```
     19R31
     267R24
     16R37
     20R38
     11R36
     END FILL
END ARRAY
READ BNDS -XY=MIRROR   END BNDS
READ GEOM
UNIT 1
CYLINDER 1 1 0.46482 2P0.635
CYLINDER 7 1 0.474472 2P0.635
CYLINDER 2 1 0.53594 2P0.635
CUBOID   3 1 4P0.71501 2P0.635
UNIT 2
CYLINDER 3 1 0.6502 2P0.635
CYLINDER 2 1 0.6934 2P0.635
CUBOID   3 1 4P0.71501 2P0.635
UNIT 3
CUBOID 5 1 4P0.381 2P0.635
UNIT 4
XHEMICYL+Y 4 1 0.5410 1.43002 1.31318
XHEMICYL+Y 0 1 0.5588 1.43002 0.29972
CUBOID     5 1 1.43002 0.0 0.762 0.0 2P0.635
UNIT 5
YHEMICYL+X 4 1 0.5410 1.43002 1.31318
YHEMICYL+X 0 1 0.5588 1.43002 0.29972
CUBOID     5 1 0.762 0.0 1.43002 0.0 2P0.635
UNIT 6
XHEMICYL+Y 4 1 0.5410 2P0.71501
XHEMICYL+Y 0 1 0.5588 2P0.71501
CUBOID     5 1 2P0.71501 0.762 0.0 2P0.635
UNIT 7
YHEMICYL+X 4 1 0.5410 2P0.71501
YHEMICYL+X 0 1 0.5588 2P0.71501
CUBOID     5 1 0.762 0.0 2P0.71501 2P0.635
UNIT 8
XHEMICYL+Y 4 1 0.5410 0.9271 0.0
XHEMICYL+Y 0 1 0.5588 0.9271 0.0
CUBOID     5 1 1.43002 0.0 0.762 0.0 2P0.635
UNIT 9
YHEMICYL+X 4 1 0.5410 0.9271 0.0
YHEMICYL+X 0 1 0.5588 0.9271 0.0
CUBOID     5 1 0.762 0.0 1.43002 0.0 2P0.635
UNIT 10
CUBOID 3 1 2P0.44577 2P0.71501 2P0.635
UNIT 11
CUBOID 3 1 2P0.71501 2P0.44577 2P0.635
```

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UNIT 12
CUBOID 3 1 4P0.44577 2P0.635
UNIT 13
CYLINDER 1 1 0.46482 2P0.3175
CYLINDER 7 1 0.474472 2P0.3175
CYLINDER 2 1 0.53594 2P0.3175
CUBOID   3 1 4P0.71501 2P0.3175
UNIT 14
CYLINDER 3 1 0.6502 2P0.3175
CYLINDER 2 1 0.6934 2P0.3175
CUBOID   3 1 4P0.71501 2P0.3175
UNIT 15
CUBOID 5 1 4P0.381 2P0.3175
UNIT 16
CUBOID 5 1 2P0.71501 2P0.381 2P0.3175
UNIT 17
CUBOID 5 1 2P0.381 2P0.71501 2P0.3175
UNIT 18
CUBOID 5 1 2P0.44577 2P0.381 2P0.3175
UNIT 19
CUBOID 5 1 2P0.381 2P0.44577 2P0.3175
UNIT 20
CUBOID 3 1 2P0.44577 2P0.71501 2P0.3175
UNIT 21
CUBOID 3 1 2P0.71501 2P0.44577 2P0.3175
UNIT 22
CUBOID 3 1 4P0.44577 2P0.3175
UNIT 23
ARRAY 1 0.0 0.0 -0.3175
UNIT 24
ARRAY 2 0.0 0.0 -0.635
UNIT 25
XHEMICYL+Y 4 1 0.35306 1.43002 0.45974
XHEMICYL+Y 0 1 0.37084 1.43002 0.22352
CUBOID     5 1 1.43002 0.0 0.762 0.0 2P0.635
UNIT 26
YHEMICYL+X 4 1 0.35306 1.43002 0.45974
YHEMICYL+X 0 1 0.37084 1.43002 0.22352
CUBOID     5 1 0.762 0.0 1.43002 0.0 2P0.635
UNIT 27
XHEMICYL+Y 4 1 0.35306 2P0.71501
XHEMICYL+Y 0 1 0.37084 2P0.71501
