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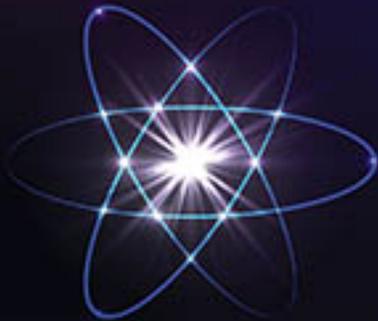
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DATES TO REMEMBER

Hands-On Training & Education Course Dates:
Two-week Practitioner Course Dates:
Aug 8-19, 2022

One-week Manager's Course Dates:
Sandia – April 4-8, 2022
NCERC - Jun 6-10, 2022

Course Registration:
<https://ncsp.llnl.gov/training-education/trng-apply>

LINKS TO REMEMBER

- [NCSP Website](#)
- [NCSP Program Management](#)
- [NCSP Mission and Vision](#)
- [NCSP Five-Year Execution Plan](#)
- [NCSP Planning Calendar](#)
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A Message from the NCSP Manager

Members of the NCSP Management Team recently travelled to Los Alamos to visit the Los Alamos Neutron Science Center (LANSCC). The first ever NCSP measurement at LANSCC was a measurement of U-233 neutron capture reaction data conducted in December of 2020 (For more info, see the Spring 2021 Newsletter [here](#).). The second NCSP measurement at LANSCC, a Pu-240 neutron spectrum measurement, is planned for later this year. In February, the NCSP hosted the annual Technical Program Review (see article below) with over 200 registrants. Thank you to everyone who made the review a great success. As we move into spring, COVID travel restrictions are being lifted, and I anticipate that by this summer we will be back to being able to host our international collaborators at some of our upcoming meetings and experiments. Please keep the providing feedback on the program. It is very much appreciated and helps us meet our continuous improvement goal. Hope to see you all soon.



NCSP Technical Program Review and Joint Meetings

This year's NCSP Technical Review Program (TPR) was hosted virtually by Oak Ridge National Lab (ORNL), February 15 – 17, 2022. The [agenda](#) accommodated a total of 66 presentations from international collaborators, NCSP task managers, and technical principal investigators. More than 200 people registered for the TPR and the meeting averaged over 100 attendees over the three-day period. Registration represented foreign institutions (22 people from AWE, European Commission, Joint Research Centre, French Alternative Energies and Atomic Energy Commission (CEA), Institut de Radioprotection et de Surete Nucleaire (IRSN), OECD NEA and UK National Nuclear Laboratory), 16 from industry (21 Consulting Group, Amentum, CS Engineering, Fluor, JFoster & Associates, Self-employed and Spectra Tech), 135 from national labs (Argonne, Brookhaven, Idaho, Lawrence Livermore, Los Alamos, Naval Nuclear, Oak Ridge, Pacific Northwest, Sandia, Savannah River and Y-12, 12 from universities (Massachusetts Institute of Technology, North Carolina State, Purdue, Rensselaer Polytechnic Institute, University of New Mexico and University of Tennessee) and 18 from the US government (Army Test and Evaluation Command and the Department of Energy). The virtual Analytical Methods Working Group (AMWG) [meeting](#) held on February 14 and hosted and co-chaired by Mathieu Dupont and Travis Greene, Oak Ridge National Laboratory. Attendance included 29 people.

The Nuclear Data Advisory Group (NDAG) [meeting](#) was also held on February 14 and led by Mike Zerkle, Naval Nuclear Laboratory with 29 in attendance.

The 2022 TPR Presentations web page is now available [here](#) with all the presentations approved for public distribution at this time. Several presentations are still under review and when they are available an announcement email will be sent to all attendees.

Chlorine Worth Study Experiment Performed at the DOE's National Criticality Experiments Research Center (NCERC)

