

**Fission Mo-99**

**Uncertainty Analysis on Nuclear Design in HANARO Core  
for Fission Mo-99 Production**

Fission Mo-99

가 . 가 가  
, MCNP WIMS-VENTURE  
가 가  
가

**Abstract**

Uncertainty caused by variation of HANARO core condition was evaluated for the optimum fission moly target design under the condition of more reasonable model. Equilibrium core was modeled by MCNP and WIMS/VENTURE code system to analyze the uncertainty of response parameters caused by variation of input parameters which constitute core and target condition. Modeled equilibrium core was shown to be reliable to calculate reactivity worth by target loading and other design parameters such as Mo-99 yield ratio, heat generation rate, etc. Characteristics of design parameters evaluated from fresh fuel loaded core model was consistent to those evaluated from equilibrium core model. The variation of design parameters to the variation of the core condition was enough to be neglected.

# 1.

Fission Moly, Mo-99, Fission Moly, Mo-99, ( ), MCNP/ORIGEN2 (Fresh Fuel Assembly)가 가, 가 (nominal value), Fission Moly 가, 가 (reference core) 가 Fission Moly (fresh fuel assembly)가 가, 가

# 2.

## 2.1 가

Fission Moly, 가, 가 (excess reactivity)가, MCNP 가, Fission Moly, 가, 가 OR, Fission Moly

OR

가 가

, 가 , 가 , 가

2.2

MCNP

가

(Fixed Source)  
(Neutron Source Distribution)

. MCNP

가

, MCNP

ORIGEN2

(decay chain)

MOCKUP

가

가

MCNP ORIGEN

가

(statistical error)가

(propagation)

(biased)

가

Hybrid

가

가

, 가

MCNP

WIMS - VENTURE

1) WIMS - VENTURE

WIMS/VENTUER

1

WIMS

36

3

, 18

2

VENTURE

MCNP

VENTURE

5cm

14 Mesh

70cm

Pitch Size

1.15cm

6

Mesh

가

가

가

VENTURE

, WIMS

2) MCNP

MCNP

가

VENTURE

VENTUER

Mesh

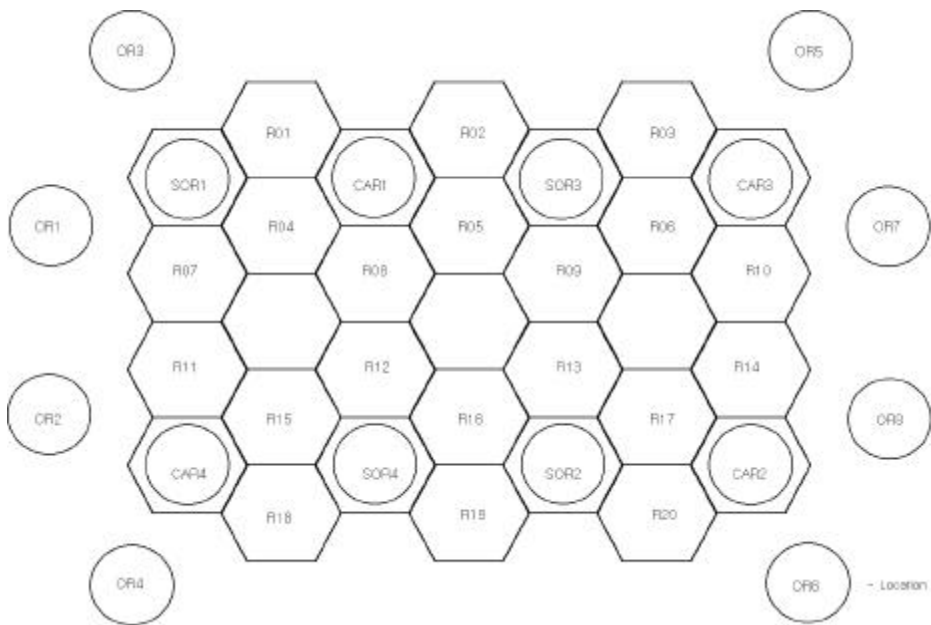
WIMS

MCNP

가

MCNP

(cell)  
 VENTURE Geometry Map 가 WIMS  
 (set) (cell)  
 FORTRAN MCNP Cell  
 , MCNP Material Card, Geometry Card, Source Card  
 , MCNP WIMS-VENTURE  
 1 , OR3 가 R01,  
 R02, R04, R05, R07, R08, OR1, SOR1, CAR1 WIMS/VENTURE ,  
 (cell) 5cm 14 Segment ,  
 가 가 가  
 ,  
 20  
 가 WIMS-VENTURE 가



1 Core Map

3.

