*INSTANTAN

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*INSTANTAN Module

Calculate instantaneous flux and power distributions based on instantaneous fuel burnup distribution.

Let channel (i,j) has Age (i,j)

Burnup of bundle (i,j,k) = ω(i,j,k,o) + Age(i,j) x [ω(i,j,k,l) - ω(i,j,k,o)]

where

ω(i,j,k,o) = burnup of bundle (i,j,k) at the beginning of cycle

ω(i,j,k,l) = burnup of bundle (i,j,k) at the end of cycle

Age = 0 at the beginning of cycle and 1.0 at the end of cycle

Bundle irradiation at the beginning and at the end of cycle are calculated in the Time-Average Core Calculation

INSTANTAN Module (con't)

Two options to generate channel age distribution:

1) **Pure random age distribution generated by a random number generator**

   input required: random seed
   minimum age difference between adjacent channels

2) **PATTERN RANDIS (patterned random distribution) created by an external program RANDIS**

   input required: first channel to be refuelled (out of 7 by 7 channels)
   average age (default = 0.50)

   output: G Cards (channel age for each channel)

Selection Criterion of Channel to be Refuelled

Figure of Merit of Potential Candidate Channel (i)

- $W(i) \sum Age(j) \times D(i,j)$,

where j is evaluated over all channels which have been refuelled

W(i) is a weighting factor normally 0.0 and 1.0

W(i) is zero if channel (i) has the same fuelling direction as the last channel refuelled,

W(i)=0.1 if an adjacent channel has been refuelled recently

Age(j) is the age of channel j (age=0 for channels not yet refuelled), and

D(i,j) is the distance between channel i and channel j.

The channel with the highest merit, i.e., Maximum Age Distance (MAD), is chosen for refuelling.

Example of Refuelling Sequence in a 7 by 7 Lattice

-3	12	-23	6	-27	10	-19
18	-39	32	-19	34	-37	4
-29	14	-47	38	-17	42	-15
9	-43	26	-1	48	-25	30
-33	22	-49	28	-31	20	-7
16	-41	36	-13	40	-35	44
-5	24	-9	46	-21	2	-11

