

2000

RAPID FRAPCON - 3 TUBRNP 가  
Transplantation of RAPID program into FRAPCON - 3 and its  
comparison with TUBRNP model

105 , 305 - 600

UO<sub>2</sub> 가  
가  
UO<sub>2</sub>  
RAPID(RAdial power and burnup Prediction by following fissile  
Isotope Distribution) FRAPCON - 3 TUBRNP  
가 RAPID가

Abstract

Due to the radial variation of neutron flux and its energy spectrum inside the UO<sub>2</sub> fuel pellet, local fission density and fissile isotope production rate are varied with the burnup, which leads to local variation of burnup, power and fissile isotope densities. RAPID(RAdial power and burnup Prediction by following fissile Isotope Distribution) program, which predicts power and burnup distribution of UO<sub>2</sub> fuel by considering all affecting factors was inserted into FRAPCON - 3 to be compared with TUBRNP model. It is expected that RAPID with more detailed models for all the fissionable nuclides would have better accuracy.

1.

가  
 (neutron flux)      Pu - 239      가      가  
 가      (fissile material)  
 가

[1].

RAPID      TUBRNP /  
 가      TUBRNP      FRAPCON - 3      RAPID

## 2. TUBRNP(TransUranus BuRNP model)

가      FRAPCON - 3[2]      TUBRNP  
 RADAR      [1]      . RADAR      U - 238, Pu -  
 239  
 (< 40 MWD/kgU)      가  
 Pu      Pu - 239가      가  
 Pu - 240, Pu - 241, Pu - 242

TUBRNP      Pu - 240, Pu - 241, Pu - 242  
 U - 238      Pu - 239

RADAR

$$f(r) = 1 + 3.45 \exp(-3(r_{out} - r)^{0.45})$$

f(r) =      , r<sub>out</sub> =      , r =

Bessel

가      TUBRNP      U - 238

가

reaction rate

[3].

## 3. RAPID

RAPID TUBRNP  
 TUBRNP U - 235, Pu - 240, Pu - 241, Pu - 242  
 , , 가 U - 238  
 가

(reaction rate)

가 .

RAPID HELLIOS[4]

best fitting

U - 238

- U - 238 :

$$s_a^{238}(t) = (0.9414 - 0.0109 \cdot EN) \cdot (0.8995 + 1.205 \times 10^{-3} \cdot BU - 8.0335 \times 10^{-7} \cdot BU^2 - 1.3819 \times 10^{-8} \cdot BU^3)$$

- U - 238 :

$$f(r) = 0.9219 + (7.0629 + 0.0691 \cdot EN) \exp(-6.879 \cdot (1 - r)^{0.3285})$$

- U - 238 :

$$s_a^{238}(t, r) = s_a^{238}(t) \cdot f(r)$$

가

가 .

HELLIOS

(one - group

neutron flux)

$$f(t, r) = [(C_1^n + C_2^n \cdot EN + C_3^n \cdot EN^2) + C_4^n \cdot BU + C_5^n \cdot BU] \cdot POWDEN$$

$C_j^n$  (j = 1 to 5) HELLOS , POWDEN = ,

BU = , EN = .

U - 235, U - 238, Pu - 239, Pu - 240, Pu - 241, Pu - 242

U - 235

/ 가 [5].

RAPID

,

U, Pu

RIM effect

3. RAPID

가

RAPID

TUBRNP

/

가

TUBRNP

FRAPCON - 3

RAPID

. RAPID

RAPID

FRAPCON - 3

(dimension)

. 1

RAPID

RAPID

RAPID

time step loop

FRAPCON - 3

time step loop

가 1

loop

RAPID

가

node(axial node)

RAPID

가

RAPID

FRAPCON - 3

RAPID

가

2

FRAPCON - 3

RAPID

RAPID

. 3

4

40 MWD/kgU

U - 235

FRAPCON - 3

RAPID

FRAPCON - 3

RAPID

TUBRNP

/ 가

4. RAPID

TUBRNP

RAPID

RAPID

TUBRNP

/

가

5

RAPID가 TUBRNP

가 가 69

MWD/kgU

(normalized radius=1.0)

RAPID가

TUBRNP

6

가

TUBRNP

가 가

7

[6]

TUBRNP

RAPID

가

8 9

Pu - 239, Pu - 240, Pu - 241, Pu - 242

RAPID TUBRNP

가

, RAPID가

HELLIOS

5.