CUBOID     5 1 2P0.71501 0.762 0.0 2P0.635
UNIT 28
YHEMICYL+X 4 1 0.35306 2P0.71501
YHEMICYL+X 0 1 0.37084 2P0.71501
CUBOID     5 1 0.762 0.0 2P0.71501 2P0.635
UNIT 29
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CUBOID     5 1 0.89154 0.0 0.762 0.0 2P0.635
UNIT 30
CUBOID     5 1 0.762 0.0 0.89154 0.0 2P0.635
UNIT 31
ARRAY 3 0.0 0.0 -0.635
UNIT 32
CUBOID     5 1 0.89154 0.0 0.762 0.0 2P0.635
UNIT 33
CUBOID     5 1 0.762 0.0 0.89154 0.0 2P0.635
UNIT 34
CUBOID     3 1 4P0.71501 2P0.635
UNIT 35
CUBOID     3 1 4P0.71501 2P0.3175
UNIT 36
ARRAY 4  0.0 0.0 -0.3175
UNIT 37
ARRAY 5  0.0 0.0 -0.635
UNIT 38
ARRAY 6  0.0 0.0 -0.635
UNIT 39
XHEMICYL+Y 4 1 0.35306 0.9271 0.0
XHEMICYL+Y 0 1 0.37084 0.9271 0.0
CUBOID     5 1 1.43002 0.0 0.762 0.0 2P0.635
UNIT 40
YHEMICYL+X 4 1 0.35306 0.9271 0.0
YHEMICYL+X 0 1 0.37084 0.9271 0.0
CUBOID     5 1 0.762 0.0 1.43002 0.0 2P0.635
CORE 7 1 0.0 0.0 0.635
CUBOID 3 1 23.2029 0.0 23.2029 0.0 424.815 0.0
CUBOID 5 1 24.1554 0.0 24.1554 0.0 424.815 0.0
CUBOID 6 1 30.8864 0.0 30.8864 0.0 424.815 0.0
CUBOID 5 1 34.6964 0.0 34.6964 0.0 452.755 -24.13
CUBOID 8 1 100.0 0.0 100.0 0.0 510.0 -75.0
END GEOM
END DATA
END
```

den96

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=CSAS25
4 PWR ASSEM. W(15X15) OFA, E=3.1, BU=00, H20 Den = 0.96
27BURNUPLIB  LATTICECELL
UO2  1 0.95 293 92235 3.15 92238 96.85 END
ZIRCALLOY  2 1.0 END
H2O  3 0.96 END
B4C  4 0.864 293.0 5010 96.0 5011 4.0 END
SS304  5 1.0 END
URANIUM  6 1.0 293.0 92235 0.3 92238 99.7 END
H2O  7 0.96 END
H2O  8 1.0 END
END COMP
SQUAREPITCH 1.43002 0.92964 1 3 1.07188 2 0.948944 7 END
FLAT FULL HEIGHT GA-4, 4/96, 90% FOR NRC WITH B4C
READ PARAM  TME=200.0 GEN=200 NPG=1000 FLX=NO FDN=NO
NUB=YES END PARAM
READ ARRAY
ARA=1 NUX=17 NUY=17 NUZ=1
FILL
     15 15R16 18
     17 15R13 20
     17 15R13 20
     17 2R13 14 2R13 14 3R13 14 2R13 14 2R13 20
     17 7R13 14 7R13 20
     17 4R13 14 5R13 14 4R13 20
     17 2R13 14 9R13 14 2R13 20
     17 15R13 20
     17 3R13 14 3R13 14 3R13 14 3R13 20
     17 15R13 20
     17 2R13 14 9R13 14 2R13 20
     17 4R13 14 5R13 14 4R13 20
     17 7R13 14 7R13 20
     17 2R13 14 2R13 14 3R13 14 2R13 14 2R13 20
     17 15R13 20
     17 15R13 20
     19 15R21 22
     END FILL
ARA=2 NUX=17 NUY=17 NUZ=1
FILL
     3 4 13R6 8 32
