**Impact of FENDL-2.1 Updates on Nuclear Analysis of ITER and Other Fusion Systems**

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### FENDL-2.1 Background

- Revision to FENDL-2.0 (1995/96)
- Compiled November 2003, INDC(NDS)-451
- 71 elements/isotopes
- Reference data library for nuclear analysis of ITER and other fusion systems

### Data Source for FENDL-2.1

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### Findings of ENDF/B-VII.0 Data Impact

- Minor impact on ITER nuclear analysis is expected except for ITER-TBM nuclear analysis due to changes in data for Li-6, Pb-208, and F-19
- Calculations of foil activation and tritium breeding for ITER relevant FNG integral experiments yield nearly similar results for FENDL-2.1 and ENDF/B-VII.0
- Effects of changes could be large in other fusion systems
  - Power plants with breeding blankets
  - Inertial fusion systems (e.g., H-3 and Au-197 data are important for ICF target neutrons)

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### FENDL-3 Development

- An effort was initiated by the IAEA in 2008 to update the FENDL library with the objective of improving the status of nuclear databases for fusion devices including FF-MF
- The library (FENDL-3) represents a substantial extension of FENDL-2.1 library toward higher fusion devices including IFMIF
- Improving the status of nuclear databases for ITER relevant integral experiments

### FENDL-3/SLIB2 Calculation for FNG Bulk Shield Experiment

- Using FENDL-3/SLIB2 in place of FENDL-2.1 in ITER relevant calculations gives 1.5-3.5% higher nuclear parameters behind the thick water-cooled shield. This was identified as processing error
- Using the corrected processed FENDL-3/SLIB2 files instead of FENDL-2.1 resulted in large increase in nuclear parameters behind the thick water-cooled shield. This was identified as processing error and was corrected in a recent processed library FENDL-3/SLIB2a

### ITER Calculational Benchmark

- To further investigate increase in low energy (E<0.1 MeV) neutron flux observed with FENDL-3/SLIB2 we performed simple calculations for slabs with all water, all SS316, and SS316/H2O mixture
- Small change (~5%) for pure water but a factor of ~7 increase for SS/water implied that larger changes are not related to change in H data
- Largest difference obtained in Mo (JENDL-3.3-JENDL-HE)
- Independent assessment by A. Tkrov (JSI) confirmed differences
- A temporary patch to NJOY was proposed that solves processing problems for all affected materials
- New processed ACE files (FENDL-3/SLIB2a) in Feb 2010

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### Identifying and Fixing Processing Errors in FENDL-3/SLIB2 Files

- Using the corrected processed FENDL-3/SLIB2a files prevented the large overestimate at deep penetration locations
- Neutron and gamma fluxes at VV and magnet that are heavily shielded by water-cooled SS are higher by 1-3% than predicted by FENDL-2.1
- Energy spectra from FENDL-3/SLIB2a and FENDL-2.1 are close with differences up to ~10% at E>2 MeV
- Lower (n,γ) cross sections for H-1 at high energy could be reason for higher (High E) neutron flux in regions heavily shielded by water-cooled SS
- Nuclear parameters at magnet are higher by ~1.5-3.5% than predicted by FENDL-2.1 with largest differences in fast neutron fluence and dpa

### Conclusions

- Replacing ENDF/B-VII.0 data in FENDL-2.1 by ENDF/B-VII.0 resulted in minor change (<1%) in nuclear parameters for ITER relevant calculations. However, larger changes in calculated ICF target neutronics parameters and tritium breeding were observed in previous analysis
- Calculations of foil activation and tritium breeding for ITER relevant integral experiments yield nearly similar results for FENDL-2.1 and ENDF/B-VII.0
- Using the initial ACE FENDL-3/SLIB2 files instead of FENDL-2.1 in ITER relevant calculations gives 1.5-3.5% higher nuclear parameters in regions that are heavily shielded with water-cooled SS (vacuum vessel, magnets) and differences could be due to change in H-1 evaluation used
- These results should be taken into account when calculating ITER magnet parameters with FENDL-2.1