Tutorial: exploring content of an ORIGEN reactor library file with OBIWAN
- Fundamentals: comparison of ORIGEN reactor libraries files
- Tutorial: comparing library files using OBIWAN

(12) Introduction to ORIGAMI

- Fundamentals: what is ORIGAMI; input for UO2 Express form
- Tutorial: nuclide inventory calculation with ORIGAMI UO2 Express
- Tutorial: compare decay heat of LEU to LEU+/HBU fuel using ORIGAMI UO2 Express
- Workshop

Retrospective Day 2

Day 3

Creating and applying ORIGEN reactor libraries**(13) Creating ORIGEN reactor libraries with TRITON**

- Fundamentals: ORIGEN cross section vs. reactor libraries
- Workshop: use SCALE's reactor libraries
- Fundamentals: ORIGEN reactor library generation
- Walkthrough TRITON input/output files for different models
- Workshop: generate and use your own ORIGEN reactor library

(14) Introduction to the ORIGEN + ARP depletion workflow

- Fundamentals: ORIGEN reactor library interpolation using ARP; ORIGEN depletion calculations with ARP-interpolated libraries
- Workshop

In-depth ORIGAMI for easy spent fuel calculations

(15) ORIGAMI detailed input for rapid spent fuel calculations

- Fundamentals: create ORIGAMI input from scratch
- Tutorial: modeling axial variation in burnup and coolant density for a BWR assembly
- Fundamentals: other frequently used ORIGAMI input
- Workshop: ORIGAMI detailed input for rapid LWR spent fuel calculations
- Fundamentals: radial modeling with ORIGAMI
- Tutorial: Gd-bearing BWR assembly - effect on decay heat and Pu inventory
- Fundamentals: input options for generating files for follow-on analyses

Retrospective Day 3

Day 4

ORIGEN sensitivity and applications

(16) ORIGEN sensitivity

- Fundamentals
- Tutorial: Xe-135 sensitivity
- Workshop: sensitivity analysis with ORIGEN

Lunch break (12:00 pm – 1:00 pm)

ORIGEN advanced applications and validation

(17) ORIGEN advanced processing options

- Fundamentals: processing options input
- Tutorial: feed/removal options for filtration problem
- Tutorial: blend option to simulate the decay heat power for a spent fuel
- Workshop: advanced processing options

(18) ORIGEN validation for nuclide inventory calculations

- Summary of RCA measurement data used for validation
- Results: nuclide inventory validation
- Workshop: nuclide inventory benchmark for PWR spent fuel

Retrospective Day 4

Day 5

Decay heat validation; ORIGIN updates in SCALE 6.3.1; feedback & discussions
(19) Decay heat validation ○ Validation based on full-assembly decay heat experiments ○ Validation based on fissile material irradiation experiments ○ Workshop: decay heat benchmark for a PWR assembly (20) ORIGIN updates in SCALE 6.3.1 Attendees' feedback Discussions & users' problems