Study on SUPEL Scenario for Direct Recycling of Spent BWR Fuel in BWR System

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Outline

- *Background*
- *Objective*
- *Methodology*
- *Results and Discussion*
- *Conclusion*

PHYSICS

Background

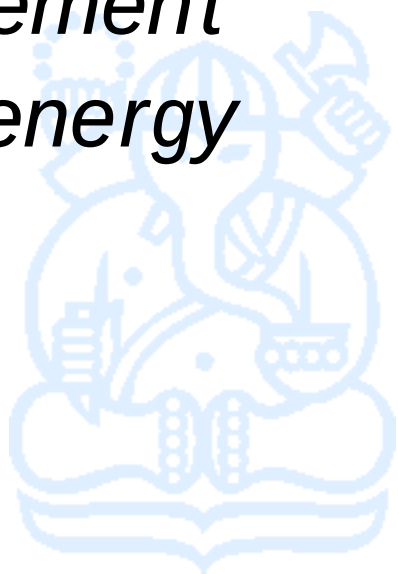
Nuclear Energy Industry grows with 3 main issues:

1. *Reactor safety ➔ Multi-barrier System : Defense in Depth*
2. *Nuclear Proliferation ➔ political aspects*
3. *High level wastes (HLW) management*

➔ *The truly problem in nuclear energy*

⇩

if we can manage HLW, public acceptance maybe increase



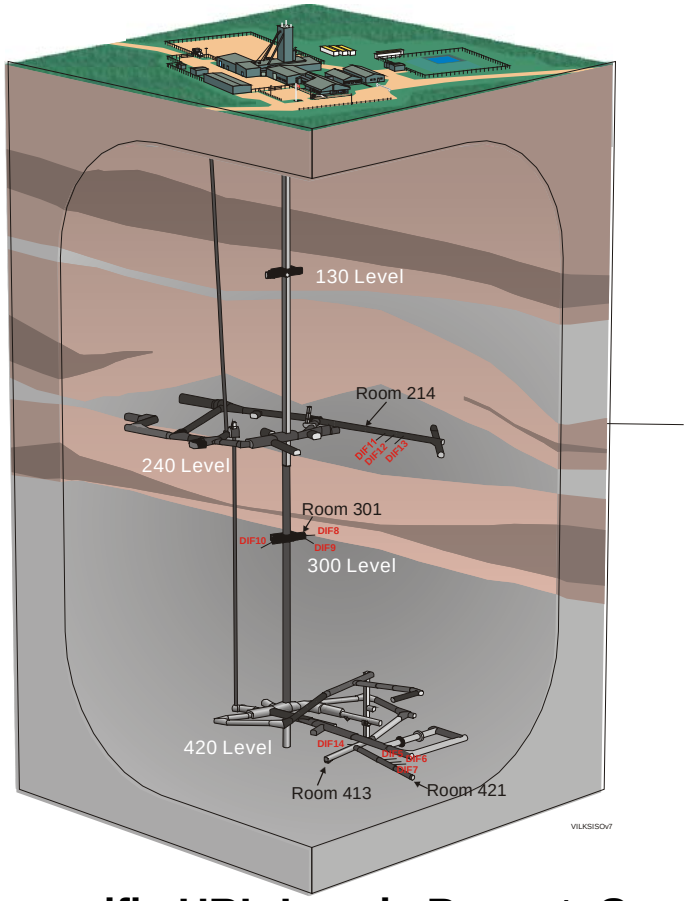
PHYSICS

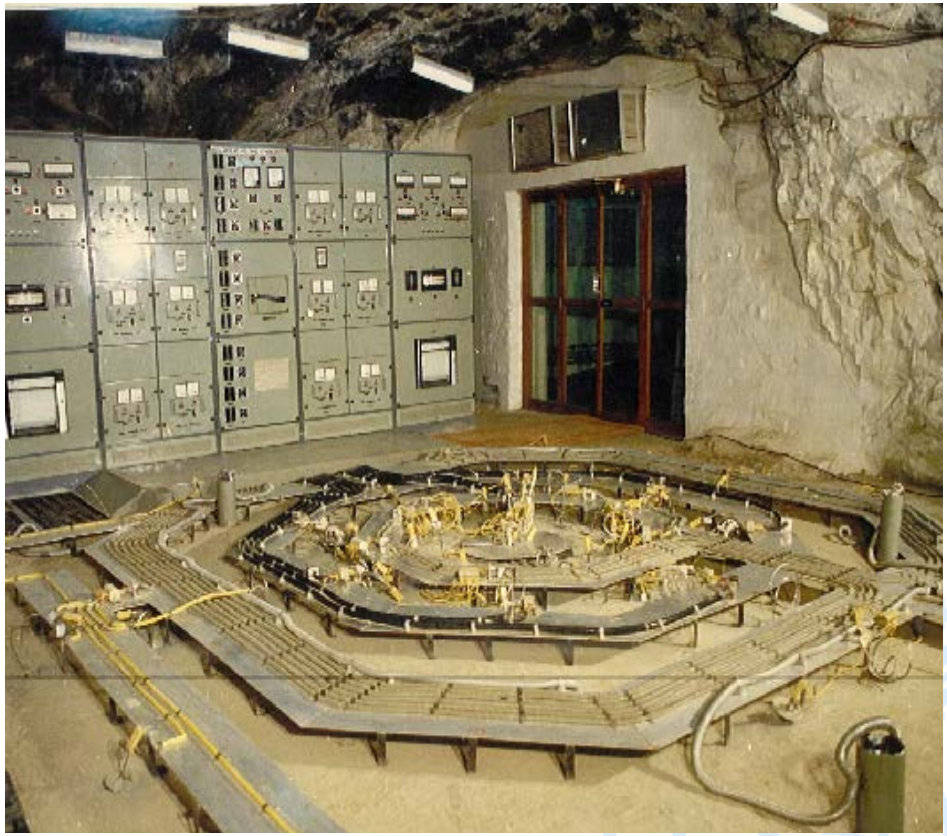
Background ...

- Once countries decide to “go nuclear” they may think about “HLW repository site” or at least “underground research laboratory (URL)”

PHYSICS

Underground Research Laboratories





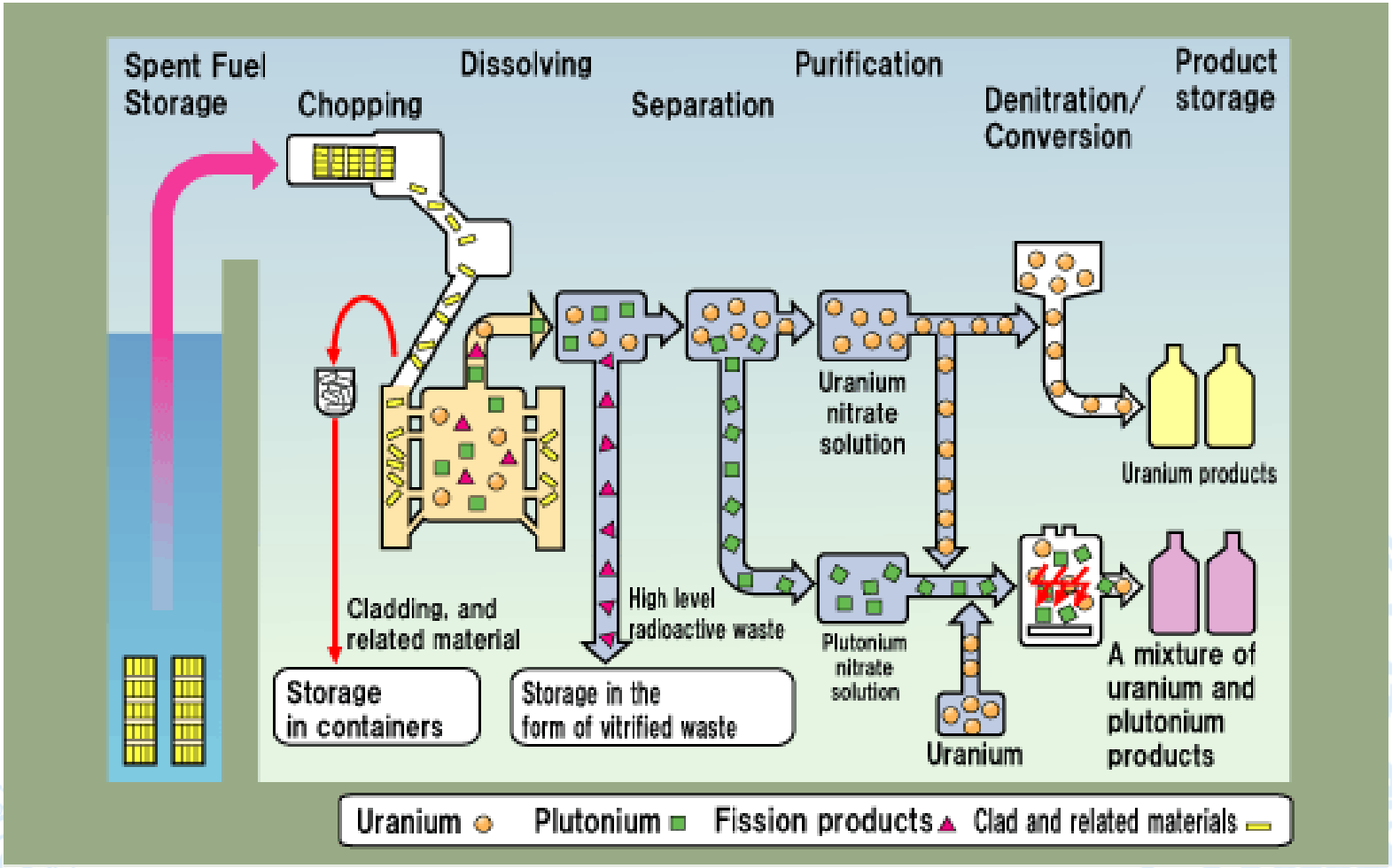
Site specific URL:Lac de Bonnet, Canada (http://www.oecd-nea.org)

