Comparison of the Results of the Whole Core Decay Power by Using the ORIGEN Code and the ANS-1979 for the Uljin Unit 6

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Introduction

Objectives

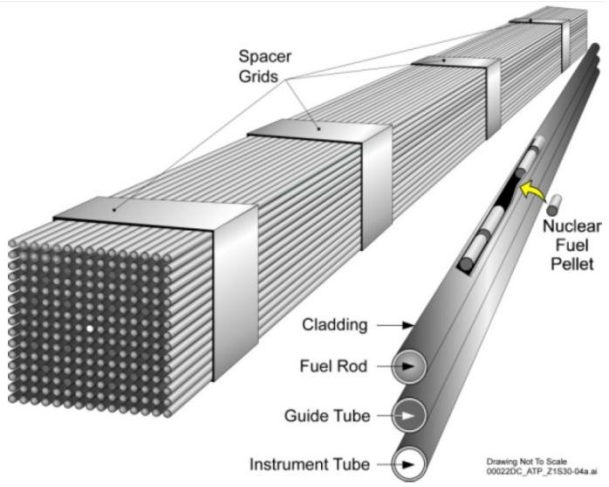
- **Investigation of Importance Radioactive Materials from the Calculation of the ORIGEN Code for an Assembly**
  - Classification of the Radioactive Material is important for the simulation of the fission product transport and the importance of the materials should be determined with the quantitative study.
- **Comparison of the Results of the Whole Core Decay Power from the ORIGEN Code and the ANS-1979**
  - It is expected that the simplified calculation of the ANS-1979 is not accurate because that it uses a lot of assumptions and the plant specific characteristics are neglected.

Major Parameter to Investigate

- **Mass of Elements and Nuclides**
- **Radioactivity of Elements and Nuclides**
- **Energy Release of Elements and Nuclides**
- **Whole Core Decay Power after Reactor Shut Down**

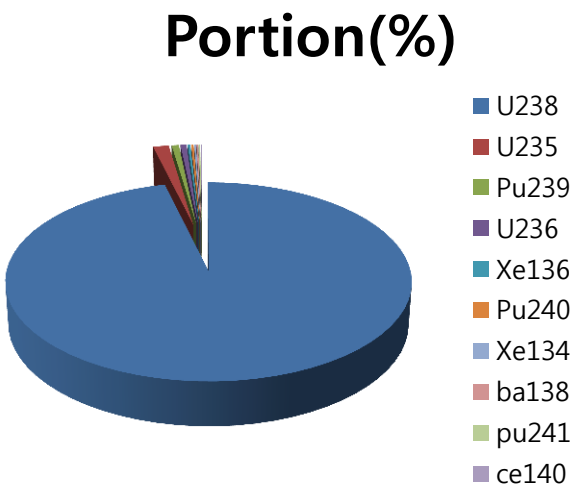
Problem Description

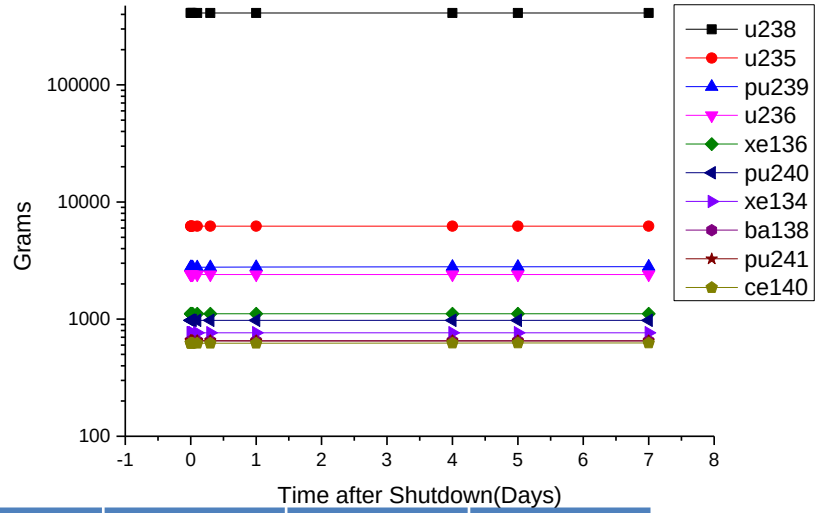
Uljin Unit 6



- OPR 1000
- CE type assembly(16X16)
- Enrichment : 4.399wt%
- 44 Group ENDF X-section
- Average Burnup : 37154 MWD/MTU
- Operating Period : 1009.5 Days
- Assembly Power : 36.8045MW
- Radioactive Decay Time After Shut down : 7 Days
- ORIGEN version : SCALE 6 module

