APPENDIX

FORM-A

INFORMATION ON TRANSMUTATION DEVICES AND THEIR PHYSICS PARAMETERS

Name :

Affiliation :

Address :

Tel : Fax ::

I. General

(1) Selected nuclides to be transmuted in your transmutation device:

(2) Principal design consideration in your design work, such as transmutation capability, conservative design, small change from original core Performance, safety consideration and so on:

(3) Type of transmutation devices, reactor or accelerator-driven device:

•l reactor ❑ accelerator-driven device

If you give x for reactor, go to Section II in page 2, and if YOU give x for accelerator driven device, go to Section III in page 8.

11. Nuclear Reactor used for transmutation

We provide the information form for uraium-plutonium cycle based nuclear reactor here. Then,if You work for thorium-uranium based reactor,please kindly provide similar form.

(1) Description of nuclear reactor:

1) Type of reactor:

❑ PWR ☐ BWR •l Gas-cooled reactor ❑ Heavy water-moderated reactor
❑ LMFBR ❑ Liquid metal-cooled reactor •l Others

If You select Others or there is fairly large difference between your proposing reactor and its original reactor listed above,please give its brief description or illustration here or another white sheet.

2) Thermal and electric powers:

- Thermal power : _____ MWt
- Electric power: _____ MWe

3) Core dimension:

- Equivalent core diameter: _____ cm
- Equivalent core bight : _____ cm

4) Fuel arrangement regarding transmutation materials:

❑ Homogeneous arrangement ❑ Heterogeneous arrangement

In the case of Heterogeneous arrangement,

. Volume ratio of fuels with trannsrnutation materials to all fuels: _____ %

5) Type of fuels:

•l Oxide fuel •l Nitride fuel •l Carbide fuel ❑ Metallic fuel

6) Core averaged fresh fuel composition (wt%):

- U : Pu : Np,Am,Cm : long-lived FP= : : :

7) Isotopic composition (wt%) of Pu, Minor Actinide (Np, Am, Cm) and long-lived FP:

" Pu

Pu-238	Pu-239	Pu-240	Pu-241	Pu-242

· Minor Actinide (Np, Am, Cm)

Np-237	Am-241	Am-242	Am-243	Cm-243	Cm-244

Long-lived fission products (ex. Tc, I etc.)

Please add isotopes of long-lived FP, if necessary.

8) Averaged core composition (vol%):

Fuel	Clad+Structure	Coolant	Moderator*

*: for gas-cooled reactor, heavy water-moderated reactor, etc.

(2) General physics parameters and transmutation capability:

1) Principal core characteristics:

Items	BOL[1)]	BOEC[2)]
Thermal power in core (MWt) Power density : averaged in core (w/cm') maximum in core (w/cm') Linear heat rate : avaraged (w/cm) maximum (w/cm) Neutron flux averaged in core (n/cm^2.see) Neutron energy averaged in core (KeV) Fuel dwelling time in core (EFPD)* Burnup reactivity swing (%δk/k/365EFPD)		

*: Equivalent Full Power Days, 1) Beginning of life, 2) Beginning of Equilibrium cycle

2) Inventory and transmutation capability:

· Fuel and transmutation material inventory and their mass balance:

Nuclides	Initial inventory (kg)	Mass balance in EOC (unit:kg)		
		BOEC[1] mass	EOEC[2] mass	EOEC-BOEC
Uranium				
U-235				
U-236				
U-238				
Plutonium				
Pu-238				
Pu-239				
Pu-240				
Pu-241				
Pu-242				
Neptunium				
NP-237				
Amerisium				
Am-241				
Am-242m				
Am-243				
Curium				
Cm-242				
Cm-243				
Cm-244				
Cm-245				
Higher actinides				
Long-lived FP				

1):Beginning Of Equilibrium Cycle, 2):End Of Equilibrium Cycle.
Please add isotopes of long-lived FP for transmutation,if necessary.

. Transmutation capability

$$\text{Transmutation capability} = \frac{\text{Difference of minor actinides between EOEC and BOEC}}{\text{(EFPY*between EOEC and BOEC) x thermal power(MWt)}}$$

$$= \underline{\qquad\qquad\qquad} \text{ kg/MWt · EFPY}$$

*:Equivalent Full Power Year.

(3) Safety-related physics parameters:

Please fill the table with the values at BOL.