RAPID

TUBRNP

/ 가

RAPID

FRAPCON - 3

가

FRAPCON - 3

RAPID

RAPID

TUBRNP

, , Pu

RAPID

TUBRNP

가

RAPID가

6.

7.

seminars on the Mathematical/Mechanical Modeling of Reactor Fuel Elements, Commission of the European Communities, EUR - 13660 EN (1991) 267

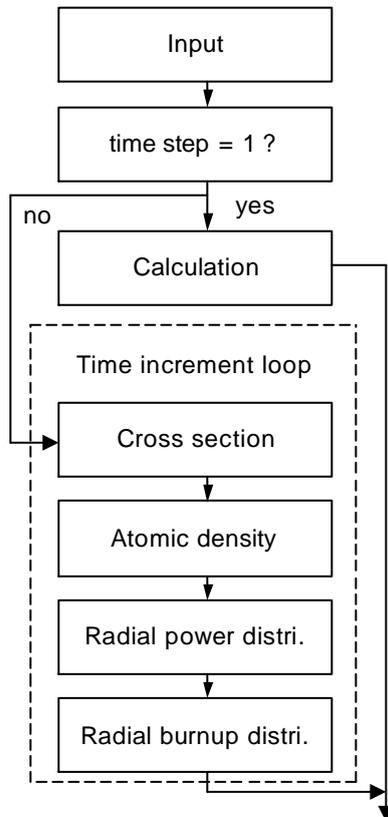
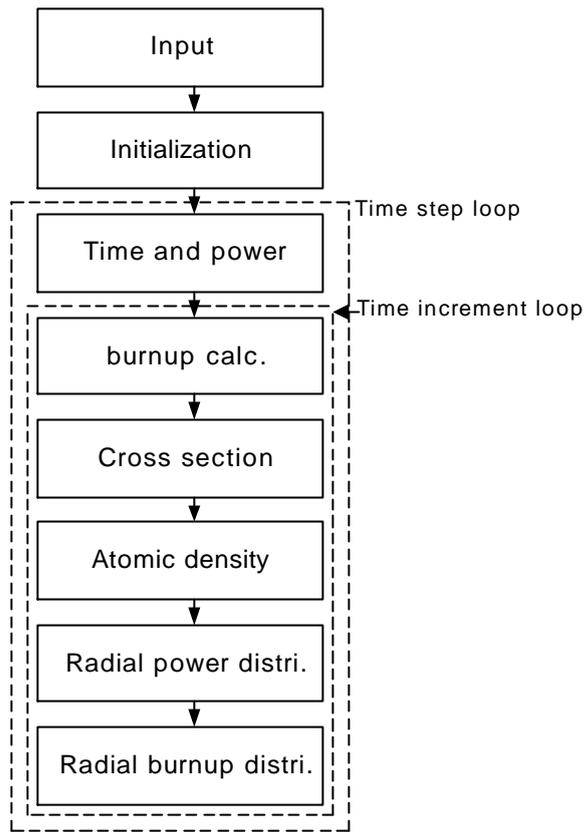
[2] D.D. Lanning et al., "FRAPCON - 3 : Modifications to Fuel Rod Material Properties and Performance Models for High - Burnup Application", NUREG/CR - 6534, PNNL - 11513, vol1, 1997

[3] K. Lassman, et al., "The radial distribution of plutonium in high burnup UO<sub>2</sub> fuels", J. Nucl. Mats, 208 (1994) 223 - 231