     5 15R1 10
     7 15R1 10
     7 2R1 2 2R1 2 3R1 2 2R1 2 2R1 10
     7 7R1 2 7R1 10
     7 4R1 2 5R1 2 4R1 10
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     7 2R1 2 9R1 2 2R1 10
     7 15R1 10
     7 3R1 2 3R1 2 3R1 2 3R1 10
     7 15R1 10
     7 2R1 2 9R1 2 2R1 10
     7 4R1 2 5R1 2 4R1 10
     7 7R1 2 7R1 10
     7 2R1 2 2R1 2 3R1 2 2R1 2 2R1 10
     7 15R1 10
     9 15R1 10
     33 15R11 12
     END FILL
ARA=3 NUX=17 NUY=17 NUZ=1
FILL
     3 25 13R27 39 29
     26 15R1 10
     28 15R1 10
     28 2R1 2 2R1 2 3R1 2 2R1 2 2R1 10
     28 7R1 2 7R1 10
     28 4R1 2 5R1 2 4R1 10
     28 2R1 2 9R1 2 2R1 10
     28 15R1 10
     28 3R1 2 3R1 2 3R1 2 3R1 10
     28 15R1 10
     28 2R1 2 9R1 2 2R1 10
     28 4R1 2 5R1 2 4R1 10
     28 7R1 2 7R1 10
     28 2R1 2 2R1 2 3R1 2 2R1 2 2R1 10
     28 15R1 10
     40 15R1 10
     30 15R11 12
     END FILL
ARA=4 NUX=17 NUY=17 NUZ=1
FILL
     15 15R16 18
     17 15R35 20
     17 15R35 20
     17 15R35 20
     17 15R35 20
     17 15R35 20
     17 15R35 20
     17 15R35 20
     17 15R35 20
     17 15R35 20
     17 15R35 20
     17 15R35 20
     17 15R35 20
     17 15R35 20
     17 15R35 20
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     17 15R35 20
     17 15R35 20
     19 15R21 22
     END FILL
ARA=5 NUX=17 NUY=17 NUZ=1
FILL
     3 4 13R6 8 32
     5 15R34 10
     7 15R34 10
     7 15R34 10
     7 15R34 10
     7 15R34 10
     7 15R34 10
     7 15R34 10
     7 15R34 10
     7 15R34 10
     7 15R34 10
     7 15R34 10
     7 15R34 10
     7 15R34 10
     7 15R34 10
     7 15R34 10
     9 15R34 10
     33 15R11 12
     END FILL
ARA=6 NUX=17 NUY=17 NUZ=1
FILL
     3 25 13R27 39 29
     26 15R34 10
     28 15R34 10
     28 15R34 10
     28 15R34 10
     28 15R34 10
     28 15R34 10
     28 15R34 10
     28 15R34 10
     28 15R34 10
     28 15R34 10
     28 15R34 10
     28 15R34 10
     28 15R34 10
     28 15R34 10
     28 15R34 10
     40 15R34 10
     30 15R11 12
     END FILL
ARA=7 NUX=1 NUY=1 NUZ=344
FILL
     7R36
     4R23
```

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     19R31
     267R24
     16R37
     20R38
     11R36
     END FILL
END ARRAY
READ BNDS -XY=MIRROR   END BNDS
READ GEOM
UNIT 1
CYLINDER 1 1 0.46482 2P0.635
CYLINDER 7 1 0.474472 2P0.635
CYLINDER 2 1 0.53594 2P0.635