Generic URL: Kolar Gold Field, India

Background ...

- The other option ➔they may choose "*closed cycle strategy*" to recycle HLW in any type of nuclear reactor or hybrid systems ➔reprocessing plant is required
- Its very difficult to have country's own reprocessing plant ➔ International regulation and very high cost
- Even OECD countries likes Korea is not allowed to has a reprocessing plant

Background...



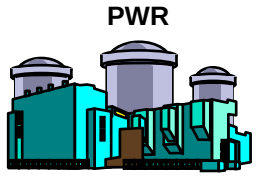
Spent Fuel Reprocessing
(http://www.jaea.go.jp/english/04/tokai-cycle/02.htm)

PHYSICS

Background ...

- IAEA (International Atomic Energy Agency) suggests to construct and operate some regional reprocessing plants (for example in east asia region)
- Non-proliferation strategy proposed *not to separate Plutonium with Minor Actinides* during the spent fuel reprocessing
- Some countries (especially which not allowed to have any reprocessing plant and enrichment plant) should find a ***best way to deal with their HLW.***

DUPIC: Direct Use of spent PWR fuel In CANDU reactors Strategy



Korea:

-Advanced NE Industry

-- Good budget

--Not allowed to have RP & EP

-- More than 1 type of NPP (LWR & CANDU)

*** DUPIC : Direct Use of spent PWR fuel In CANDU reactors**

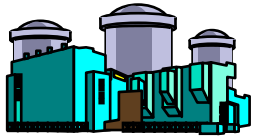
PHYSICS

Background ...

- Country likes Indonesia (not allowed to has reprocessing plant & enrichment plant, and If “go nuclear” may has only 1 type of nuclear reactor) should has another alternative way for dealing with nuclear waste
- Best nuclear power plant (NPP) candidate for Indonesia is LWR (light water reactor) either pressurized water reactor (PWR) or boiling water reactor (BWR)
- We have proposed a scenario that called: **SUPEL** (Straight Utilization of sPEnt LWR fuel in LWR reactors) **scenario** for Nuclear Waste Recycling Strategy

PHYSICS

SUPEL Scenario for Recycling Strategy



LWR

Spent LWR Fuel

On-site Storage

AFR Storage

Permanent Disposal

No Disposal

Proliferation Resistance

SUPEL Fuel Fab

SUPEL

PWR once-through

Uranium Saving

Enriched Uranium

LWR

Spent LWR/SUPEL Fuel

On-site Storage

Permanent Disposal

Less Disposal

*** SUPEL : Straight Utilization of sPEnt LWR fuel in LWR reactors**

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Objective

- We have evaluated SUPEL scenario for Nuclear Waste Recycling Strategy in PWR

- The objective of this study is to **evaluate the SUPEL scenario for BWR spent fuel direct recycling scheme in BWR System**