Fission Moly ,  
 가(reactivity worth) KCODE ,  
 (fixed source) .  
 KCODE , (generation) (transport)  
 (homogeneous) (heterogeneous)  
 , (fixed source)

(transport) KCODE  
 K\_eff 가(reactivity worth) 가  
 K\_eff가 (fixed source) 가 가  
 가  
 가  
 1 CASE \*-1  
 가 8 5cm 14 Segment  
 (cell) (material composition) MCNP  
 (cell) CASE \*-2 8 CASE \*-1 가  
 MCNP 36 (cell)  
 , CASE \*-3 가 8  
 Fissile  
 가 , <sup>235</sup>U 가  
 10cm 20cm 40cm 3

	BOC	MOC	EOC
CASE *-1	1.02452 ± 0.00119	1.03860 ± 0.00116	1.04166 ± 0.00130
CASE *-2	1.02006 ± 0.00121	1.02978 ± 0.00112	1.03197 ± 0.00118
CASE *-3	1.00948 ± 0.00039	1.01719 ± 0.00028	1.01651 ± 0.00039

\* : BOC B, MOC M, EOC E

1 가 (cell)  
 가 (cell)  
 가  
 , <sup>235</sup>U 가 <sup>235</sup>U  
 Fissile Fissile

(fission importance)가 (leakage rate) (fission reaction rate) 가 , 1

, EOC

가

MCNP

가

,  
가

가 (case)

가

(reference core)

가(reactivity worth)

K\_eff

가

가

가

2 MOC

가

가 R01, R02, R04, R05, R07, R08,

OR1, SOR1, CAR1

KCODE

가

가

MOC

, MOC

가

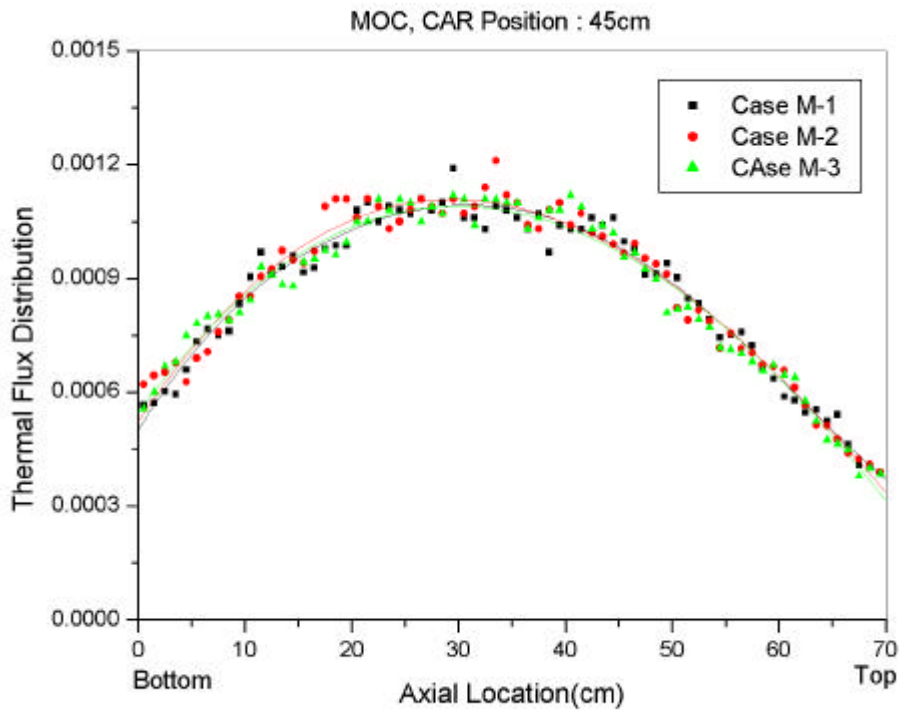
가

CASE

M-3,

1

가



2 MOC OR3



가 . 3 , 3 mk history  
 , MCNP  
 , 3

3 CASE 가

Case #	Reactivity Worth ( mk ± 1 )
Fresh Fuel Loaded Core	0.54 ± 0.25
CASE B-3	0.34 ± 0.59
CASE M-3	-0.10 ± 0.66
CASE E-3	1.32 ± 0.55

## 2) Thermal Hydraulic Safety

가 .  
 (1), (2) (3) , /  
 OR form loss  
 friction loss 가

$$\Delta P = \rho v^2 \sum (K + f \frac{L}{D}) \quad (1)$$

$$f = 0.184 Re^{-0.2} \quad (2)$$

$$Re = \frac{D_e U}{\nu} \quad (3)$$

4 가 4 , 가  
 가 가

4 CASE

Case #	Max. SHF (MW/m <sup>2</sup> )	Max. Clad. Temp. ( )	T (Outlet - Inlet) ( )
Fresh Fuel Loaded Core	0.808 ± 0.042	81.7 ± 2.05	0.62
CASE B-3	0.804 ± 0.028	81.5 ± 1.49	0.47
CASE M-3	0.816 ± 0.025	82.2 ± 1.64	0.47
CASE E-3	0.800 ± 0.026	81.5 ± 1.46	0.46

## 3) Mo-99

(Ci <sup>99</sup>Mo/gU)  
 가 가



5 CASE

Case #	5 days Irradiation	
	Yield Ratio(Ci <sup>99</sup> Mo/gU) OR3, 5 average	Yield Ratio(Ci <sup>99</sup> Mo/gU) OR3
Fresh Fuel Loaded Core	31.41 ± 0.47	34.97 ± 0.80
CASE B-3	-	35.31 ± 0.36
CASE M-3	-	35.50 ± 0.39
CASE E-3	-	34.31 ± 0.35

4) Mo-99 Annual Production and Waste Production Amount

가 Mo-99  
CASE

5.

Fission Moly 가 ,  
가 가 MCNP  
가(reactivity worth)  
가 가 가  
가 가  
가 가

Acknowledgements

WIMS/VENTURE

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