LA-UR-22-20004

Theresa Cutler, Jesson Hutchinson, Laura Worl

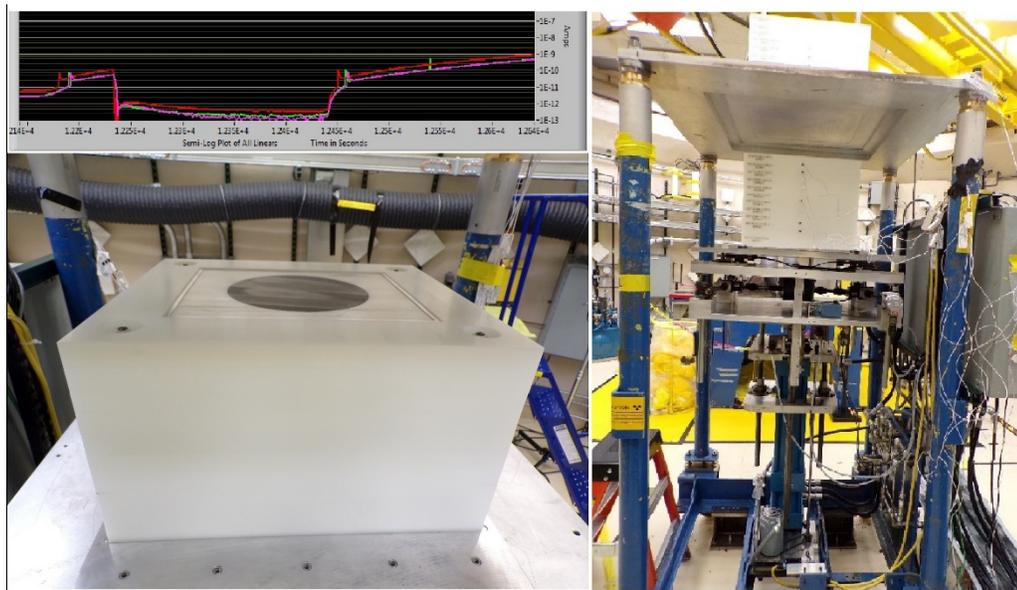
The CWS (Chlorine Worth Study) measurement campaign was completed in December 2021 at the DOE's National Criticality Experiments Research Center (NCERC) at the Nevada National Security Site (NNSS). This measurement campaign provides three unique integral experiments investigating the effects of chlorine interstitial material in a critical reactor system. It was performed in direct support of PF-4 aqueous chloride operations and was a collaboration between NEN, NCS, AMPP, INP and C Divisions at Los Alamos National Laboratory (LANL).

Aqueous chloride operations at PF-4 at LANL serve a number of important functions: (1) recovering plutonium from other processes, (2) reducing waste sent to the Waste Isolation Pilot Plant (WIPP), (3) reducing the number of legacy vault items, and (4) increasing the throughput for americium-241 production. The current criticality safety limits for aqueous chloride operations at PF-4 are 520 grams of plutonium in solution – however, the significant quantities of chlorine in solution, which are known by differential measurements to have high neutron capture, are not in the criticality safety evaluations. Three experimental efforts are underway to validate the chlorine content and to support increased criticality safety limits for aqueous chloride operations: density law measurements, in-situ multiplication measurements, and critical experiments. The CWS experiments are the critical experiment efforts and provide technical

justification to include chlorine in the criticality safety evaluations for aqueous chloride operations.

The CWS experiments consist of layers of Zero Power Physics Reactor (ZPPR) plutonium plates moderated by high-density polyethylene (HDPE), polyvinyl chloride (PVC), or chlorinated polyvinyl chloride (CPVC), arranged to produce a thermal critical experiment. A thick HDPE reflector surrounds the experiments and reduces the overall critical mass as well as providing additional moderation. Numerous Resistance Temperature Detectors (RTDs) are situated in the fuel trays of the CWS experiment to track and record temperatures. The CWS experiments are designed to be constructed on the Planet vertical lift assembly machine at NCERC, which allows the critical mass to be separated vertically into two halves and brought together in a safe manner remotely.

One configuration was designed for each of the three aqueous chloride operation models (representing plutonium concentrations of 30 grams per liter, 300 grams per liter, and 600 grams per liter).



The image on the upper left shows nuclear detector data indicating criticality for the first configuration; the photo on the lower left shows the bottom stack for the second configuration, including the central PVC surrounded by HDPE; and the photo on the right shows the full assembly for the third configuration with the 11 RTDs.

The designs of the experiment - and in particular the moderator designs (including geometry, thicknesses, etc.) - were performed using MCNP6® and optimized using the Whisper code. The methodology followed the framework developed during the LANL ARCHIMEDES project, which optimizes a critical experiment design to an application. Using Whisper, the k_{eff} sensitivities and associated nuclear data uncertainties of the application (i.e., models of the PF-4 aqueous chloride operations) were compared to the k_{eff} sensitivities and uncertainties of the experimental models. A similarity coefficient (partial c_k , where a partial c_k value of one indicates a near perfect match between the application and experiment) was calculated that compared the application model to the experimental model. The experimental models were then adjusted (geometries, dimensions, etc.) until the similarity coefficient was as close to one as could be reasonably achieved within the range of potential designs. The design process also focused on reducing uncertainties associated with geometry, material compositions, and other parameters that would affect a final benchmark evaluation.

