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Production of Criticality Safety Standard Data with Monte-Carlo Code MVP / Nuclear Data Library JENDL-3.2 Validated Using ICSBEP Data

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Introduction

- JAEA's effort
 - Development of computational methods
 - Validation
 - Calculation of criticality data
 - Publication
- Growing-up computational capability
 - Monte-Carlo calculation more usual
- 2nd-ver. Data Collection Part of Handbook



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Handbook History

— The First Version

- The 1st handbook in 1998
 - Basic principles of criticality safety
 - Validation of JACS
(KENO-IV / MGCL-137 Lib. of ENDF/B-IV)
 - Introduction of ECMF and ECLLMF
- Criticality safety assessment of ROKKASHO reprocessing plant



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Handbook History

— ECMF & ECLLMF Values

- ECMF: Estimated Critical Multiplication Factor
- ECLLMF: Estimated Critical Lower Limit Multiplication Factor

Group		Simple-form		General-form	
		ECMF	ECLLMF	ECMF	ECLLMF
Homo.	-LEU	0.991	0.973	0.989	0.958
	-HEU	0.985	0.954	0.989	0.954
	-Pu	1.008	0.980	1.004	0.973
	-MOX	1.013	0.980	1.018	0.980
	-MIX	1.010	0.980	0.991	0.950
Hetero.	-LEU	0.995	0.978	0.996	0.978
	-Pu	1.004	0.964	1.004	0.964
	-MOX	0.997	0.980	0.998	0.980

- Limit $k = 0.95$ for practical use to judge subcriticality



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Handbook History — Revisions

- In 1999, release of the 2nd-ver. hand book (except its data collection part)
 - Safety margins related to dissolution and extraction process in a reprocessing plant
 - Alarm system for criticality accidents
- In 2001, publication of preliminary version of a guide introducing the burnup credit



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New Validation

— Selection of Benchmarks from ICSBEP HB

Group	ICSBEP ID	Facility / Institute
Homo. -LEU	LEU-SOL-THERM	SHEBA / LANL, IPPE, STACY / JAEA
	LEU-COMP-THERM	MARACAS / IRSN
	-HEU HEU-SOL-THERM	ORNL, IPPE
	-Pu PU-MET-FAST	LANL, VNIIEF
	PU-SOL-THERM	Hanford, PNL
-Mix	MIX-SOL-THERM	PNC-DOE
Hetero. -LEU	LEU-COMP-THERM	PNL, TCA / JAEA, Apparatus B / IRSN, AEA Technology, Kurchatov Institute
	-MOX MIX-COMP-THERM	PNL, CRX / Westinghouse, TCA / JAEA, Hanford



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New Validation

— MPV and JENDL-3.2

- MVP : JAEA's cont.-energy Monte-Carlo code
 - In 1994, **1st-ver.** for a vector processor computer
 - In 2004, 2nd-ver. with new capabilities in scattering treatment, time-dependent tallies, reaction rate calculation, etc. Available also for the parallel processing machines.
- JENDL : Japanese Evaluated Nuclear Data Lib.
 - In 1977, ver. 1, with 72-nuclide
 - In 1994, **ver. 3.2**, with 340-nuclide
 - In 2010, ver. 4, with 406-nuclide



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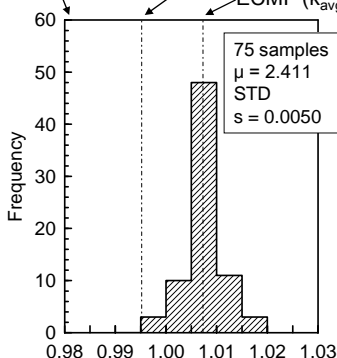


New Validation — Statistical Study

ECLLMF : 0.98 ECLLMF candidate : $k_{avg} - \mu s = 0.9952$

ECMF (k_{avg}) : 1.0073

Summary



Group	Samples	ECMF (k_{avg})	STD (s)	μ	ECLLMF candidate ($k_{avg} - \mu s$)
Homo. -LEU	75	1.0073	0.0050	2.411	0.9952
-HEU	55	1.0052	0.0070	2.503	0.9877
-Pu	46	1.0044	0.0077	2.566	0.9846
-Mix	29	0.9999	0.0057	2.775	0.9840
Hetero. -LEU	121	1.0026	0.0064	2.303	0.9878
-MOX	47	0.9991	0.0053	2.558	0.9855

Probability of misjudge : 2.5% / Confidence level : 97.5%

Histogram of benchmark calculation results (Homo-LEU)

- ECLLMF = 0.98 for All Groups



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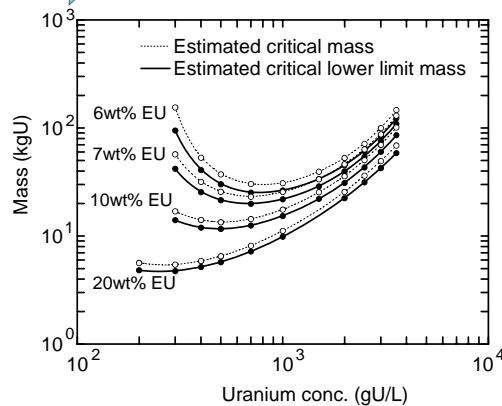
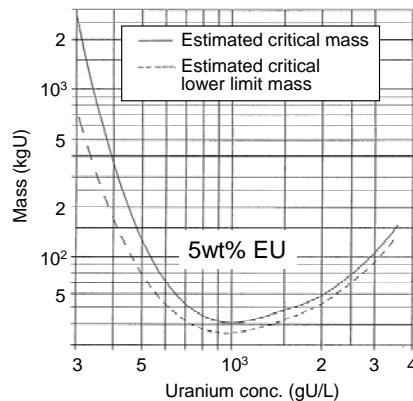


Calculation of Criticality Data

1st Version



2nd Version



Estimated critical and critical lower limit masses of ADU (example)



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Future Plan

- Introduction >5%EU fuel in LWRs
The program has been postponed.
- Safe and Efficient SF storage and transportation
 - Introduction of the burnup credit
 - Validation and utilization of JENDL-4
 - Criticality data of SF, MA, SiO₂-fissile mixtures
- Fukushima debris handling
- Publication of data, in English, on Internet



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Conclusions

- New experimental data from ICSBEP, where STACY data are also included.
- New computation method with MVP / JENDL 3.2
- Validation of the method has concluded that $k = 0.98$ can be used for a new safety limit value.
- New criticality data has been published in 2009 based on the new safety limit value.
- JAEA activity in the criticality safety field will continue on the BUC and Fukushima debris issues.

