

# Polaris Depletion Calculations: Selected Best Practices

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# Materials for Depletion Regions

- Create one specific material ID for each region of depletion desired in the .out file
  - Rod-wise depletion in Polaris does not require a separate fuel material for each rod
    - Separate materials can make the .out file more readable
    - Gad rods separated into radial rings do not require separate materials for each radial region
  - If depletion information in .out is not desired on a per-rod basis, one fuel material ID is okay

```
20 %%%%Fuel Material
21 comp enr1 : UOX 4.4
22 comp enr2 : UOX 10
23
24 comp gd200 : WT GD203=4 enr2=-100
25 comp gd201 : WT GD203=8 enr2=-100
```

```
76 %%%%PINS
77 pin 1 : 0.438 0.447 0.513 : FUEL.1 GAP CLAD
78 pin 2 : 0.438 0.447 0.513 : FUEL.2 GAP CLAD
79 pin 200 : 0.438 0.447 0.513 : FUEL.200 GAP CLAD
80 pin 201 : 0.438 0.447 0.513 : FUEL.201 GAP CLAD
```

```
49 %%%%MATS
50 mat FUEL.1 : enr1 10.64
51 mat FUEL.2 : enr2 10.64
52 mat FUEL.200 : gd200 10.5108
53 mat FUEL.201 : gd201 10.3816
```

```
131 %%%%pinmap
132 pinmap
133 9
134 5 8
135 1 213 2
136 8 6 212 10
137 6 211 2 210 2
138 6 2 209 W W 2
139 4 2 10 W W 2 200
140 8 208 2 206 2 204 2 201
141 1 10 207 2 205 2 203 2 202
142 5 8 10 7 7 7 7 6
```

# Reading from External Files

- For some cases, reading data from external text files is useful:
  - Multiple pin definitions
  - Multiple branch cases

```
5=polaris
6% -----
7% general options
8% -----
9title "WEC 17x17 4.2_i128-CR0-MDC-MPC-MTF lattice"
10
11<vogle-geom-options.txt
12<vogle-detector.txt
13<vogle-pindef.txt
14
15
16<4.2_i128-mat-pin.txt
17<vogle-depletion.txt
18state BankA : in= no BankB : in= no ALL : temp= 585
19
20
21end
```

```
% -----
% pins definitions
% -----
pin F : 0.4096 0.418 0.475
      : FUEL.1 GAP CLAD

pin Y : 0.1969 0.4096 0.418 0.475
      : GAP FUEL.1 GAP CLAD

pin Z : 0.4096 0.4106 0.418 0.475
      : FUEL.1 BP.3 GAP CLAD

pin I : 0.559 0.605 0.63
      : COOL.1 TUBE COOL.1

pin H : 0.2832 0.3835 0.484 0.561 0.602 0.63
      : GAP BP.4 STRUCT COOL.1 TUBE COOL.1

pin G : 0.561 0.602 0.63
      : COOL.1 TUBE COOL.1
```

```
% -----
% maps
% -----
pinmap
E
Y F
Y F F
G Y Y G
Y F F V F
Y F F Y Y G
G Y Y G Y Y F
Y F F F F F F
F Y F F Y F F F Y

control BankB : RODLET
--
B _ _ B
_ _ _ _ B
B _ _ _ _
_ _ _ _ _
_ _ _ _ _

control BankA : RODLET
--
A _ _ A
_ _ _ _ A
A _ _ _ _
_ _ _ _ _
```

```
% -----
% states
% -----
power 40
bu 0 0.1 1 2 4 6 8 10 12 14 16 18 20 24 28 32 36 40 44 48 52 56 60 64 68 72 76 80
```

# Depletion Step Sizes

- Depletion step sizes can be controlled:
  - Using “dt” to define time steps
  - Using “bu” to define burnup steps
- Smaller depletion step sizes may be needed at low burnups to adequately capture the physics
  - 0.1 – 1 GWd/MTU burnup
  - Captures important neutronics such as depletion of burnable absorbers
- Use of depletion steps greater than 4 GWd/MTU is not recommended, as it could lead to less accurate results

```
55 pow 36.8  
56 % dt 1500  
57 bu 0.1 1 2 4 6 8 10 12 14 16 18 20 24 28 32 36 40 44 48 52 56 60 64 68 72 76 80
```

# Creating arpdata.txt from Polaris Output

- Confirm depletion steps when making arpdata.txt files
  - arpdata.txt steps should indicate the initial burnup at each statepoint
    - arpdata.txt requires initial burnup of 0, which is not in the Polaris input file
  - Check statepoint burnups in Polaris .out file

Polaris .inp file:

```
55 pow 36.8
56 % dt 1500
57 bu 0.1 1 2 4 6 8 10 12 14 16 18 20 24 28 32 36 40 44 48 52 56 60 64 68 72 76 80
```

Polaris .out file:

```
Initial time = 0.0000E+00, delta = 2.7174E+00, final time = 2.7174E+00 (days)
Initial burnup = 0.0000E+00, delta = 1.0000E-01, final burnup = 1.0000E-01 (GWD/MTHM)
Statepoint 2
History = 'BASE_HISTORY'
Power = 3.6800E+01 (MW/MTHM)
Initial time = 2.7174E+00, delta = 2.4457E+01, final time = 2.7174E+01 (days)
Initial burnup = 1.0000E-01, delta = 9.0000E-01, final burnup = 1.0000E+00 (GWD/MTHM)
Statepoint 3
History = 'BASE_HISTORY'
Power = 3.6800E+01 (MW/MTHM)
Initial time = 2.7174E+01, delta = 2.7174E+01, final time = 5.4348E+01 (days)
Initial burnup = 1.0000E+00, delta = 1.0000E+00, final burnup = 2.0000E+00 (GWD/MTHM)
Statepoint 4
History = 'BASE_HISTORY'
Power = 3.6800E+01 (MW/MTHM)
Initial time = 5.4348E+01, delta = 5.4348E+01, final time = 1.0870E+02 (days)
Initial burnup = 2.0000E+00, delta = 2.0000E+00, final burnup = 4.0000E+00 (GWD/MTHM)
```

arpdata.txt:

```
'W1717WL-e5.0.arplib'
0.00E+00
1.00E+02
1.00E+03
2.00E+03
4.00E+03
6.00E+03
8.00E+03
1.00E+04
1.20E+04
1.40E+04
1.60E+04
1.80E+04
2.00E+04
2.40E+04
2.80E+04
3.20E+04
3.60E+04
4.00E+04
4.40E+04
4.80E+04
5.20E+04
5.60E+04
6.00E+04
6.40E+04
6.80E+04
7.20E+04
7.60E+04
8.00E+04
```