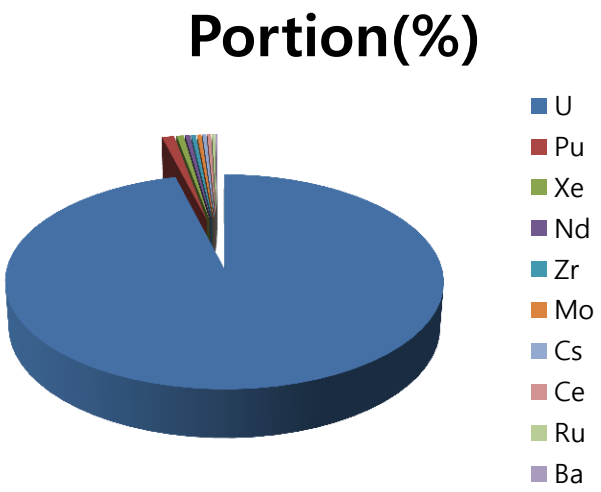
ORIGEN Result for an Assembly : Top 10 Nuclides for Mass

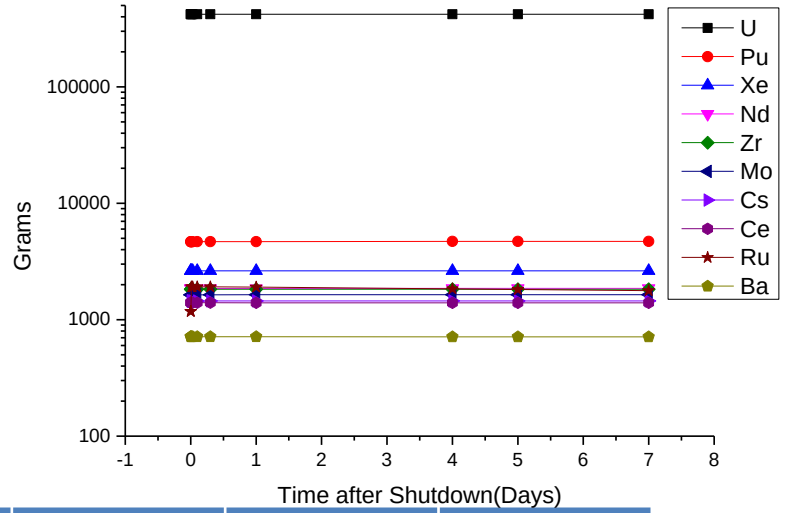




	CATEGORY	CHARGE (g)	DISCHARGE (g)	Int. Value (G*DAY)	Portion (%)	Half Life
U238	ACTINIDES	0.4172E+06	0.4112E+06	0.2878E+07	93.01	4.47E+09 Year
U235	ACTINIDES	0.1146E+05	0.6223E+04	0.4356E+05	1.41	7.04E+08 Year
Pu239	ACTINIDES	0.2178E+04	0.2772E+04	0.1959E+05	0.63	2.41E+04 Year
U236	ACTINIDES	0.1567E+04	0.2403E+04	0.1682E+05	0.54	2.342E+07Year
Xe136	FIS. PRO	0.5469E+03	0.1112E+04	0.7784E+04	0.25	2.11E+21 Year
Pu240	ACTINIDES	0.4429E+03	0.9766E+03	0.6836E+04	0.22	6.5E+03 Year
Xe134	FIS. PRO.	0.3858E+03	0.7636E+03	0.5346E+04	0.17	>1.1E+16 Year
Ba138	FIS. PRO.	0.3333E+03	0.6535E+03	0.4574E+04	0.15	N/A
Pu241	ACTINIDES	0.2832E+03	0.6525E+03	0.4565E+04	0.15	14 Year
Ce140	FIS. PRO.	0.3111E+03	0.6228E+03	0.4377E+04	0.14	N/A