Table 1. CWS Preliminary Data

Configuration	Measured Reactor Period (seconds)	Associated Excess Reactivity (cents)
1 30 g/l Pu	57.6	16.5
2 300 g/l Pu	58.1	16.4
3 600 g/l Pu	85.5	12.4

Table 1 gives preliminary results for the three measured configurations for the CWS experiments, including the measured reactor period and associated excess reactivity. Further analysis of the CWS experiments and experimental data will continue in the future and calculations will be performed to analyze experimental and measurement uncertainties. Extensive physical measurements (heights, dimensions, weights, and gap sizes) were taken for each configuration. It is planned that evaluations of these CWS experiments will be submitted to the International Criticality Safety Benchmark Evaluation Project (ICSBEP).



The image on the left shows one of the ZPPR plate trays fully loaded and secured; the photo on the right shows NEN-2 and AMPP-4 personnel involved in the experiment. The PF-4 aqueous chloride operations group (AMPP-4) visited NCERC during the CWS experiments and participated in fuel loadings as well as approaches to critical.

Acknowledgements

This work was supported by the Los Alamos Integrated Nuclear Programs Material Recycle and Recovery Program Office.

NCERC is supported by the DOE Nuclear Criticality Safety Program, funded and managed by the National Nuclear Security Administration for the Department of Energy.

Pulse Reproducibility and Characterization of Godiva-IV

Sandia National Laboratories (SNL) Radiation Modeling and Metrology (Org. 1386) and Applied Nuclear Technologies (Org. 1384) departments have partnered with Los Alamos National Laboratory (LANL) for Godiva Characterization activities (IER 557). Godiva-IV is proposed for use in IER 498, which focuses on the shielding benchmark using a metal critical

source. For these benchmark experiments, the source term variability must be low compared to other sources of experimental uncertainty. The primary goal of the upcoming reproducibility experiments is to attempt to quantify the source term variability, or reproducibility, of Godiva bursts; with a primary focusing on the 70 °C burst. [1]

For this work, LANL has employed the expertise of SNL's Radiation Metrology Laboratory (RML). Utilized in initial data analysis are the SNL standard dosimetry packs. These standard packs include the following passive components: 1 nickel foil, 4 sulfur pellets and 4 calcium fluoride (CaF₂:Mn) thermoluminescent dosimeters (TLD). Sandia's standard dosimetry is selected to monitor a majority of the total neutron fluence in many fission reactor systems. TLDs provide dose to cross-confirm the dose to silicone, a common radiation damage metric in electronic components. Both nickel foils and sulfur pellets follow fluence monitoring in accordance with ASTM standards ASTM E264-19: Standard Test Method for Measuring Fast-Neutron Reaction Rates by Radioactivation of Nickel and E265-15: Standard Test Method for Measuring Reaction Rates and Fast-Neutron Fluences by Radioactivation of Sulfur-32. These standard dosimetry packs were placed outside of the core, on the Godiva TopHat and within the reactor cell to monitor the radiation field.



Figure 1. SNL standard dosimetry packs. Each pack contains one nickel foil seen in the center, 4 pressed sulfur tablets seen in yellow, and 4 calcium fluoride (CaF₂:Mn) thermoluminescent dosimeters (TLD) as seen in the top two packs with 2-D barcodes. The bottom is an example of a characterization scoping pack that contains tungsten, titanium, scandium, and iron.

For in-core and initial reproducibility efforts, five loose nickel foils and 4 sulfur pellets were fielded in the glory hole. To reduce uncertainty in the measurements, a greater number of nickel activation foils were required. The increased number of measurements on the activation of the nickel foils will reduce both systematic and random errors associated with the overall uncertainty in the neutron population, and therefore the reactor power.