CUBOID   3 1 4P0.71501 2P0.635
UNIT 2
CYLINDER 3 1 0.6502 2P0.635
CYLINDER 2 1 0.6934 2P0.635
CUBOID   3 1 4P0.71501 2P0.635
UNIT 3
CUBOID 5 1 4P0.381 2P0.635
UNIT 4
XHEMICYL+Y 4 1 0.5410 1.43002 1.31318
XHEMICYL+Y 0 1 0.5588 1.43002 0.29972
CUBOID     5 1 1.43002 0.0 0.762 0.0 2P0.635
UNIT 5
YHEMICYL+X 4 1 0.5410 1.43002 1.31318
YHEMICYL+X 0 1 0.5588 1.43002 0.29972
CUBOID     5 1 0.762 0.0 1.43002 0.0 2P0.635
UNIT 6
XHEMICYL+Y 4 1 0.5410 2P0.71501
XHEMICYL+Y 0 1 0.5588 2P0.71501
CUBOID     5 1 2P0.71501 0.762 0.0 2P0.635
UNIT 7
YHEMICYL+X 4 1 0.5410 2P0.71501
YHEMICYL+X 0 1 0.5588 2P0.71501
CUBOID     5 1 0.762 0.0 2P0.71501 2P0.635
UNIT 8
XHEMICYL+Y 4 1 0.5410 0.9271 0.0
XHEMICYL+Y 0 1 0.5588 0.9271 0.0
CUBOID     5 1 1.43002 0.0 0.762 0.0 2P0.635
UNIT 9
YHEMICYL+X 4 1 0.5410 0.9271 0.0
YHEMICYL+X 0 1 0.5588 0.9271 0.0
CUBOID     5 1 0.762 0.0 1.43002 0.0 2P0.635
UNIT 10
CUBOID 3 1 2P0.44577 2P0.71501 2P0.635
UNIT 11
CUBOID 3 1 2P0.71501 2P0.44577 2P0.635
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```
UNIT 12
CUBOID 3 1 4P0.44577 2P0.635
UNIT 13
CYLINDER 1 1 0.46482 2P0.3175
CYLINDER 7 1 0.474472 2P0.3175
CYLINDER 2 1 0.53594 2P0.3175
CUBOID   3 1 4P0.71501 2P0.3175
UNIT 14
CYLINDER 3 1 0.6502 2P0.3175
CYLINDER 2 1 0.6934 2P0.3175
CUBOID   3 1 4P0.71501 2P0.3175
UNIT 15
CUBOID 5 1 4P0.381 2P0.3175
UNIT 16
CUBOID 5 1 2P0.71501 2P0.381 2P0.3175
UNIT 17
CUBOID 5 1 2P0.381 2P0.71501 2P0.3175
UNIT 18
CUBOID 5 1 2P0.44577 2P0.381 2P0.3175
UNIT 19
CUBOID 5 1 2P0.381 2P0.44577 2P0.3175
UNIT 20
CUBOID 3 1 2P0.44577 2P0.71501 2P0.3175
UNIT 21
CUBOID 3 1 2P0.71501 2P0.44577 2P0.3175
UNIT 22
CUBOID 3 1 4P0.44577 2P0.3175
UNIT 23
ARRAY 1 0.0 0.0 -0.3175
UNIT 24
ARRAY 2 0.0 0.0 -0.635
UNIT 25
XHEMICYL+Y 4 1 0.35306 1.43002 0.45974
XHEMICYL+Y 0 1 0.37084 1.43002 0.22352
CUBOID     5 1 1.43002 0.0 0.762 0.0 2P0.635
UNIT 26
YHEMICYL+X 4 1 0.35306 1.43002 0.45974
YHEMICYL+X 0 1 0.37084 1.43002 0.22352
CUBOID     5 1 0.762 0.0 1.43002 0.0 2P0.635
UNIT 27
XHEMICYL+Y 4 1 0.35306 2P0.71501
XHEMICYL+Y 0 1 0.37084 2P0.71501
CUBOID     5 1 2P0.71501 0.762 0.0 2P0.635
UNIT 28
YHEMICYL+X 4 1 0.35306 2P0.71501
YHEMICYL+X 0 1 0.37084 2P0.71501
CUBOID     5 1 0.762 0.0 2P0.71501 2P0.635
UNIT 29
```

```
CUBOID     5 1 0.89154 0.0 0.762 0.0 2P0.635