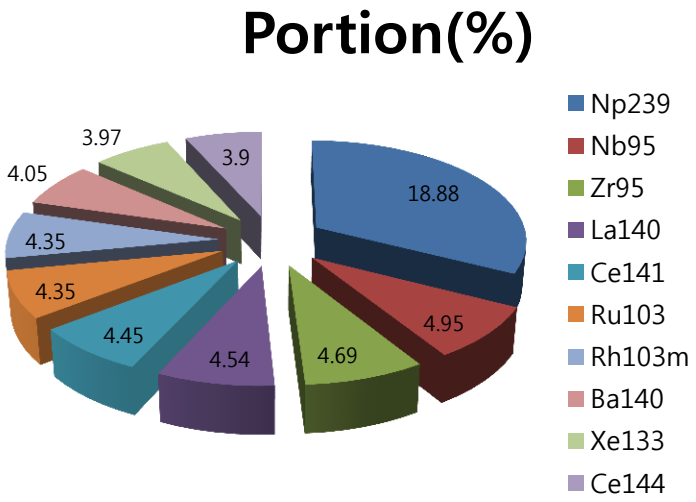
ORIGEN Result for an Assembly : Top 10 Elements for Mass

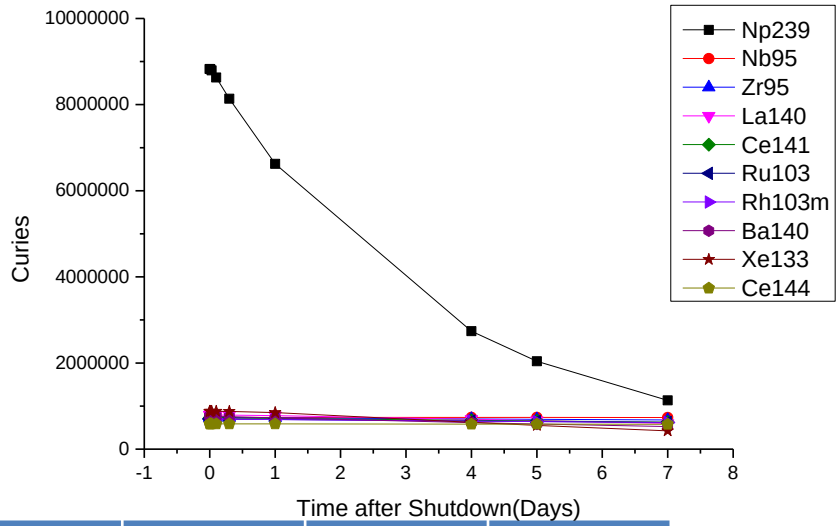




	CATEGORY	CHARGE (g)	DISCHARGE (g)	Int. Value (G*DAY)	Portion (%)
U	ACTINIDES	0.4304E+06	0.4200E+06	0.2940E+07	94.99
Pu	ACTINIDES	0.2954E+04	0.4677E+04	0.3293E+05	1.06
Xe	FIS. PRO	0.1302E+04	0.2630E+04	0.1842E+05	0.60
Nd	FIS. PRO	0.8942E+03	0.1854E+04	0.1300E+05	0.42
Zr	FIS. PRO	0.9790E+03	0.1826E+04	0.1278E+05	0.41
Mo	FIS. PRO	0.8066E+03	0.1637E+04	0.1147E+05	0.37
Cs	FIS. PRO.	0.7411E+03	0.1448E+04	0.1015E+05	0.33
Ce	FIS. PRO.	0.7840E+03	0.1399E+04	0.9772E+04	0.32
Ru	FIS. PRO	0.5535E+03	0.1178E+04	0.8232E+04	0.27
Ba	FIS. PRO.	0.3555E+03	0.7147E+03	0.4990E+04	0.16

