SCALE Activities in FY22

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ORNL AM2 SCALE: Overview

• NCSP-facing codes
  – criticality safety (CSAS)
  – shielding (MAVRIC)
  – sensitivity/uncertainty (TSUNAMI and Sampler)
  – bias analysis (VADER)

• Maintain new/current production version (v6.3 series)
  – coordination - management, SQA
  – support – interact with users, documentation, scalehelp@ornl.gov
  – development – make new things
  – maintenance - fix bugs

• Develop next version (v7.0 series)

6.3 Product Owners

<table>
<thead>
<tr>
<th>Code</th>
<th>Owner</th>
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<tbody>
<tr>
<td>AMPX</td>
<td>Jordan McDonnell</td>
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<tr>
<td>CSAS</td>
<td>Kursat Bekar</td>
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<tr>
<td>DATA</td>
<td>Jesse Brown</td>
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<td>FULCRUM</td>
<td>Rob Lefebvre</td>
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<td>MAVRIC</td>
<td>Cihangir Celik</td>
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<tr>
<td>OMNIBUS</td>
<td>Seth Johnson</td>
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<td>ORIGAMI</td>
<td>Steve Skutnik</td>
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<td>ORIGEN</td>
<td>BK Jeon</td>
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<td>POLARIS</td>
<td>Matt Jessee</td>
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<td>SAMPLER</td>
<td>Ugur Mertyurek</td>
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<tr>
<td>STDCOMP</td>
<td>Rob Lefebvre*</td>
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<td>TRITON</td>
<td>Rike Bostelmann</td>
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<td>TSUNAMI</td>
<td>Jordan McDonnell*</td>
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<td>VADER</td>
<td>BJ Marshall</td>
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<td>XSPROC</td>
<td>Kang Seog Kim</td>
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*Interim owner
New product owner for FY22/FY23
SCALE 6.3 In a Nutshell

- Significant strides towards modernizing and centralizing Monte Carlo capabilities with Shift integration
- Improvements to uncertainty quantification and sensitivity analysis
- Performance improvements to Polaris for LWR lattice calculations
- New capabilities targeting advanced reactors

SCALE “sequences” in v6.3.0

1. MAVRIC - radiation shielding
2. CSAS - criticality safety
3. TRITON - general reactor fuel depletion
4. ORIGEN - general depletion/decay/activation
5. ORIGAMI - LWR spent fuel isotopes generation
6. Polaris - LWR reactor fuel depletion
7. TSUNAMI - sensitivity, similarity analysis, and data assimilation
8. Sampler - general uncertainty propagation
9. AMPX - nuclear data processing (transforms ENDF/B to SCALE format)
10. SCALE nuclear data libraries - curated, verified, and validated
11. ORIGEN reactor libraries - data to generate system-specific spent fuel isotopes
12. VADER – trending-based validation
13. OMNIBUS – Leadership class Monte Carlo Transport (experimental)
Updates on scale.ornl.gov

• Download SCALE 6.2.4 Validation Reports directly from the SCALE website

• 6.3.0 validation reports are not far behind

• 6.3.1 maintenance patch will be first available from RSICC

SCALE

SCALE is a comprehensive modeling and simulation suite for nuclear safety analysis and design developed and maintained by Oak Ridge National Laboratory under contract with the U.S. Nuclear Regulatory Commission, U.S. Department of Energy, and the National Nuclear Security Administration to perform reactor physics, criticality safety, radiation shielding, and spent fuel characterization for nuclear facilities and transportation/storage package designs.

The SCALE 6.2.4 validation report four-volume set is now available on OSTI:

1. SCALE 6.2.4: Validation Overview
2. SCALE 6.2.4 Validation: Nuclear Criticality Safety
3. SCALE 6.2.4 Validation: Reactor Physics
4. SCALE 6.2.4 Validation: Radiation Shielding

The SCALE 6.3.0 validation reports will be released in 2023 with an additional volume specifically for spent fuel inventory and decay heat (Spent Fuel Applications) and additional Polaris and PARCS LWR validation in the Reactor Physics volume.

The SCALE 6.3 Online Manual is now available.
Current efforts to update to include “Known Issues” in a particular version as they are discovered
Accessible, High-quality Validation

- One of the most valuable things we can do for the community

- SCALE v6.2 series
  - Released in 2016
  - Last patch v6.2.4 (2021) provides validation baseline with ENDF/B-VII.1

- SCALE v6.3 series is now used internally for all analyses at ORNL
  - NCSP and NRC support to continue increasing validation basis
  - All validation inputs/outputs will be public
  - Strides towards push-button re-validation for any version or new nuclear data

Bias in ICSBEP criticality benchmarks as a function of category for 4 SCALE data libraries

https://info.ornl.gov/sites/publications/Files/Pub138917.pdf
Practical Tools for Rapid Analysis (1/3)

• Fulcrum GUI
  – Validate input as you type
  – Beautiful 3D visualization
  – Same GUI on Mac/Windows/Linux

• VADER
  – Trending-based analysis with standard methods
  – Will grow in functionality to meet needs/desires of criticality safety community

• Sampler
  – Comprehensive, integrated uncertainty quantification
  – New (7.0 beta) optimization searches

Input showing instantaneous input error for mistyped nuclides.
Practical Tools for Rapid Analysis (2/3)

- Fulcrum GUI
  - Validate input as you type
  - **Beautiful 3D visualization**
  - Same GUI on Mac/Windows/Linux

- VADER
  - Trending-based analysis with standard methods
  - Will grow in functionality to meet needs/desires of criticality safety community

- Sampler
  - Comprehensive, integrated uncertainty quantification
  - New (7.0 beta) optimization searches

Immediate input visualization, allowing color change, transparency, and easy checking of mixture/volume association.
Practical Tools for Rapid Analysis (3/3)

- Fulcrum GUI
  - Validate input as you type
  - Beautiful 3D visualization
  - Same GUI on Mac/Windows/Linux

- VADER
  - Trending-based analysis with standard methods
  - Will grow in functionality to meet needs/desires of criticality safety community

- Sampler
  - Comprehensive, integrated uncertainty quantification
  - **New (7.0 beta) optimization searches**
Summary

• FY22 produced valuable validation reports, publicly available via scale.ornl.gov
  - 6.2.4 baseline
  - 6.3 validation (including ENDF/B-VIII.0) will come out this FY

• Arduous export control review for v6.3 is over, SCALE will be 10 CFR 810 (just like MCNP)
  - v6.3.0 used internally since January 2022
  - v6.3.1 will be at RSICC in FY23/Q2

• New SCALE 7.0 beta capabilities
  - Available quarterly to anyone with a 6.3 license
  - Optimization/search function
  - Inclusion of WHISPER-like methodology in SCALE validation tools
  - Visualization of fission sites, particle tracks

https://www.osti.gov/biblio/1760121
https://code.ornl.gov/scale/primers/kenovi
https://www.osti.gov/biblio/1760129
https://code.ornl.gov/scale/primers/kenova

These primers, written for SCALE 6.2 are still a great way to learn SCALE/CSAS in 6.3.