UNIT 30
CUBOID     5 1 0.762 0.0 0.89154 0.0 2P0.635
UNIT 31
ARRAY 3 0.0 0.0 -0.635
UNIT 32
CUBOID     5 1 0.89154 0.0 0.762 0.0 2P0.635
UNIT 33
CUBOID     5 1 0.762 0.0 0.89154 0.0 2P0.635
UNIT 34
CUBOID     3 1 4P0.71501 2P0.635
UNIT 35
CUBOID     3 1 4P0.71501 2P0.3175
UNIT 36
ARRAY 4  0.0 0.0 -0.3175
UNIT 37
ARRAY 5  0.0 0.0 -0.635
UNIT 38
ARRAY 6  0.0 0.0 -0.635
UNIT 39
XHEMICYL+Y 4 1 0.35306 0.9271 0.0
XHEMICYL+Y 0 1 0.37084 0.9271 0.0
CUBOID     5 1 1.43002 0.0 0.762 0.0 2P0.635
UNIT 40
YHEMICYL+X 4 1 0.35306 0.9271 0.0
YHEMICYL+X 0 1 0.37084 0.9271 0.0
CUBOID     5 1 0.762 0.0 1.43002 0.0 2P0.635
CORE 7 1 0.0 0.0 0.635
CUBOID 3 1 23.2029 0.0 23.2029 0.0 424.815 0.0
CUBOID 5 1 24.1554 0.0 24.1554 0.0 424.815 0.0
CUBOID 6 1 30.8864 0.0 30.8864 0.0 424.815 0.0
CUBOID 5 1 34.6964 0.0 34.6964 0.0 452.755 -24.13
CUBOID 8 1 100.0 0.0 100.0 0.0 510.0 -75.0
END GEOM
END DATA
END
```

den90

```
=CSAS25
4 PWR ASSEM. W(15X15) OFA, E=3.1, BU=00, H20 Den = 0.90
27BURNUPLIB  LATTICECELL
UO2  1 0.95 293 92235 3.15 92238 96.85 END
ZIRCALLOY  2 1.0 END
H2O  3 0.90 END
B4C  4 0.864 293.0 5010 96.0 5011 4.0 END
SS304  5 1.0 END
URANIUM  6 1.0 293.0 92235 0.3 92238 99.7 END
H2O  7 0.90 END
H2O  8 1.0 END
END COMP
SQUAREPITCH 1.43002 0.92964 1 3 1.07188 2 0.948944 7 END
FLAT FULL HEIGHT GA-4, 4/96, 90% FOR NRC WITH B4C
READ PARAM  TME=200.0 GEN=200 NPG=1000 FLX=NO FDN=NO
NUB=YES END PARAM
READ ARRAY
ARA=1 NUX=17 NUY=17 NUZ=1
FILL
     15 15R16 18
     17 15R13 20
     17 15R13 20
     17 2R13 14 2R13 14 3R13 14 2R13 14 2R13 20
     17 7R13 14 7R13 20
     17 4R13 14 5R13 14 4R13 20
     17 2R13 14 9R13 14 2R13 20
     17 15R13 20
     17 3R13 14 3R13 14 3R13 14 3R13 20
     17 15R13 20
     17 2R13 14 9R13 14 2R13 20
     17 4R13 14 5R13 14 4R13 20
     17 7R13 14 7R13 20
     17 2R13 14 2R13 14 3R13 14 2R13 14 2R13 20
     17 15R13 20
     17 15R13 20
     19 15R21 22
     END FILL
ARA=2 NUX=17 NUY=17 NUZ=1
FILL
     3 4 13R6 8 32
     5 15R1 10
     7 15R1 10
     7 2R1 2 2R1 2 3R1 2 2R1 2 2R1 10
     7 7R1 2 7R1 10
     7 4R1 2 5R1 2 4R1 10
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     7 2R1 2 9R1 2 2R1 10
     7 15R1 10
     7 3R1 2 3R1 2 3R1 2 3R1 10
     7 15R1 10
     7 2R1 2 9R1 2 2R1 10
     7 4R1 2 5R1 2 4R1 10