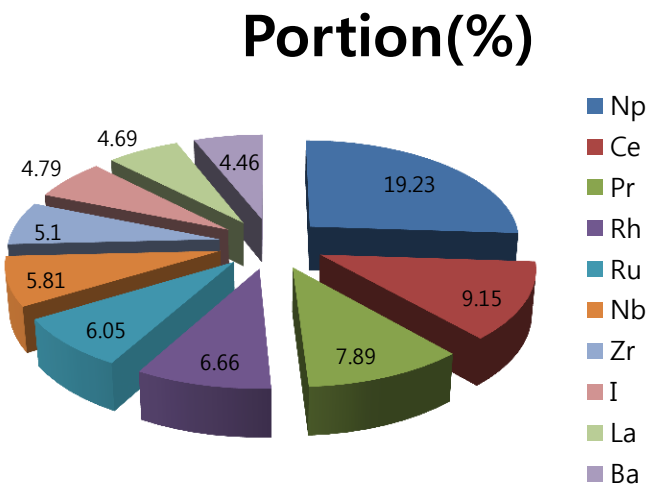
ORIGEN Result for an Assembly : Top 10 Nuclides for Radioactivity

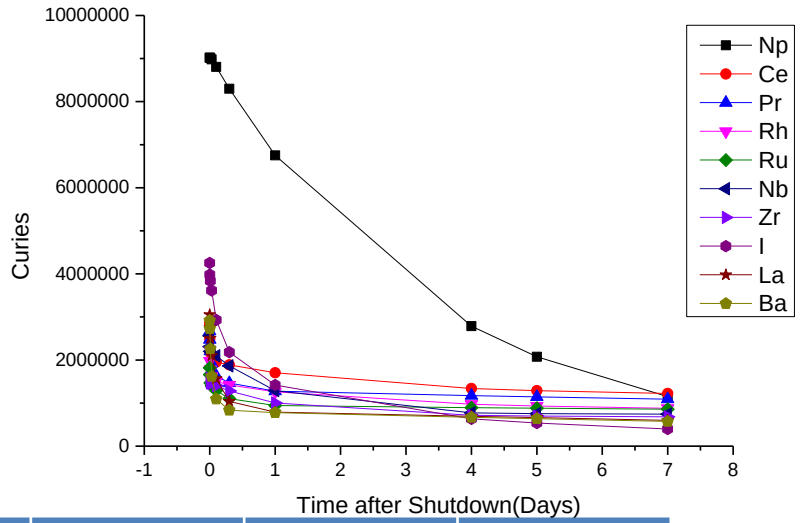




	CATEGORY	CHARGE (g)	DISCHARGE (g)	Int. Value (Curie*DAY)	Portion (%)	Half Life
Np239	ACTINIDES	0.7423E+07	0.8827E+07	0.1966E+08	18.88	2.356 Day
Nb95	FIS. PRO	0.8030E+06	0.7385E+06	0.5153E+07	4.95	34.991 Day
Zr95	FIS. PRO	0.7997E+06	0.7324E+06	0.4883E+07	4.69	64.02 Day
La140	FIS. PRO	0.8186E+06	0.7954E+06	0.4723E+07	4.54	1.678 Day
Ce141	FIS. PRO	0.7574E+06	0.7243E+06	0.4631E+07	4.45	32.501 Day
Ru103	FIS. PRO	0.5997E+06	0.7008E+06	0.4531E+07	4.35	39.26 Day
Rh103m	FIS. PRO.	0.5987E+06	0.6999E+06	0.4523E+07	4.35	39.27 Day
Ba140	FIS. PRO.	0.8013E+06	0.7670E+06	0.4220E+07	4.05	12.75 Day
Xe133	FIS. PRO	0.8887E+06	0.8785E+06	0.4129E+07	3.97	5.247 Day
Ce144	FIS. PRO.	0.4891E+06	0.5867E+06	0.4062E+07	3.90	284.893 Day