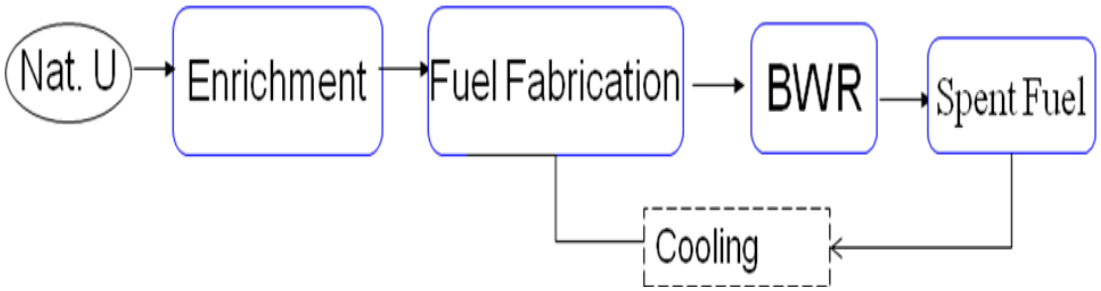


Diagram of SUPEL Scenario for BWR

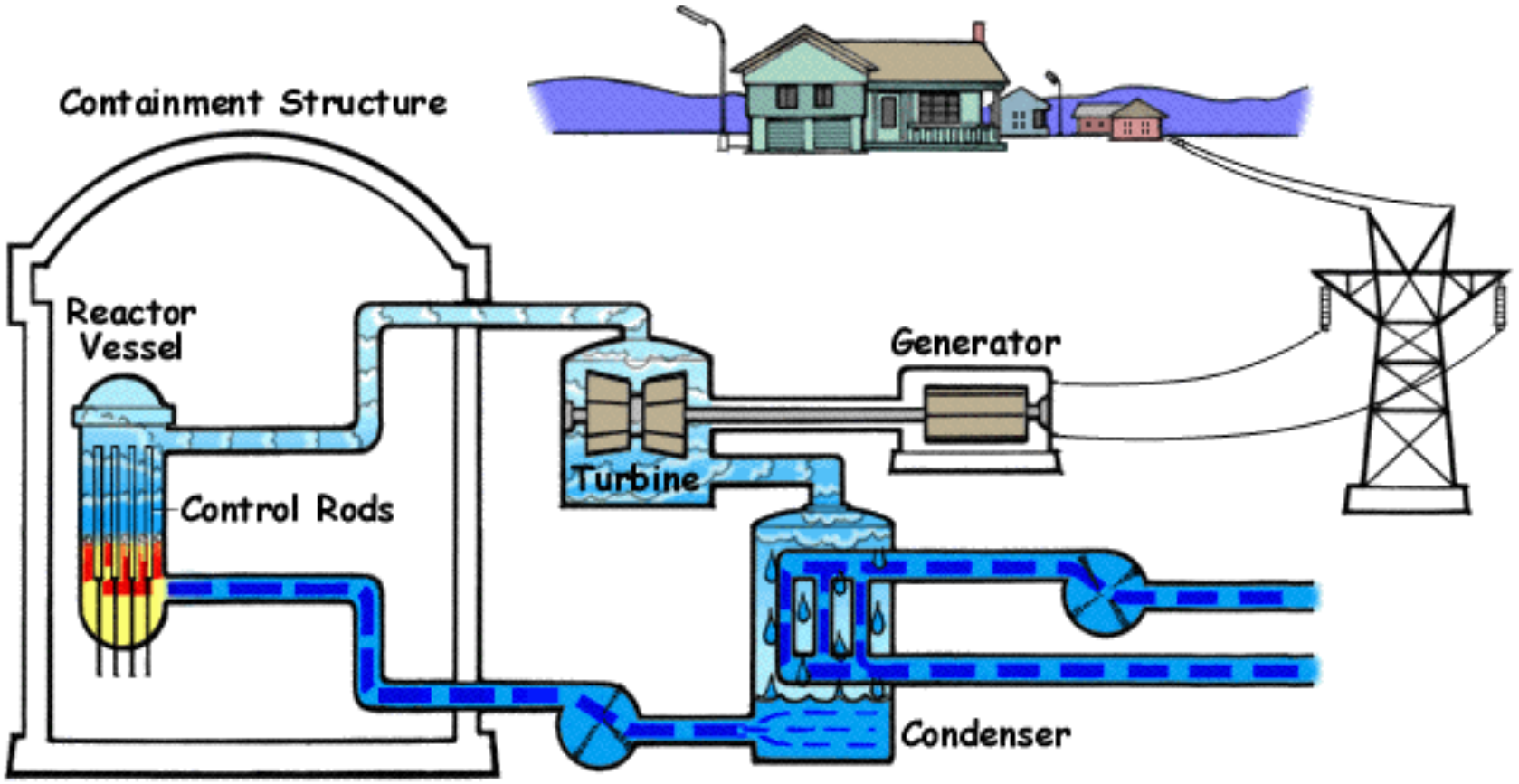
PHYSICS

Methodology

Design parameter of studied BWR

Thermal power output	3000 MWth
Average cell power density	59 Wcm^{-3}
Fuel pellet diameter	0.529 cm
Fuel rod diameter	0.615 cm
Pin pitch	1.444 cm
Fuel type	Oxide
Cladding	Zircaloy-2
Coolant	H_2O

Nuclear Power Plant using Boiling Water Reactor (BWR)