     7 7R1 2 7R1 10
     7 2R1 2 2R1 2 3R1 2 2R1 2 2R1 10
     7 15R1 10
     9 15R1 10
     33 15R11 12
     END FILL
ARA=3 NUX=17 NUY=17 NUZ=1
FILL
     3 25 13R27 39 29
     26 15R1 10
     28 15R1 10
     28 2R1 2 2R1 2 3R1 2 2R1 2 2R1 10
     28 7R1 2 7R1 10
     28 4R1 2 5R1 2 4R1 10
     28 2R1 2 9R1 2 2R1 10
     28 15R1 10
     28 3R1 2 3R1 2 3R1 2 3R1 10
     28 15R1 10
     28 2R1 2 9R1 2 2R1 10
     28 4R1 2 5R1 2 4R1 10
     28 7R1 2 7R1 10
     28 2R1 2 2R1 2 3R1 2 2R1 2 2R1 10
     28 15R1 10
     40 15R1 10
     30 15R11 12
     END FILL
ARA=4 NUX=17 NUY=17 NUZ=1
FILL
     15 15R16 18
     17 15R35 20
     17 15R35 20
     17 15R35 20
     17 15R35 20
     17 15R35 20
     17 15R35 20
     17 15R35 20
     17 15R35 20
     17 15R35 20
     17 15R35 20
     17 15R35 20
     17 15R35 20
     17 15R35 20
     17 15R35 20
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     17 15R35 20
     17 15R35 20
     19 15R21 22
     END FILL
ARA=5 NUX=17 NUY=17 NUZ=1
FILL
     3 4 13R6 8 32
     5 15R34 10
     7 15R34 10
     7 15R34 10
     7 15R34 10
     7 15R34 10
     7 15R34 10
     7 15R34 10
     7 15R34 10
     7 15R34 10
     7 15R34 10
     7 15R34 10
     7 15R34 10
     7 15R34 10
     7 15R34 10
     9 15R34 10
     33 15R11 12
     END FILL
ARA=6 NUX=17 NUY=17 NUZ=1
FILL
     3 25 13R27 39 29
     26 15R34 10
     28 15R34 10
     28 15R34 10
     28 15R34 10
     28 15R34 10
     28 15R34 10
     28 15R34 10
     28 15R34 10
     28 15R34 10
     28 15R34 10
     28 15R34 10
     28 15R34 10
     28 15R34 10
     28 15R34 10
     28 15R34 10
     40 15R34 10
     30 15R11 12
     END FILL
ARA=7 NUX=1 NUY=1 NUZ=344
FILL
     7R36
     4R23
```

```
     19R31
     267R24
     16R37
     20R38
     11R36
     END FILL
END ARRAY
READ BNDS -XY=MIRROR   END BNDS
READ GEOM
UNIT 1
CYLINDER 1 1 0.46482 2P0.635
CYLINDER 7 1 0.474472 2P0.635
CYLINDER 2 1 0.53594 2P0.635
CUBOID   3 1 4P0.71501 2P0.635
UNIT 2
CYLINDER 3 1 0.6502 2P0.635
CYLINDER 2 1 0.6934 2P0.635
CUBOID   3 1 4P0.71501 2P0.635
UNIT 3
CUBOID 5 1 4P0.381 2P0.635
UNIT 4
XHEMICYL+Y 4 1 0.5410 1.43002 1.31318
XHEMICYL+Y 0 1 0.5588 1.43002 0.29972
CUBOID     5 1 1.43002 0.0 0.762 0.0 2P0.635
UNIT 5
YHEMICYL+X 4 1 0.5410 1.43002 1.31318
YHEMICYL+X 0 1 0.5588 1.43002 0.29972