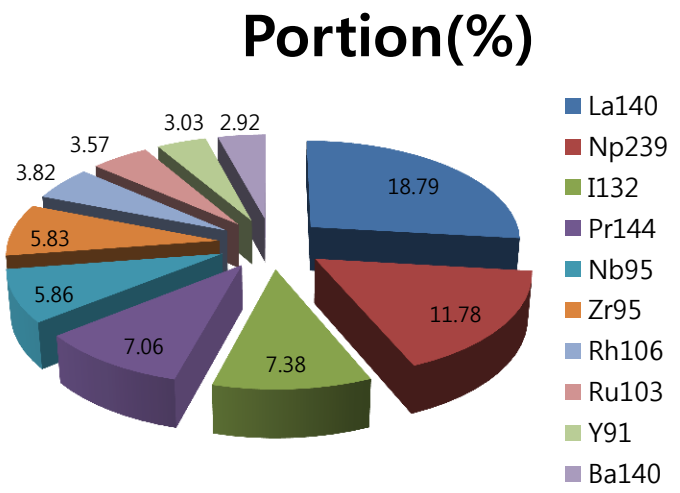
ORIGEN Result for an Assembly : Top 10 Elements for Radioactivity

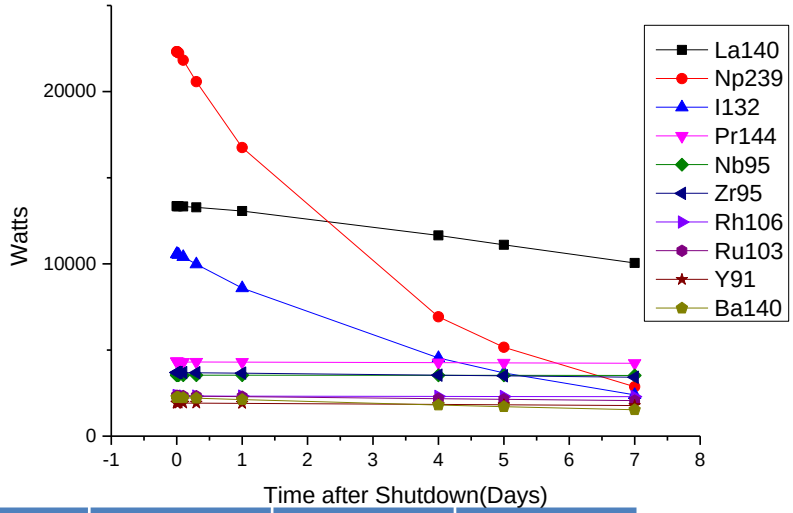




	CATEGORY	CHARGE (g)	DISCHARGE (g)	Int. Value (G*DAY)	Portion (%)
Np	ACTINIDES	0.7493E+07	0.9021E+07	0.2001E+08	19.23
Ce	FIS. PRO	0.3485E+07	0.3441E+07	0.9524E+07	9.15
Pr	FIS. PRO	0.2955E+07	0.2982E+07	0.8210E+07	7.89
Rh	FIS. PRO	0.1839E+07	0.2703E+07	0.6929E+07	6.66
Ru	FIS. PRO	0.1500E+07	0.2091E+07	0.6293E+07	6.05
Nb	FIS. PRO	0.6629E+07	0.6600E+07	0.6050E+07	5.81
Zr	FIS. PRO.	0.4609E+07	0.4436E+07	0.5307E+07	5.10
I	FIS. PRO.	0.5330E+07	0.5331E+07	0.4983E+07	4.79
La	FIS. PRO	0.4621E+07	0.4362E+07	0.4879E+07	4.69
Ba	FIS. PRO.	0.4644E+07	0.4383E+07	0.4642E+07	4.46

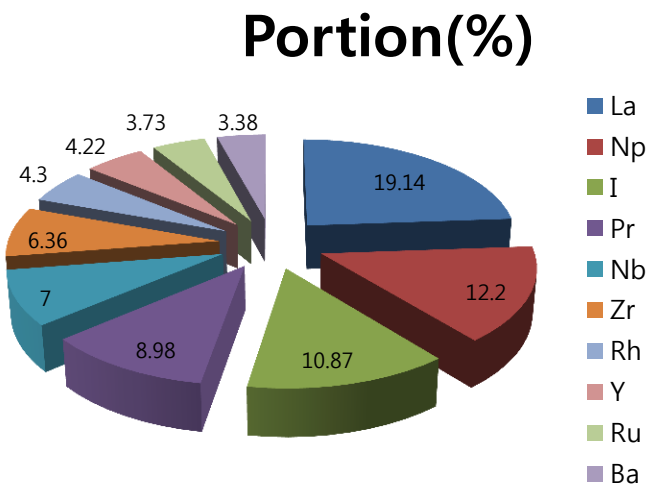
ORIGEN Result for an Assembly : Top 10 Nuclides for Energy Release