[4] E.A. Villarino, et al., "HELLIOS : Angularly dependent collision probabilities", Nucl. Sci. and Eng., 112 (1992) 223 - 231

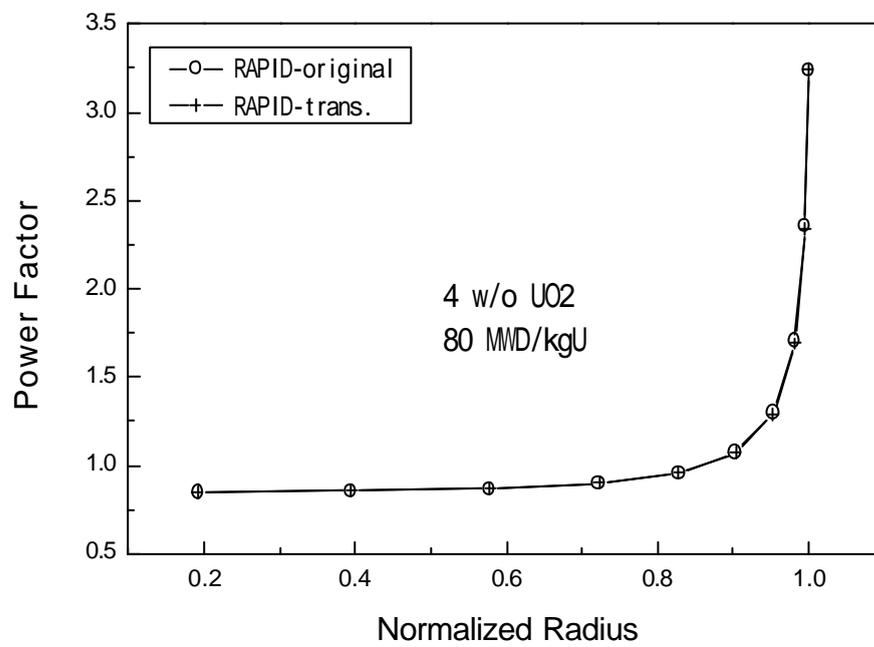
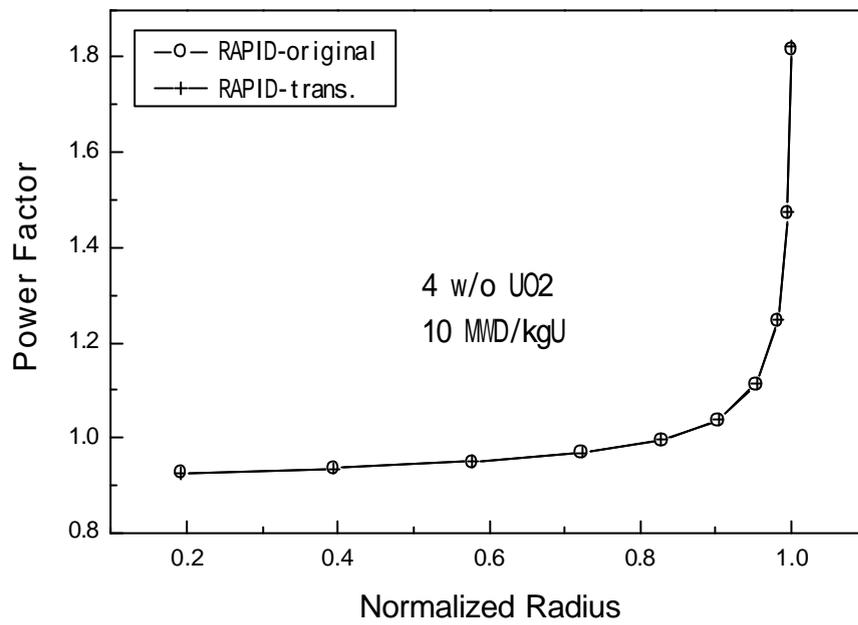
[5] , "RAPID Program to Predict Radial Power and Burnup distribution in UO<sub>2</sub> Fuel", KAERI/TR - 1217/99, 1999

[6] J. Spino, D. Baron, M. Coquerelle, A.D. Stalios, J. Nucl. Mater. 256(1998) 189.