CUBOID     5 1 0.762 0.0 1.43002 0.0 2P0.635
UNIT 6
XHEMICYL+Y 4 1 0.5410 2P0.71501
XHEMICYL+Y 0 1 0.5588 2P0.71501
CUBOID     5 1 2P0.71501 0.762 0.0 2P0.635
UNIT 7
YHEMICYL+X 4 1 0.5410 2P0.71501
YHEMICYL+X 0 1 0.5588 2P0.71501
CUBOID     5 1 0.762 0.0 2P0.71501 2P0.635
UNIT 8
XHEMICYL+Y 4 1 0.5410 0.9271 0.0
XHEMICYL+Y 0 1 0.5588 0.9271 0.0
CUBOID     5 1 1.43002 0.0 0.762 0.0 2P0.635
UNIT 9
YHEMICYL+X 4 1 0.5410 0.9271 0.0
YHEMICYL+X 0 1 0.5588 0.9271 0.0
CUBOID     5 1 0.762 0.0 1.43002 0.0 2P0.635
UNIT 10
CUBOID 3 1 2P0.44577 2P0.71501 2P0.635
UNIT 11
CUBOID 3 1 2P0.71501 2P0.44577 2P0.635
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```
UNIT 12
CUBOID 3 1 4P0.44577 2P0.635
UNIT 13
CYLINDER 1 1 0.46482 2P0.3175
CYLINDER 7 1 0.474472 2P0.3175
CYLINDER 2 1 0.53594 2P0.3175
CUBOID   3 1 4P0.71501 2P0.3175
UNIT 14
CYLINDER 3 1 0.6502 2P0.3175
CYLINDER 2 1 0.6934 2P0.3175
CUBOID   3 1 4P0.71501 2P0.3175
UNIT 15
CUBOID 5 1 4P0.381 2P0.3175
UNIT 16
CUBOID 5 1 2P0.71501 2P0.381 2P0.3175
UNIT 17
CUBOID 5 1 2P0.381 2P0.71501 2P0.3175
UNIT 18
CUBOID 5 1 2P0.44577 2P0.381 2P0.3175
UNIT 19
CUBOID 5 1 2P0.381 2P0.44577 2P0.3175
UNIT 20
CUBOID 3 1 2P0.44577 2P0.71501 2P0.3175
UNIT 21
CUBOID 3 1 2P0.71501 2P0.44577 2P0.3175
UNIT 22
CUBOID 3 1 4P0.44577 2P0.3175
UNIT 23
ARRAY 1 0.0 0.0 -0.3175
UNIT 24
ARRAY 2 0.0 0.0 -0.635
UNIT 25
XHEMICYL+Y 4 1 0.35306 1.43002 0.45974
XHEMICYL+Y 0 1 0.37084 1.43002 0.22352
CUBOID     5 1 1.43002 0.0 0.762 0.0 2P0.635
UNIT 26
YHEMICYL+X 4 1 0.35306 1.43002 0.45974
YHEMICYL+X 0 1 0.37084 1.43002 0.22352
CUBOID     5 1 0.762 0.0 1.43002 0.0 2P0.635
UNIT 27
XHEMICYL+Y 4 1 0.35306 2P0.71501
XHEMICYL+Y 0 1 0.37084 2P0.71501
CUBOID     5 1 2P0.71501 0.762 0.0 2P0.635
UNIT 28
YHEMICYL+X 4 1 0.35306 2P0.71501
YHEMICYL+X 0 1 0.37084 2P0.71501
CUBOID     5 1 0.762 0.0 2P0.71501 2P0.635
UNIT 29
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CUBOID     5 1 0.89154 0.0 0.762 0.0 2P0.635
UNIT 30
CUBOID     5 1 0.762 0.0 0.89154 0.0 2P0.635
UNIT 31
ARRAY 3 0.0 0.0 -0.635
UNIT 32
CUBOID     5 1 0.89154 0.0 0.762 0.0 2P0.635
UNIT 33
CUBOID     5 1 0.762 0.0 0.89154 0.0 2P0.635
UNIT 34
CUBOID     3 1 4P0.71501 2P0.635
UNIT 35
CUBOID     3 1 4P0.71501 2P0.3175
UNIT 36
ARRAY 4  0.0 0.0 -0.3175