Parameters	Values
Coolant void reactivity effect (%δ k/k)	
- All reactor region voided	
- Core and axial blanket voided"	
- Only core voided*	
Doppler reactivity coefficient* (Tdk/dT)	
Effective delayed neutron fraction"	
Prompt neutron life time* (see)	
Contol rod material	
Central control rod worth (%δ k/k/kg)	

*:only for fast reactors.

(4) Data and method used in reactor design work:

1) Nuclear data:

· Nuclear data source library or group cross-section library:

❑ ENDF/B- ❑ JEF •l JENDL- •i Others

❑ ORIGEN- ❑ WIMS ❑ JFS ❑ CARNAVAL- •I Others

If You select Others or there are any significant modifications for the original library on minor actinides and long-lived FP isotopes, please give their brief description.

2) Calculation method:

. Neutronic calculation code:

Name of code : ❑ Diffusion ❑ Transport
•l 2D •l 3D

Number of energy group used for calculation:

If there are any significant differences between your code and usually used code,please give their brief description.

· Burnup calculation code:

Name of code: ❑ OD ❑ 1D ☐ 2D ❑ 3D

If there are any significant differences in calculation model and/or burnup chain model of minor actinide and long-lived FP isotopes, please give their brief description.

(5) Integral experiment related to transmutation:

1) Irradiation experiments in power reactor:

· Name of facility:

❑ Fast reactor
•l Thermal reactor

· Irradiated minor actinide and long-lived FP isotopes:

· Purpose of experiment:
•l Nuclear data verification
•l Transmutation rate measurement
•l Others

If You select Others, please give a brief description.

2) Experiment in critical assembly and research reactor:

. Name of facility:

•l Fast neutron field
•l Thermal neutron field

Measured minor actinide and long-lived FP isotopes:

· Kind of measurements:
•l Reaction rate ratio
❑ Sample reactivity worth
•l Others

If You select Others, please give a brief description.

3) Future programme, if You have:

Thank You for your hearty cooperation !!

III. Accelerator-driven Devices used for transmutation

We provide the information form for uranium-plutonium cycle based nuclear rectors here. Then, if You work for thorium-uranium based reactors, please kindly Provide similar form.

(1) Description of Accelerator driven devices:

1) Type of Accelerator:

❑ Proton LINAC •l Electron LINAC ❑ Others

If you select Others, please give its brief description or illustration here or another white sheet.

2) Particle's energy and current:

· Particle : _____
. Energy : _____ MeV
· Current : _____ mA

3) Type of device:

❑ Subcritical core ❑ Subcritical core wtih target* ❑ Others
*: specific spallation target, such as Pb and W.

If You select Others, please give its brief description or illustration here or another white sheet

4) Neutron spectrum in device:

•! Fast ❑ Thermal ❑ Others

5) Thermal and electric powers :

· Thermal power : _____ MWt
· Electric power : _____ MWe

6) Target and/or subcritical core dimension, and subcriticality:

· Equivalent target
diameter : _____ cm and height : _____ cm

· Equivalent subcritical core
diameter : _____ cm and height : _____ cm

· Effective neutron multiplication factor : _____

7) Fuel arrangement in subcritical core:

•l Homogeneous arrangemnet •l Heterogeneous arrangement

In the case of Heterogeneous arrangement,

· Volume ratio of fuels with transmutation materials to all fuels: _____ %

8) Type of fuels :

•l Metallic fuel •l Molten salt or slurry fuel •l Oxide fuel
•l Nitride fuel •l Carbide fuel •l Others

If You select Others,please give brief description.

9) Core avearged fresh fuel composition (wt%):

. U : Pu : Np,Am,Cm : long-lived FP= : : :

10) Isotopic composition (wt%) of Pu, minor actinide(Np,Am,Cm) and long-lived FP:

“ Pu

Pu-238	Pu-239	Pu-240	Pu-241	Pu-242

· Minor actinide (Np,Am,Cm)

Np-237	Am-241	Am-242	Am-243	Cm-243	Cm-244

• long-lived fission products (ex.Tc,I etc.)