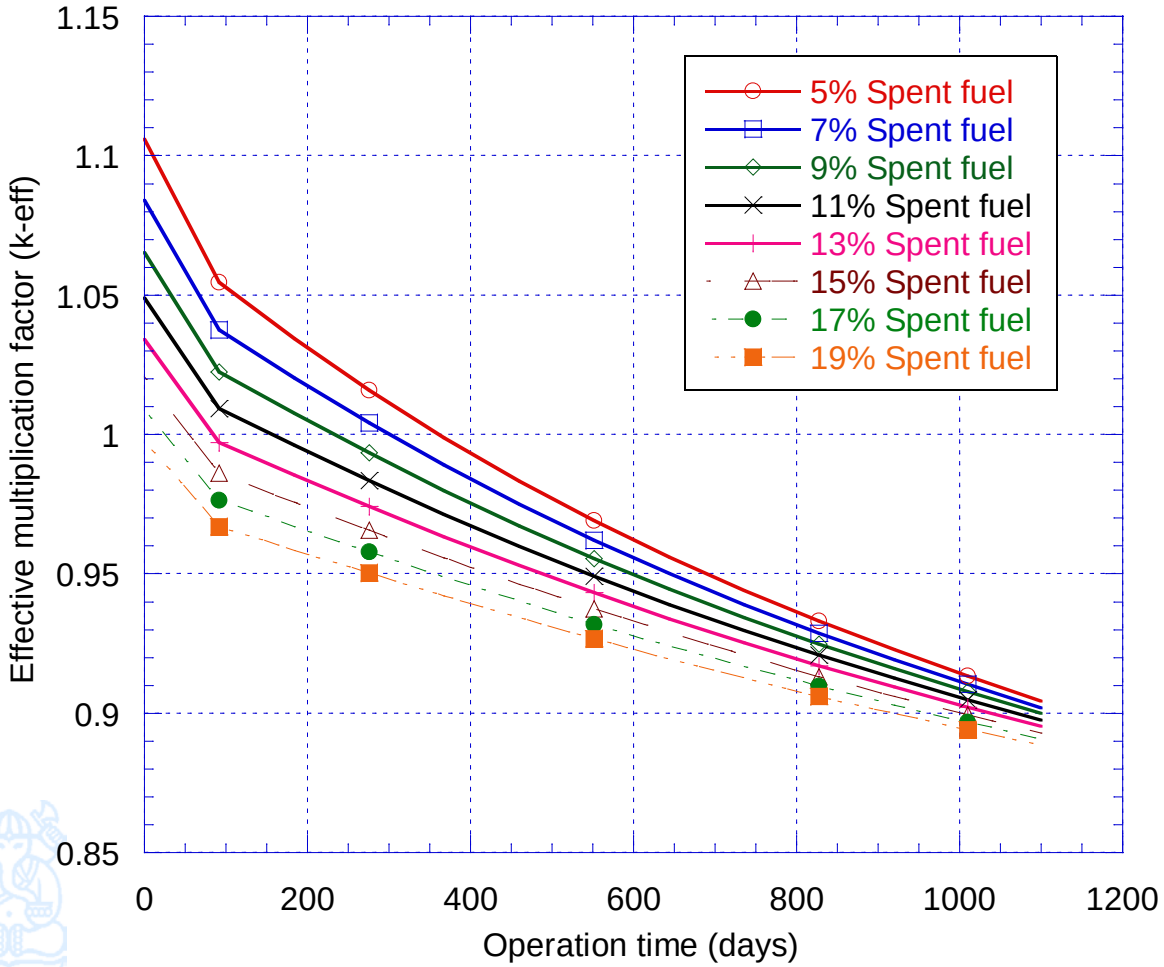


PHYSICS

http://www.nrc.gov/

RESULTS and DISCUSSION