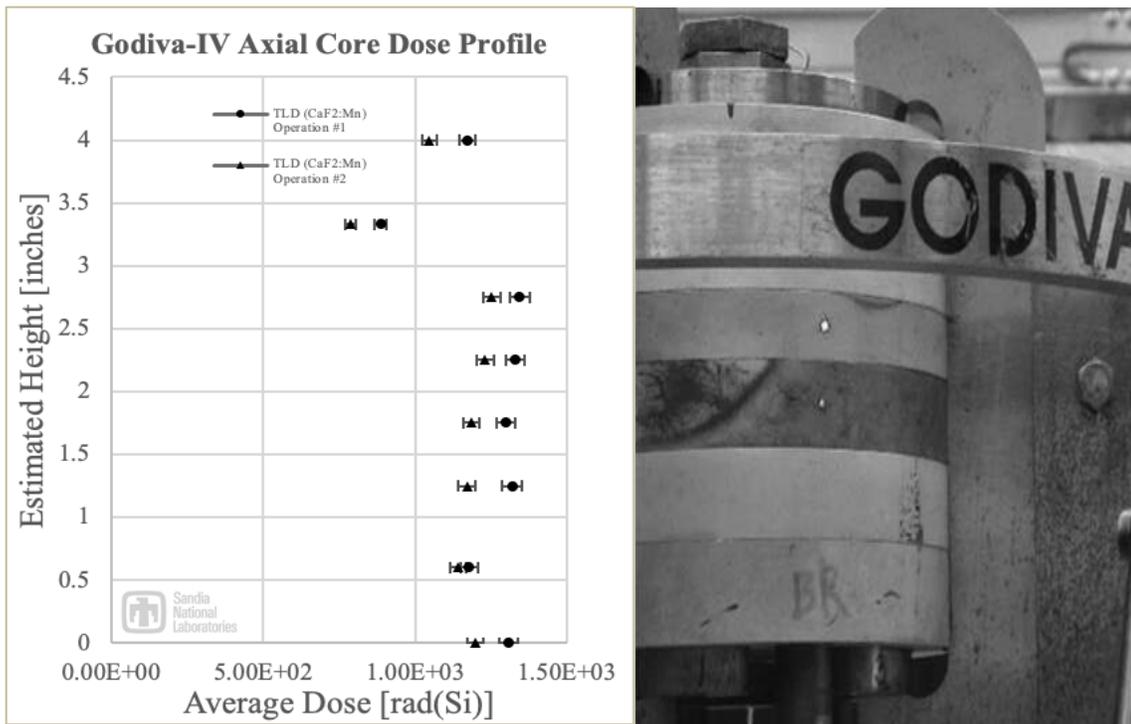


Figure 2. Preliminary dosimetry results of the TLD detectors show the effects of shielding from Godiva's Saturn ring. While variance in dose is expected, 5 of the 7 data points for dose fall within 5% of each other between 2 separate operations. [2]

Additional work proposed for Godiva would be a high-fidelity characterization of the neutron and gamma spectra. The SNL Subject Matter Expert for the Annular Core Research Reactor (ACRR) and various facility characterizations has been approached to review IER 147 and IER 148 reports. Tentatively, SNL plans to deploy dosimetry on bursts for reproducibility measurements to provide preliminary data for characterization planning. The neutron and gamma spectrum of Godiva-IV is planned for characterizing the glory hole and at position(s) outside of Godiva in accordance with ASTM E720-16 and ASTM E721-16 standards [3][4].

Spectral characterization and adjustment will utilize both LSL-M3 and GenSpec, two SNL proprietary codes. These programs use a combination of Least-Squares adjustments and a Genetic Algorithm that aim to reduce the difference between calculated and measure reaction rates within the bounds of the uncertainty covariance of the data set. This ensures the spectrum is optimally adjusted to reduce the overall uncertainty within the neutron energy spectra. A suggested 29 foils would be used to follow the neutron sensor selection criteria from ASTM E720-16. The use of Pu-239, U-235, U-238, and Np-237 are typically required as fission foils confirm spectral shape and resolution, and largely reduce uncertainty in the resulting spectra. The characterization of Godiva-IV will rely heavily on consistency and uniformity of the fluence at common test positions within the room. To ensure proper foil locations are selected, radiation field mapping within the reactor room will be conducted prior to the fielding of activation foils.

Activation foils are proposed to be placed in (1) in the glory hole, and (2) at least two locations in the reactor room. The foils placed in the glory hole (1) will provide the prompt fission neutron spectrum (PFNS) and its associated uncertainties. The foils placed at locations outside of Godiva (2) will provide information on the leakage fluence spectrum, the precision of the

measurements outside the glory hole, the total uncertainty, and the potential effects of room return on the spectrum within the usable test space.