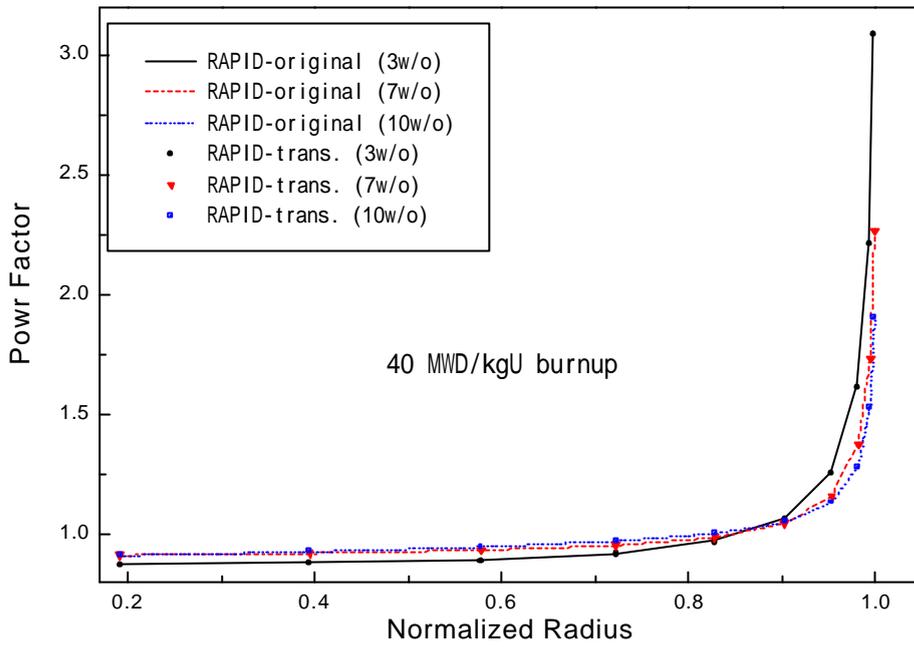


1.