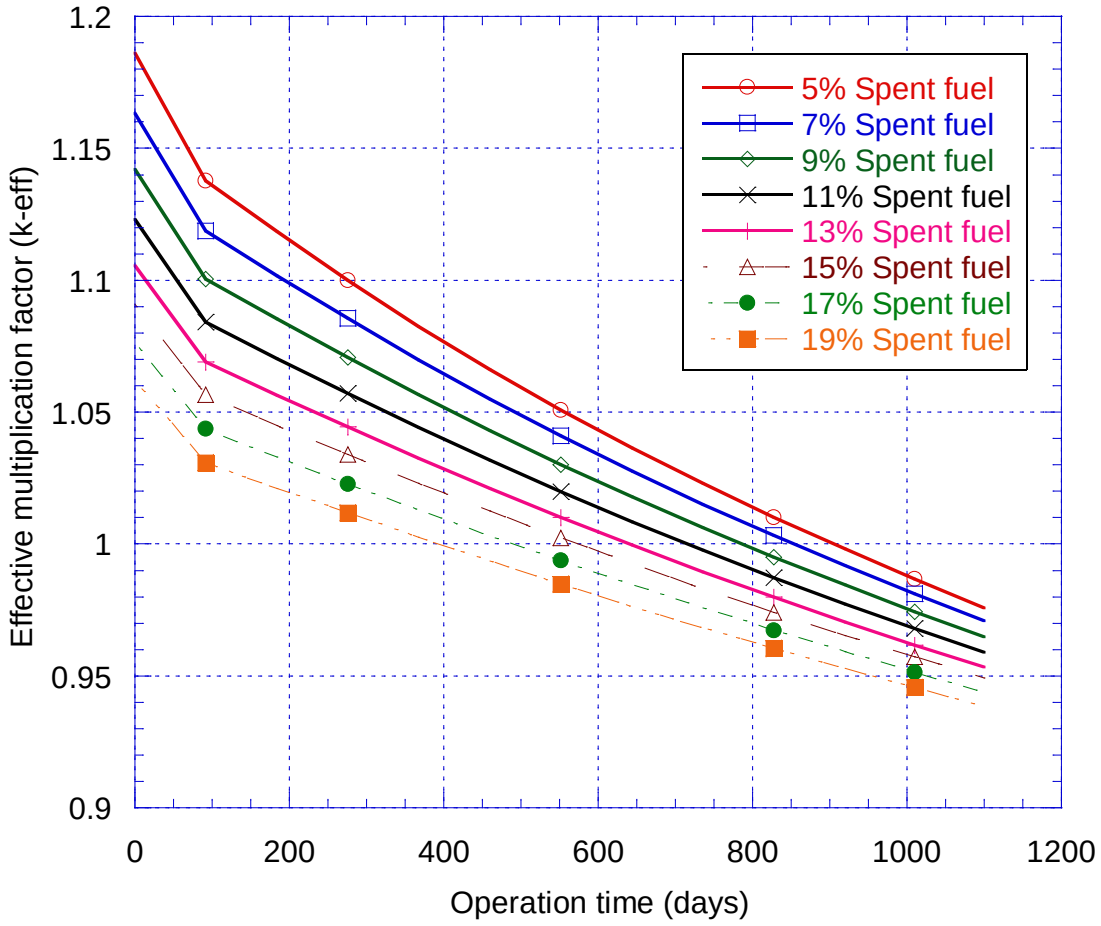
Effective multiplication factor (k-eff) of 3.0% of UO_2 enrichment