The SNL characterization SME and team have historically only characterized the ACRR central cavity and FREC-II cavity at SNL, along with their modified spectra created using various moderation or absorption materials. In recent years, the need for characterized spectra of test reactor facilities outside of SNL have prompted the characterization of the University of Texas at Austin's Mark-II TRIGA reactor at the Nuclear Engineering Teaching Laboratory (NETL) and the Fast Burst Reactor (FBR) 'MoLLy-G' at the White Sands Missile Range (WSMR) as a National Nuclear Security Administration's (NNSA) Tri-Lab's effort.

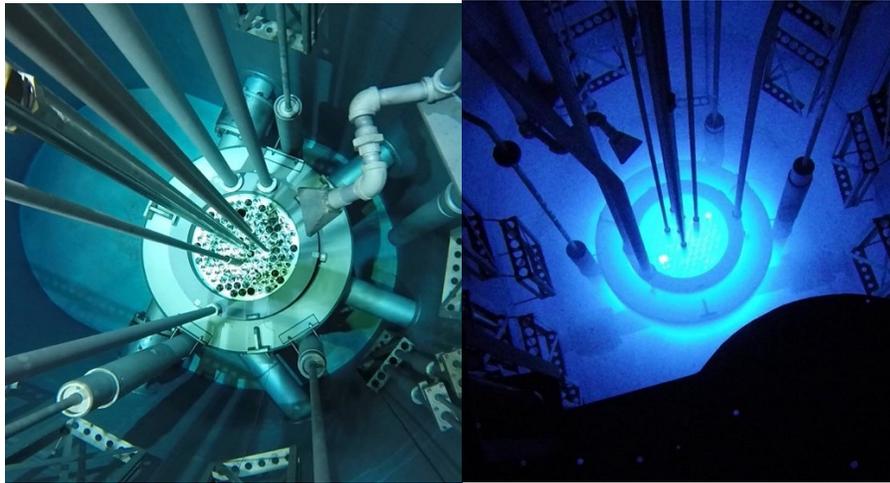


Figure 3. Pictured is the NETL Mark-II TRIGA reactor at the Nuclear Engineering Teaching Laboratory (NETL). Initial criticality of the NETL TRIGA reactor was achieved on March 12, 1992. The fuel elements for NETL are the standard uranium zirconium hydride (UZrH) TRIGA fuel.

- [1] J. GODA, et al., "IER 557: Godiva Characterization CED-2 Final Design Report", Los Alamos National Laboratory (2022).
- [2] J. GODA, et al., "A New Era of Nuclear Criticality Experiments: The First Ten Years of Godiva IV Operations at NCERC," Nuclear Science and Engineering, Submitted (2021).
- [3] ASTM E720-16, "Standard Guide for Selection and Use of Neutron Sensors for Determining Neutron Spectra Employed in Radiation-Hardness Testing of Electronics," ASTM International, Published February 2017.
- [4] ASTM E71-16, "Standard Guide for Determining Neutron Energy Spectra from Neutron Sensors for Radiation Hardness Testing of Electronics," ASTM International, Published December 2016.

Training and Education

Completion of the 2-week Hands-on Nuclear Criticality Safety Course

The two-week hands-on NCS course was held from Jan. 31-Feb. 11, 2022, at the National Atomic Testing Museum, National Criticality Experiments Research Center (NCERC) and Sandia National Laboratory. Twenty students attended the course the first week. Of the 20 students, 6 students attended the hands-on portion the second week at Sandia and 14 attended at NCERC.

Two-week Practitioner Course Dates:

Aug 8–12, 2022 – registration is open (course to be held in person)

The first week (lectures and workshops) will be held at the National Atomic Testing Museum (NATM) while the second week (hands-on portion) will be held at the National Criticality Experiments Research Center (NCERC) and Sandia National Laboratories. The courses are designed to meet the ANSI/ANS-8.26, "Criticality Safety Engineer Training and Qualification Program," requirement for hands-on experimental training. The NATM portion of the course involves virtual classroom lectures and workshops for NCS Evaluation development and the NCERC and SNL portions of the course involve hands-on experiments with the critical assemblies. MSTs, LANL, ORNL, LLNL, SNL, Y12 and NFO staff participate in the course execution.