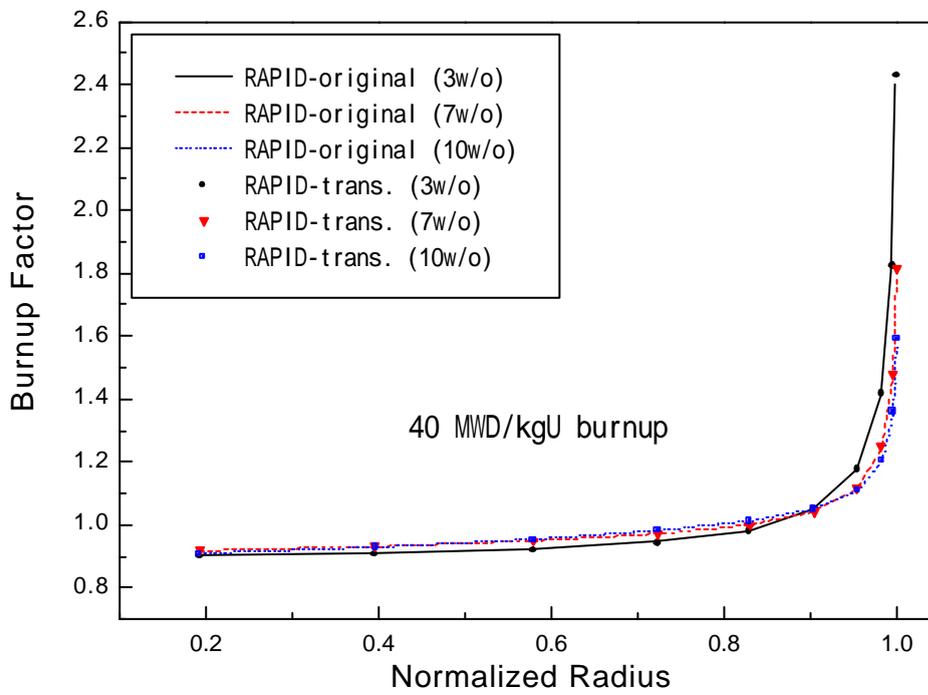
RAPID



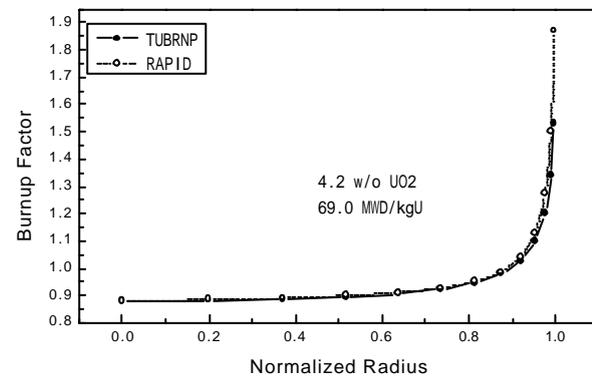
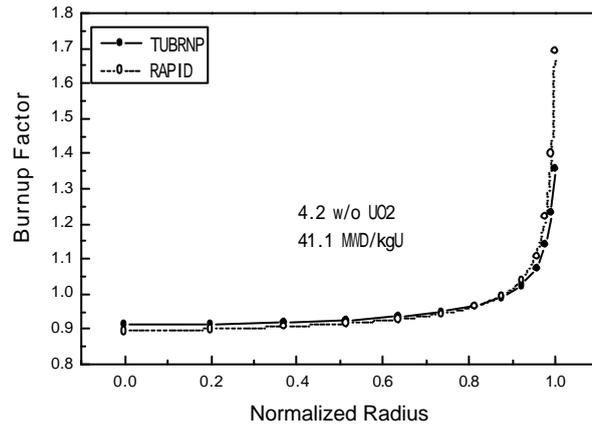
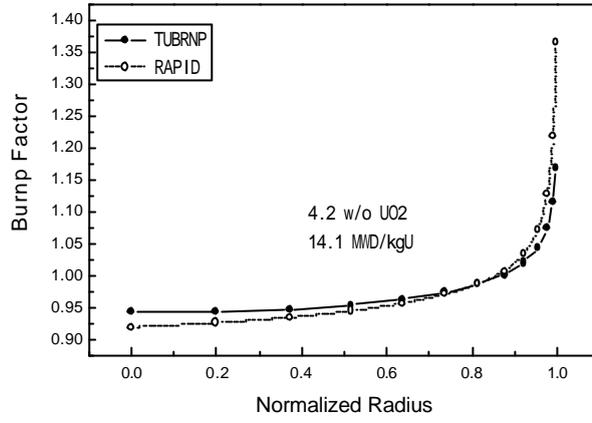
2. RAPID ( )