Tc-99	1-129	Sr-90	Cs-137		

11) Materials and Avarged composition in subcritical core:

	Fuel	Clad+Structure	Coolant	Moderator
Materials	---	---		
Ave.composition (vol%)				

12) Type of target

. Target materials and its cooling materials

(2) General physics Parameters and transmutat, on capability

1) Principal core & target characteristics :

Items	BOL[1)]	BOEC[2)]
Thermal power in core (MWt) Power density : averaged in core (w/cm^3) maximum in core (w/cm') Linear heat rate : averaged (w/cm) maximum (w/cm) Neutron flux averaged in core ($n/cm^2 \cdot sec$) Neutron energy averaged in core (keV) Fuel dwelling time in core (EFPD)* Target dwelling time in core (EFPD)* Burnup reactivity swing (%δk/k/365EFPD)		

*:Equivalent Full Power Day, 1) Beginning of life, 2) Beginning of equilibrium cycle

2) Inventory and transmutation capability:

· Fuel and transmutation material inventory and their mass balance:

Nucides	Initial inventory (kg)	Mass balance in BOC (unit : kg)		
		BOEC[1] mass	EOEC[2] mass	EOEC-BOEC
Uranium				
U-235				
U-236				
U-238				
Plutonium				
Pu-238				
Pu-239				
Pu-240				
Pu-241				
Pu-242				
Neptunium				
Np-237				
Amerisium				
AM-241				
Am-242m				
Am-243				
Curium				
Cm-242				
Cm-243				
Cm-244				
Cm-245				
Higher Actinides				
Long-1ived FPs				

1) Beginning Of Equilibrium Cycle, 2) End Of Equilibrium Cycle.
Please add isotopes of long-lived FP for transmutation,if necessary.

· Transmutation capability :

$$\text{Transmutation capability} = \frac{\text{Difference of minor actinides between EOEC and BOEC}}{(\text{EFPY*between EOEC and BOEC}) \times \text{thermal power(MWt)}}$$

$$= \underline{\qquad\qquad} \text{ kg/MWt·EFPY}$$

*:Equivalent Full Power Year.

(3) Safety-related physics parameters:

Please fill the table with the values at BOL.

Parameters	Values
Coolant void reactivity effect (%δk/k)	
- All device region voided	
- Core and target voided	
- Only core voided	
Doppler reactivity coefficient (%Tdk/dT)	
Effective delayed neutron fraction	
Beam switching off time (sec)	
Beam equivalent worth (%δk/k/MW)	
Particle beam alignment	

(4) Data and method used in the device design work:

1) Nuclear data:

Nuclear data source library or group cross-section library :

•l ENDF/B-___ •l JEF •l JENDL- •l HILO ❑ Others

•l ORIGEN-_ □ WINS ❑ JFS ❑ CARNAVAL-❑ Others

If You select Others or there are anY significant modifications for the original library on minor actinides and long-lived FP isotopes, please give their brief description.

2) Calculation method:

. Neutronic calculation code:

Name of code: _____ ❑ Diffusion •l Transport
❑ 2D •l 3D

Number of energy group used for calculation: _____

· High and medium energy reactions calculation code:

• l NMTC/JAERI •l LAHET • 1 HETC/KFA2 •l Others

If there are any significant differences between your code and usually used code, please give their brief description.

· Burnup calculation code :

Name of code: _____ ❑ OD •l ID •l 2D • l 3D

If there are any significant differences in calculat: onal model and/or burnup chain model of minor actinides and long-lived FP isotopes, please give their brief description.

(5) Integral experiments related to transmutation:

1) Spallation integral experiment:

· Name of accelerator facility: _____

· Irradiated minor actinide and target material isotopes:

· Purpose of experiments:
  - •l Measurement of nuclear data in the high energy region
  - ❑ Verification of spallation codes
  - ❑ Reaction rate, reaction products, particle energy spectrum, energy deposition
  - ❑ Others

If you select Others, please give their brief description.

2) Experiment using subcritical assembly:

· Name of facility: _____ •l Fast neutron field
•l Thermal neutron field

· Measured minor actinide and long-lived FP isotopes:

. Kind of measurements: ❑ Reaction rate ratio
❑ Others

If You select Others, please give their brief description.

3) Future programme, if you have:

Thank You for your hearty cooperation ! !

FORM-B

INFORMATION ON TRANSMUTATION STRATEGIES

Name :

Affiliation :

Address :

Tel : Fax :

I. Objectives of your transmutation strategies, such as radiotoxicity reduction in the deep storage (source-term reduction), radiotoxicity reduction at the outcome in the biological sphere (long-term risk reduction), mass reduction in a straight forward way, and others.

❑ in your national programme •l in your organisation programme
•l your own opinion

II. Your fuel cycle concept with transmutation and associated partitioning, including an illustration if possible.

III. Your opinion on overall effect of introducing partitioning and transmutation into the nuclear fuel cycle:

Thank you for your hearty cooperation !!