One-week Manager’s Course Dates:

SANDIA Manager Course – Apr 4-8, 2022 (course to be held in person)

NCERC Manager Course – Jun 6-10, 2022 (course to be held in person)

The SANDIA Manager Course in April is slated to be the course pilot for a new content applicable to Criticality Safety Officers (CSOs) in addition to process supervisors, NCS managers, regulators, and others with NCS program responsibilities.



MCNP® Courses

Class Information: <https://mcnp.lanl.gov/classes/classinformation.shtml>

Fees and Registration Information:

<https://laws.lanl.gov/vhosts/mcnp.lanl.gov/classes/CostsRegistrationInfo.shtml>

Apr 11 – 15, 2022	Intermediate MCNP6 (online)
May 23 – 27, 2022	MCNP6 for Nuclear Safeguards Practitioners (online)
Jun 6 - 10, 2022	Introduction to MCNP6 (online)
Jun 20 – 23, 2022	Criticality Calculations with MCNP6 (online)
Aug 22 – 26, 2022	Introduction to MCNP6 (online)
Aug 29 – 31, 2022	Using NJOY to Create MCNP ACE Files (online)
Oct 3 – 7, 2022	Intermediate MCNP6 (online)
Oct 24 – 28, 2022	Introduction to MCNP6 (online)
Dec 5 – 7, 202	Variance Reduction with MCNP6 (online)

MCNP® 2022 User Symposium

The 2022 MCNP® User Symposium (hosted by Los Alamos National Laboratory) will be held during the week of October 17 as a hybrid event. The in-person option will take place at the Los Alamos J.R. Oppenheimer Center while the virtual option will use the Cvent platform.

The Symposium will build on the 2021 MCNP® User Symposium and is designed to provide a venue for communication among the MCNP development team, MCNP users, and the Nuclear Data Team.

There will be presentations from developers focusing on recent and planned capabilities. The user community will be invited to propose presentations that highlight unique and challenging applications of the MCNP code. We intend to have sessions that focus on themes of current community interest.

The format will be flexible to accommodate presentations of varying length. There will be opportunities for the user community to ask questions of the developers, request ideas from all on how to solve a particular problem and suggest new code or data features. Attendees do not need an MCNP license, but registration will be required.

More detailed information will become available soon at www.lanl.gov/mcnp2022.

If you have questions or suggestions, please email mcnp2022@lanl.gov.



6th Annual SCALE Users' Group Workshop – April 27 – 29, 2022

Registration is open for the 6th annual SCALE Users' Group Workshop that will be held as a hybrid event from Oak Ridge National Laboratory (ORNL), April 27–29, 2022. Please see the meeting website at <https://scalemeetings.ornl.gov> for registration and the draft agenda. The meeting will be offered free of charge to participants. Registration is unlimited for virtual participation. Certain portions of the workshop will be in-person only or virtual only. For in-person participation, you will only be allowed to attend the technical sessions or tutorials you registered for. In-person participation is limited to a total of 50 people per day. The in-person tutorials are limited to 20 participants, and the virtual tutorials have unlimited participation.

You are invited to participate in the meeting and contribute with presentations and discussions on impactful and innovative applications of SCALE. In the “SCALE Open Mic” session participants can present lightning talks and engage the audience in lively Q&As. The “Best SCALE Model Contest” provides an opportunity for all end users to present their most innovative models and compete for special recognition. Models presented previously are showcased in a 2022 SCALE calendar that is available at <https://scalemeetings.ornl.gov/scale-meetings-2021/>.

Contributions for the SCALE Model Contest session require only a single page showing one or more images of a SCALE model. Participants will have 5–10 minutes during the session to provide background on the model, present additional information as desired, and answer questions. All workshop participants will vote on the 12 best models, which will be used for a

SCALE calendar and be displayed on the meeting website. The image(s) can be based on SCALE 6.2 or 6.3 beta rendering. For the SCALE Open Mic session, no formal presentation is required, but presentation slides are welcome as needed. Each participant will be allocated ~5–10 min to present.

Twelve hands-on tutorials will be presented. To be able to participate in these tutorials, registrants must have a user license for SCALE 6.2. To participate in the tutorials that require the use of SCALE 6.3 beta (see detailed tutorials description), licensed users for SCALE 6.2 can find information on how to request the 6.3 beta on <https://www.ornl.gov/scale/releases>. Before registering for any tutorial, please verify that you have or are eligible to request the SCALE license that is required for that tutorial. No SCALE license is required to attend the technical sessions.