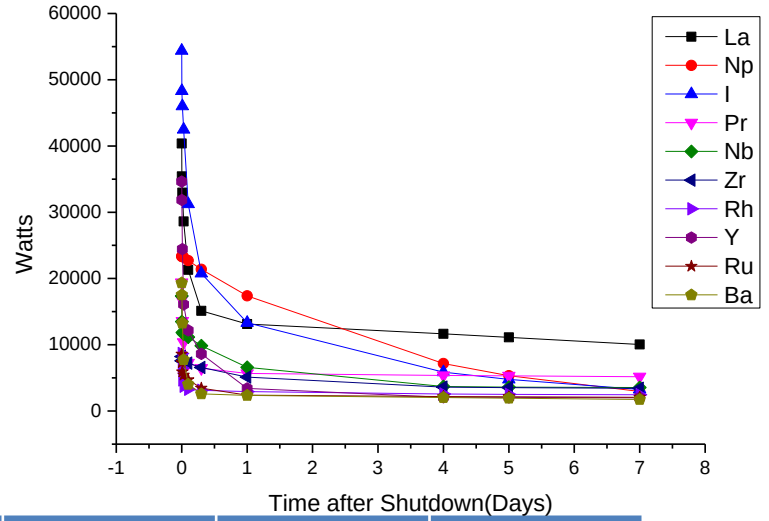




	CATEGORY	CHARGE (g)	DISCHARGE (g)	Int. Value (Watt*DAY)	Portion (%)	Half Life
La140	FIS. PRO	0.1374E+05	0.1335E+05	0.7930E+05	18.79	1.678 Day
Np239	ACTINIDES	0.1877E+05	0.2232E+05	0.4971E+05	11.78	2.356 Day
I132	FIS. PRO	0.1040E+05	0.1057E+05	0.3114E+05	7.38	2.28 Hour
Pr144	FIS. PRO	0.3614E+04	0.4333E+04	0.2981E+05	7.06	17.28 Minute
Nb95	FIS. PRO	0.3851E+04	0.3541E+04	0.2471E+05	5.86	34.991 Day
Zr95	FIS. PRO	0.4031E+04	0.3692E+04	0.2461E+05	5.83	64.02 Day
Rh106	FIS. PRO.	0.1256E+04	0.2550E+04	0.1612E+05	3.82	29.9 Second
Ru103	FIS. PRO.	0.1996E+04	0.2333E+04	0.1508E+05	3.57	39.26 Day
Y91	FIS. PRO	0.2309E+04	0.1917E+04	0.1280E+05	3.03	58.5 Day
Ba140	FIS. PRO.	0.2342E+04	0.2241E+04	0.1233E+05	2.92	12.75 Day