BWR can not attain its criticality condition

PHYSICS

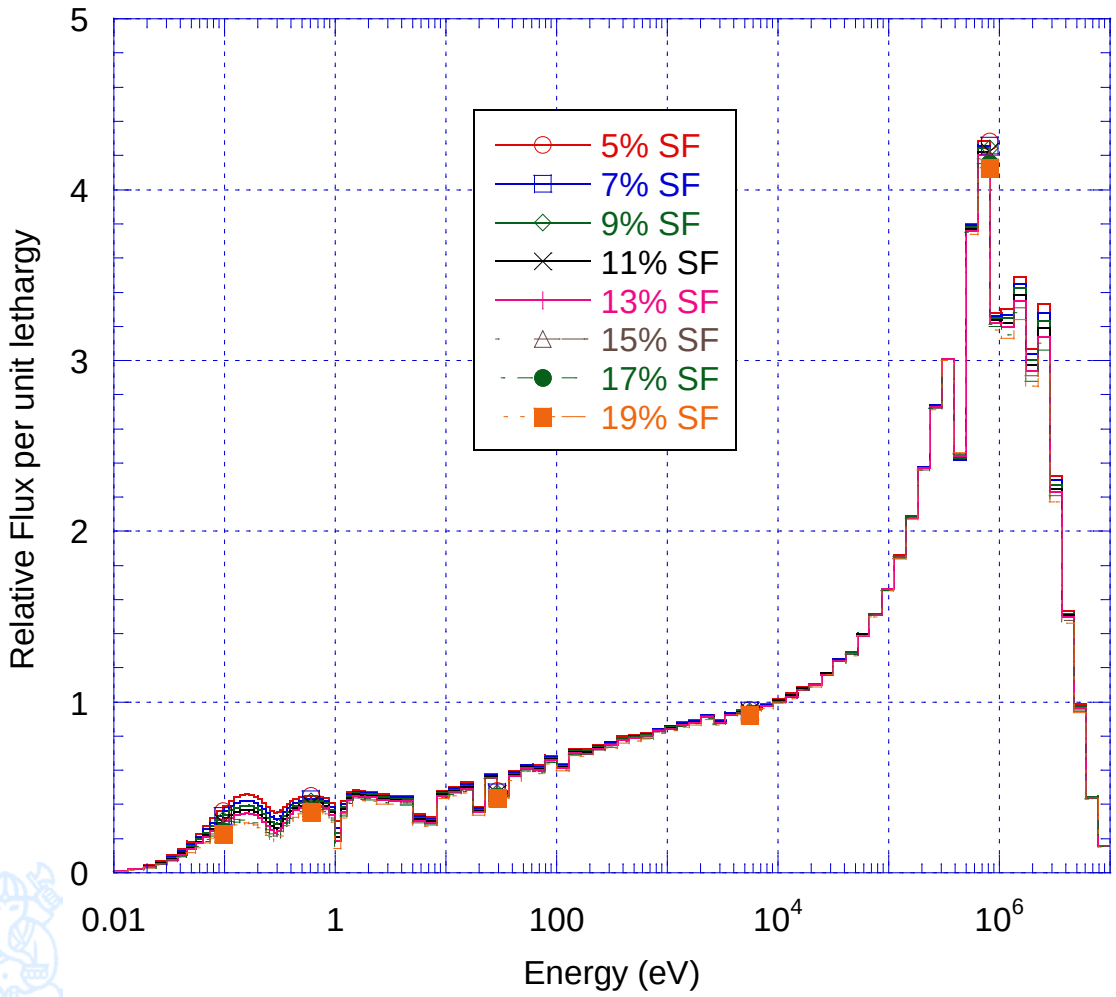
Effective multiplication factor (k-eff) of 5.0% of UO_2 enrichment



BWR can attain its criticality condition for 5% enrichment with 5% - 9% spent fuel

PHYSICS

Comparison of neutron spectrum



the neutron spectra become harder (shifts to the high energy region) with the escalating of trans-uranium (TRU) nuclides in the reactor.

PHYSICS

Conclusion

The study on direct recycling of BWR spent fuel to support SUPEL scenario has been conducted.

- The reactor can achieve it criticality for U-235 enrichment in loaded fresh fuel is higher than 5% with the amount of spent fuel in the core is less than 9%.
- The neutron spectra become harder with the increasing of U-235 enrichment in loaded fresh fuel as well as the amount of spent fuel in the core.


Arigatou Gozaimasu
Terima kasih
Thank you