NEA Tools to Support SG46 Work

+ WPRS Feedback

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WPEC SG46
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Tools Available
DICE,IDAT,JANIS,NDaST

See kick-off SG46 meeting for more details.

Summary of recent applications of the tools

Industrial engineering: is a branch of engineering which deals with the optimization of complex processes, systems, or organizations. Industrial engineers work to eliminate waste of time, money, materials, person-hours, machine time, energy and other resources that do not generate value. According to the Institute of Industrial and Systems Engineers, they create engineering processes and systems that improve quality and productivity.\[^1\]
## Sensitivity Profiles Available [DICE + IDAT]

<table>
<thead>
<tr>
<th>Handbook Edition</th>
<th>Number of Unique Cases</th>
<th>Sources</th>
</tr>
</thead>
<tbody>
<tr>
<td>2012</td>
<td>727</td>
<td>TSUNAMI1D+TSUNAMI3D [VALID]+MMK-KENO</td>
</tr>
<tr>
<td>2013</td>
<td>3575</td>
<td>Previous +Non VALID cases SCALE6.0 from Balance Inputs</td>
</tr>
<tr>
<td>2014</td>
<td>4011</td>
<td>Previous + MCNP6 + SCALE6.2BClutch</td>
</tr>
<tr>
<td>2015</td>
<td>4065</td>
<td>Previous + New Cases</td>
</tr>
<tr>
<td>2016</td>
<td>~4200</td>
<td>Previous + New Cases + P1 Sensitivities [~400 cases]</td>
</tr>
<tr>
<td>2017</td>
<td>~4200</td>
<td>Previous+P1 Sensitivities [~700 cases]</td>
</tr>
<tr>
<td>2017</td>
<td>~600</td>
<td>IDAT Sensitivities [Waiting input +Code GPT]</td>
</tr>
</tbody>
</table>

- Distributed with the Handbooks and browsable online.
- Sensitivity dot product to characterise similarity.

## Covariance Data Available [JANIS]
- All major libraries have BOXER files with MF32/MF33 processed. (~30 libraries with covariances, ~40 libraries)
- Users can add MF31. In the future these will be available
- No MF34. Will come in the future.
DICE+IDAT With Proposed 7 Group Structure

Quasi-Random ZPPR Fission Sensitivity Profiles
Action

“I also expect a contribution coming from the NEA archives as described by Ian Hill and possibly NEA helping to perform the sensitivity coefficient calculation for some specific system.”
Survey of Reactivity Worth Measurements

There are 634 measurements of reactivity worth's of materials in IRPhE.

There are 2210 measurements of spectral indices in IRPhE.

Recent Benchmarks under WPRS

WPRS

- Expert Group on Reactor Physics and Advanced Nuclear Systems (EGRPANS)
  - McMaster-CTH
  - THORS
  - MHTGR 350 MW
  - SFR-FT Task Force

- Expert Group on Reactor Core Thermal-Hydraulics

- Expert Group on Uncertainty Analysis in Modelling (EGUAM)

- Expert Group on Reactor Fuel Performance (EGRFP)

- Expert Group on Radiation Transport and Shielding (EGRTS)

- PCMI

- UAM-LWR:
  - Kalinin-3
  - Oskarshamn-2

- UAM-SFR

- FHR

- HTR 1D

- International Reactor Physics Experiments Technical Review Group

- C5G7-TD

- SINBAD

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Propagate uncertainties from nuclear data and manufacturing uncertainties to LWR systems.

Stressed that target uncertainty will encapsulate ALL uncertainties
No specific target accuracies were provided. (they were requested)
SFR-UAM

Propagation of uncertainty from pincell to reactor, check consistency. Uncertainties not just from nuclear data.
Archive Benchmarks of Note

Reviewed NEACRP-L and NEACRP-A documents:

- REACTOR SHIELDING BENCHPWX NO. 2 for a PWR (1975)
- Fast Reactor Shielding Benchmark (1975)

- EGIEMAM-I (II)
- HTGR Depletion benchmark
- Kinetic parameters at CROCUS (IRPhE)
- HTR with Reactor Grade Plutonium (R-Z model available)
- PMBR benchmark
- + Many LWR and HWR lattice benchmarks
Nuclear Data Sensitivity Tool (NDaST) Flowchart

Benchmarks (Sensitivities) → Nuclear Data (% Change or Covariance) → Integral Results

- Select / load benchmarks
- Sensitivities (S) & C/E data
  - DICE
  - IDAT
  - Personal Numerical Benchmarks
- Database of over 4000 Sensitivity Data Files

User Input Perturbation (P)
- isotope/reaction/energy cross section
- \( S^*P \) \( \Delta k_{\text{eff}} \) for selected cases
  - C/E output plot grouped by criteria
- Covariance data via JANIS (C)
  - Built in processed data for major libraries
  - Load personal (coverx)
  - M energy groups (fixed)
- \( S^*C^*S^T \)
  - \( U_{(\text{XS})} \) for selected cases
  - Additional uncertainty on output plot grouped by criteria
- Matrix plot showing individual contribution to \( U_{(\text{XS})} \) by isotope-reaction

JANIS MF33: ENDF/B-VII.1 = 2138 files, JEFF-3.2 = 5688 files, JENDL-4.0 = 2155 files, TENDL-2013 = 77811 files, SCALE6.2
Compute representativity between all profiles

Read in sensitivity file

<table>
<thead>
<tr>
<th>Isotope</th>
<th>Reaction</th>
<th>Library</th>
<th>Uncertainty (pcm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>U-238</td>
<td>Inelastic</td>
<td>TENDL2015</td>
<td>N/A</td>
</tr>
<tr>
<td>U-238</td>
<td>Inelastic</td>
<td>TENDL2017</td>
<td>566</td>
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<tr>
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<td>Inelastic</td>
<td>JEFF3.3</td>
<td>806</td>
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<td>Inelastic</td>
<td>ENDF/B-VII.1</td>
<td>1331</td>
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<tr>
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<tr>
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<td>Inelastic</td>
<td>JENDL-4.0</td>
<td>870</td>
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<tr>
<td>U-238</td>
<td>Inelastic</td>
<td>FENDL-3.1b</td>
<td>1328</td>
</tr>
</tbody>
</table>
NDaST

- NDaST was used extensively during CIELO to provide feedback to the project. [Chadwick, Trkov]
- Often it gave results that were confirmed months later by extensive direct substitution.
- Other times it failed. I’ve presented numerous times why… most GLS methods will have similar issues.
- P1/mubar
- PNFS (Ein)…….PNFS NJOY issues
- Inelastic energy/angle changes
Final notes, and some random controversial statements

- Many tools available, many formats. NEA a good place recombobulate.
- Many benchmarks exist. Most aren’t used. Many of the ‘best’ ones aren’t even used.
- I like PIA. Translate upwards to funding people.
- Numerous benchmarks are so downstream that they aren’t even thought about. How can adjustments be proposed without all downstream applications considered?
- When giving R/Z models considered computing similarity metric to detailed models.
- Adjustments might not even have access to some of the levers that evaluators are using.
- SG33 did excellent work on integral experimental correlations (Ishikawa). Continuing to examine their impact on adjustments would help calibrate the amount of effort in this area.

SG46: **Efficient** and **Effective** Use of Integral Experiments for Nuclear Data Validation