ORIGEN Result for an Assembly : Top 10 Elements for Energy Release

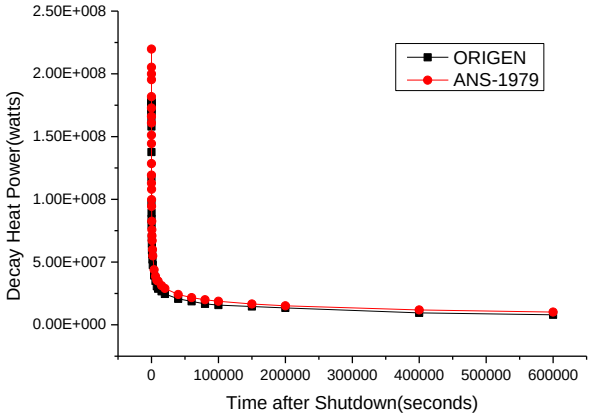


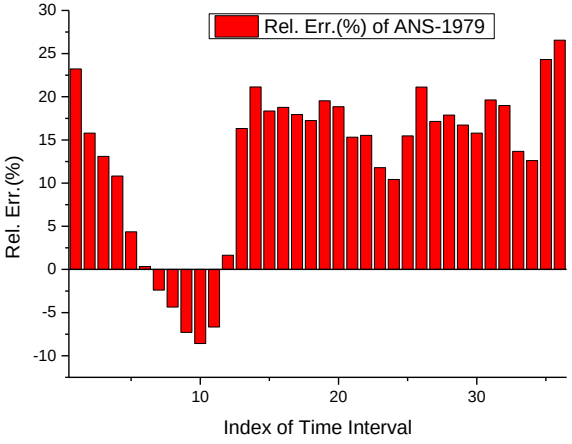


	CATEGORY	CHARGE (g)	DISCHARGE (g)	Int. Value (G*DAY)	Portion (%)
La	FIS. PRO	0.6897E+05	0.6503E+05	0.8078E+05	19.14
Np	ACTINIDES	0.1917E+05	0.2335E+05	0.5148E+05	12.20
I	FIS. PRO	0.7974E+05	0.7938E+05	0.4589E+05	10.87
Pr	FIS. PRO	0.2357E+05	0.2419E+05	0.3787E+05	8.98
Nb	FIS. PRO	0.8976E+05	0.9198E+05	0.2952E+05	7.00
Zr	FIS. PRO	0.4564E+05	0.4433E+05	0.2684E+05	6.36
Rh	FIS. PRO.	0.7615E+04	0.1293E+05	0.1815E+05	4.30
Y	FIS. PRO.	0.1017E+06	0.9425E+05	0.1781E+05	4.22
Ru	FIS. PRO	0.8235E+04	0.1154E+05	0.1573E+05	3.73
Ba	FIS. PRO.	0.4133E+05	0.3855E+05	0.1427E+05	3.38

Whole Core Decay Heat Result

Comparison of Results of the ORIGEN Code and the ANS-1979





Time of Decay Heat Power Reduction

- **Initial decay heat powers of the ORIGEN code and the ANS-1979 are 178MW and 220MW, respectively**

	ORIGEN(Seconds)	ANS-1979(Secons)
20%	0.07Days(5687)	0.05Days(3996)
10%	0.80Days(68722)	0.67Days(57475)
5%	5.49Days(474572)	5.81Days(501891)

Conclusions

Important Fission Product List Production

- About mass, radioactivity and energy release, the important materials are identified for the fission product transport and simulations

Whole Core Decay Heat Calculation

- The ANS-1979 calculation is not appropriate for the specific plant because it has a lot of assumptions and can give one result for every reactor of PWR type. Thus the detailed ORIGEN calculation should be done for severe accident simulations

Future Works

- To calculate more precise data for fission product, the ORIGEN calculation by reflecting of the assembly type information for certain period of the reactor should considered in the future.

References

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- American Nuclear Society Standards Committee Working Group ANS-5.1, American National Standard for Decay Heat Power in Light Water Reactors, ANSI/ANS-5.1-1979, American Nuclear Society, La Grange Park, IL, 1979.
- Gauld, I. C., ORIGEN-S: SCALE SYSTEM MODULE TO CALCULATE FUEL DEPLETION ACTINIDE TRANSMUTATION, FISSION PRODUCT BUILDUP AND DECAY, AND ASSOCIATED RADIATION SOURCE TERM, Oak Ridge National Laboratory, ORNL/TM-2005/39, ORNL, 2009.

Appendix A. Time Table

Index	Seconds	Days	Index	Seconds	Days
1	0	0.00000	19	800	0.00926
2	1	0.00001	20	1000	0.01157
3	1.5	0.00002	21	1500	0.01736
4	2	0.00002	22	2000	0.02315
5	4	0.00005	23	4000	0.04630
6	6	0.00007	24	6000	0.06944
7	8	0.00009	25	8000	0.09259
8	10	0.00012	26	10000	0.11574
9	15	0.00017	27	15000	0.17361
10	20	0.00023	28	20000	0.23148
11	40	0.00046	29	40000	0.46296
12	60	0.00069	30	60000	0.69444
13	80	0.00093	31	80000	0.92593
14	100	0.00116	32	100000	1.15741
15	150	0.00174	33	150000	1.73611
16	200	0.00231	34	200000	2.31481
17	400	0.00463	35	400000	4.62963
18	600	0.00694	36	600000	6.94444