3. RAPID ( )

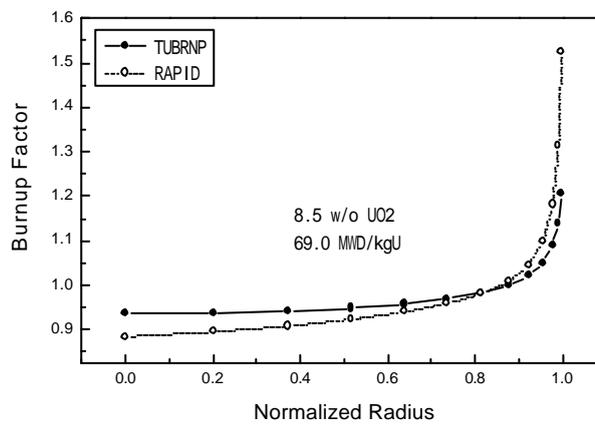
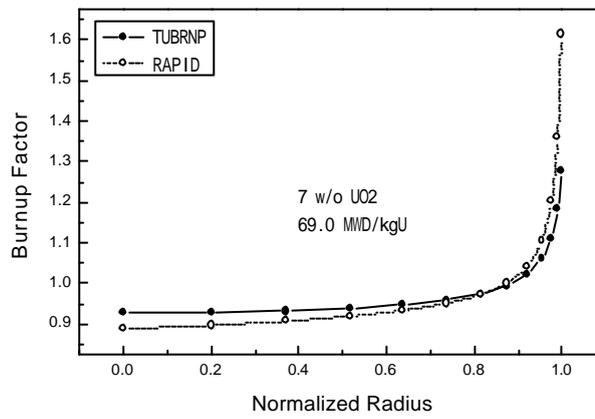
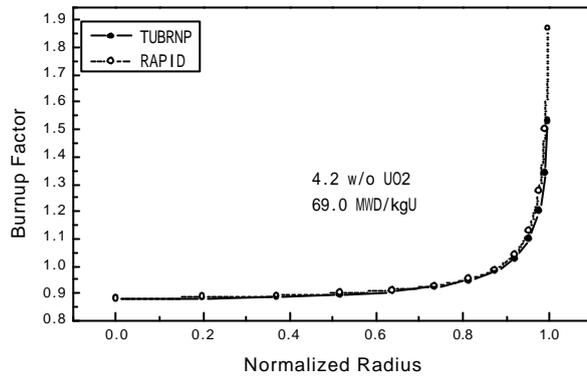


4. RAPID ( )

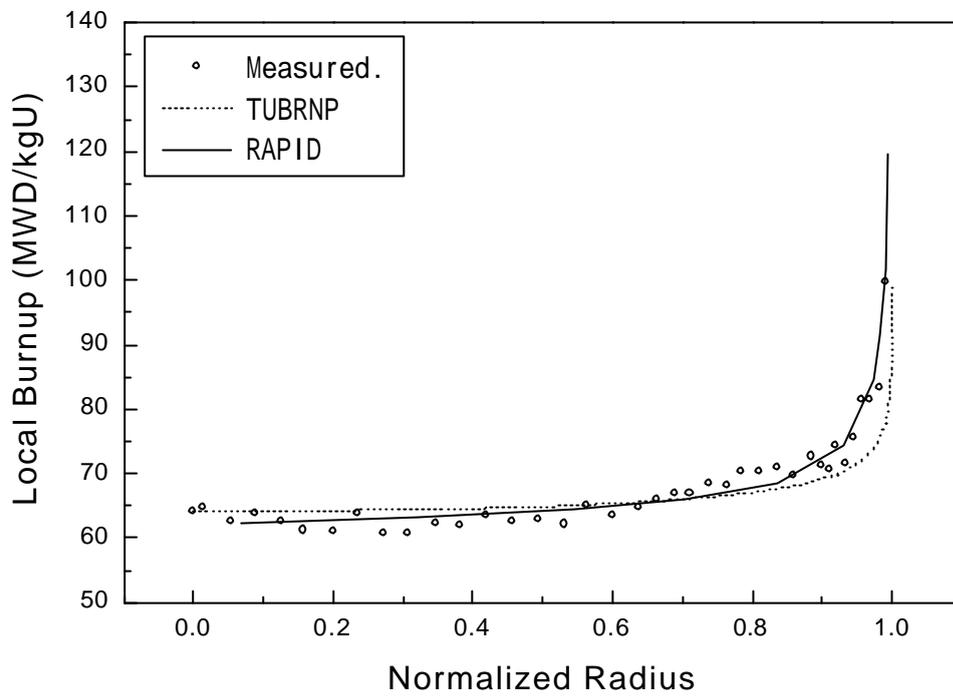


5.