Example of G cards generated by RANDIS

```
G       .0000   .0000   .0000   .0000   .0000   .0000   .0000
G       .9800   .0800   .7400   .4400   .8400   .1400   .4800
G       .9800   .0000   .0000   .0000   .0000   .0000   .0000
G       .0000
G       .0000   .0000   .0000   .0000   .0000   .3200   .6800
G       .0400   .2800   .2000   .5800   .3400   .8600   .0200
G       .0800   .3800   .1200   .0000   .0000   .0000   .0000
G       .0000
G       .0000   .0000   .0000   .0000   .8000   .2600   .1600
G       .5000   .1200   .3000   .9400   .6800   .1800   .2800
G       .7400   .2000   .3000   .6000   .0000   .0000   .0000
G       .0000
G       .0000   .0000   .0000   .7800   .6200   .9200   .7000
G       .4000   .8600   .6000   .7800   .9000   .5200   .8200
G       .4400   .5800   .9600   .7800   .6200   .0000   .0000
G       .0000
G       .0000   .0000   .8800   .9000   .9400   .7200   .5400
G       .8800   .4600   .8000   .6200   .9400   .6400   .4200
G       .8400   .3400   .6800   .9000   .9400   .7200   .0000
G       .0000
G       .0000   .0000   .1800   .5200   .6400   .2200   .3600
G       .1000   .3200   .2600   .9200   .7200   .3200   .7600
G       .1400   .3600   .1800   .5200   .6400   .2200   .0000
G       .0000
G       .0000   .0200   .2800   .8200   .4200   .7600   .0600
G       .2400   .8600   .1600   .7000   .5400   .2600   .0600
G       .4800   .0200   .2800   .8200   .6200   .7600   .0600
G       .0000
G       .9800   .0800   .7400   .4400   .8400   .1400   .4800
G       .9800   .0400   .5000   .4000   .8800   .1000   .2400
G       .9800   .0800   .7400   .4400   .8400   .1400   .4800
G       .9800
G       .0400   .3800   .2000   .5800   .3400   .8600   .0200
G       .0800   .3800   .1200   .8600   .4600   .3200   .6600
G       .0400   .3800   .2000   .5800   .3400   .8600   .0200
G       .0800
G       .5000   .1200   .3000   .9600   .6800   .1800   .2800
G       .7400   .2000   .3000   .6000   .8000   .2600   .1600
G       .5000   .1200   .3000   .9600   .6800   .1800   .2800
G       .7400
G       .4000   .8600   .6000   .7800   .9000   .5200   .8200
G       .4400   .5800   .9600   .7800   .6200   .9200   .7000
G       .4000   .8600   .6000   .7800   .9000   .5200   .8200
G       .4400
G       .8800   .4600   .8000   .6200   .9400   .6400   .4200
G       .8400   .3400   .6800   .9000   .9400   .7200   .5400
G       .8800   .4600   .8000   .6200   .9400   .6400   .4200
G       .8400
G       .1000   .3200   .2600   .9200   .7200   .3200   .7600
G       .1400   .3600   .1800   .5200   .6400   .2200   .3600
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	Channel Power			Bundle Power		
		Mean Value	+/- Sigma		Mean Val	+/- Sigma
Randis 388	7305.1 kW	7249.9	65.6	868.6 kW	855.5	7.6
S.C. on	7179.9 kW			858 kW		
1.0 FPD step	7229.5 kW			860.3 kW		
	7374.3 kW			854.6 kW		
	7223.7 kW			843.6 kW		
	7233.1 kW			858.3 kW		
	7208.1 kW			844.5 kW		
	7275.6 kW			861 kW		
	7221.2 kW			851.2 kW		
	7248.5 kW			857.1 kW		
		Mean Value	+/- Sigma		Mean Val	+/- Sigma
Randis 388	7398 kW	7357.3	92.2	876 kW	878.3	11.1
No S.C.	7336.3 kW			879.9 kW		
	7314.4 kW			878.7 kW		
	7297.8 kW			865.8 kW		
	7327.5 kW			861.1 kW		
	7446.8 kW			892.2 kW		
	7279.2 kW			867.5 kW		
	7567.1 kW			895 kW		
	7280 kW			868.7 kW		
	7343.9 kW			880.8 kW		
		Mean Value	+/- Sigma		Mean Val	+/- Sigma
Randis Originated	7033 kW	7019.1	35.3	816 kW	810.0	5.7
10 days from a	7039 kW			803.8 kW		
350FPD study	7047 kW	Max Value	Min Value	818.8 kW		
	6996 kW	7063	6968	810.7 kW		
	6962 kW			813.1 kW		
	7068 kW			812.9 kW		
	6974 kW			799.7 kW		
	7044 kW			810.4 kW		
	7046 kW			807.5 kW		
	6968 kW			807 kW		

		Mean Value	+/- Sigma		Mean Val	+/- Sigma
*Instantan	9254.8 kW	8498.3	604.8	1150.3 kW	1049.5	76.7
(AGEMIN=0.0)	8147.4 kW			1015.1 kW		
	8927.1 kW	Max Value	Min Value	1104.5 kW		
	9503.8 kW	9503.8	7611.5	1185.5 kW		
	8530.5 kW			1058.4 kW		
	7611.5 kW			942.9 kW		
	8127.4 kW			1022.8 kW		
	7990.2 kW			981.9 kW		
	8118.9 kW			991.8 kW		
	8771.7 kW			1042.2 kW		
		Mean Value	+/- Sigma		Mean Val	+/- Sigma
*Instantan	9549.3 kW	8627.2	625.5	1172.4 kW	1039.4	87.5
(AGEMIN=0.2)	8782.6 kW			1045.6 kW		
	7962.9 kW	Max Value	Min Value	932.8 kW		
	8945.1 kW	9549.3	7734.3	1107.8 kW		
	7734.3 kW			942.9 kW		
	9526.7 kW			1162.4 kW		
	7938.4 kW			937.3 kW		
	8568.7 kW			1025.8 kW		
	8732.6 kW			1029.6 kW		
	8531.7 kW			1036.9 kW		
		Mean Value	+/- Sigma		Mean Val	+/- Sigma
Randle Originated	7033 kW	7019.1	35.3	816 kW	810.0	5.7
10 days from a	7039 kW			803.8 kW		
360FPD study	7047 kW	Max Value	Min Value	818.8 kW		
	6995 kW	7063	6968	810.7 kW		
	6982 kW			813.1 kW		
	7063 kW			812.9 kW		
	6974 kW			799.7 kW		
	7044 kW			810.4 kW		
	7046 kW			807.5 kW		
	6968 kW			807 kW		

RANDIS age-pattern generator has been used to generate random age patterns for many fuel cycle studies:

SEU:	0.9% up to 3.2% U-235
MOX:	up to 4% Pu
DUPIC, RU	
Reactors:	C-6, C-8, HAC (640 channels)
Fuel design:	37-el, CANFLEX, 61-el

Maximum channel and maximum bundle powers predicted by RANDIS are generally within 5% of those derived by RFSP time-dependent fuelling simulations at a later stage.