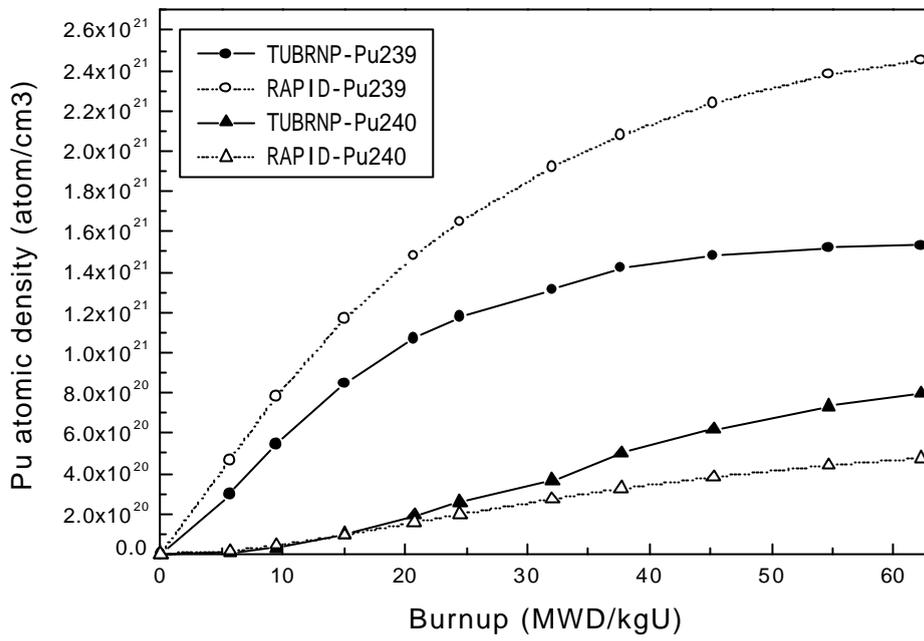
(TUBRNP & RAPID)



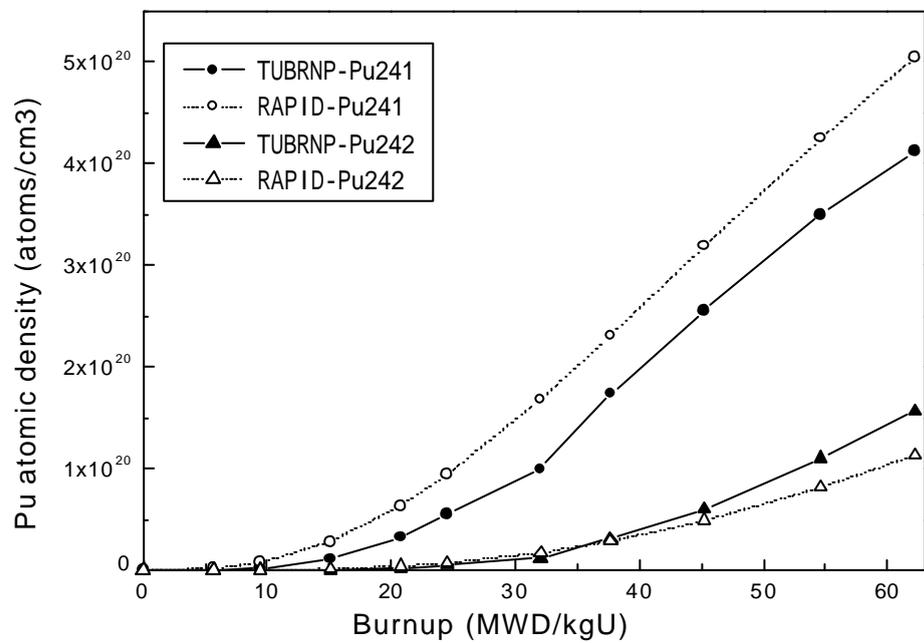
6.



7. RAPID, TUBRNP (8.6 w/o UO<sub>2</sub>, 68.5 MWD/kgU, BR - 3 test result)



8. Pu (5.75 w/o UO<sub>2</sub>)



9. Pu (5.75 w/o UO<sub>2</sub>)