UNIT 37
ARRAY 5  0.0 0.0 -0.635
UNIT 38
ARRAY 6  0.0 0.0 -0.635
UNIT 39
XHEMICYL+Y 4 1 0.35306 0.9271 0.0
XHEMICYL+Y 0 1 0.37084 0.9271 0.0
CUBOID     5 1 1.43002 0.0 0.762 0.0 2P0.635
UNIT 40
YHEMICYL+X 4 1 0.35306 0.9271 0.0
YHEMICYL+X 0 1 0.37084 0.9271 0.0
CUBOID     5 1 0.762 0.0 1.43002 0.0 2P0.635
CORE 7 1 0.0 0.0 0.635
CUBOID 3 1 23.2029 0.0 23.2029 0.0 424.815 0.0
CUBOID 5 1 24.1554 0.0 24.1554 0.0 424.815 0.0
CUBOID 6 1 30.8864 0.0 30.8864 0.0 424.815 0.0
CUBOID 5 1 34.6964 0.0 34.6964 0.0 452.755 -24.13
CUBOID 8 1 100.0 0.0 100.0 0.0 510.0 -75.0
END GEOM
END DATA
END
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den85

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=CSAS25
4 PWR ASSEM. W(15X15) OFA, E=3.1, BU=00, H20 Den = 0.85
27BURNUPLIB  LATTICECELL
UO2  1 0.95 293 92235 3.15 92238 96.85 END
ZIRCALLOY  2 1.0 END
H2O  3 0.85 END
B4C  4 0.864 293.0 5010 96.0 5011 4.0 END
SS304  5 1.0 END
URANIUM  6 1.0 293.0 92235 0.3 92238 99.7 END
H2O  7 0.85 END
H2O  8 1.0 END
END COMP
SQUAREPITCH 1.43002 0.92964 1 3 1.07188 2 0.948944 7 END
FLAT FULL HEIGHT GA-4, 4/96, 90% FOR NRC WITH B4C
READ PARAM  TME=200.0 GEN=200 NPG=1000 FLX=NO FDN=NO
NUB=YES END PARAM
READ ARRAY
ARA=1 NUX=17 NUY=17 NUZ=1
FILL
     15 15R16 18
     17 15R13 20
     17 15R13 20
     17 2R13 14 2R13 14 3R13 14 2R13 14 2R13 20
     17 7R13 14 7R13 20
     17 4R13 14 5R13 14 4R13 20
     17 2R13 14 9R13 14 2R13 20
     17 15R13 20
     17 3R13 14 3R13 14 3R13 14 3R13 20
     17 15R13 20
     17 2R13 14 9R13 14 2R13 20
     17 4R13 14 5R13 14 4R13 20
     17 7R13 14 7R13 20
     17 2R13 14 2R13 14 3R13 14 2R13 14 2R13 20
     17 15R13 20
     17 15R13 20
     19 15R21 22
     END FILL
ARA=2 NUX=17 NUY=17 NUZ=1
FILL
     3 4 13R6 8 32
     5 15R1 10
     7 15R1 10
     7 2R1 2 2R1 2 3R1 2 2R1 2 2R1 10
     7 7R1 2 7R1 10
     7 4R1 2 5R1 2 4R1 10
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     7 2R1 2 9R1 2 2R1 10
     7 15R1 10
     7 3R1 2 3R1 2 3R1 2 3R1 10
     7 15R1 10
     7 2R1 2 9R1 2 2R1 10
     7 4R1 2 5R1 2 4R1 10
     7 7R1 2 7R1 10
     7 2R1 2 2R1 2 3R1 2 2R1 2 2R1 10
     7 15R1 10
     9 15R1 10
     33 15R11 12
     END FILL
ARA=3 NUX=17 NUY=17 NUZ=1
FILL
     3 25 13R27 39 29
     26 15R1 10
     28 15R1 10
     28 2R1 2 2R1 2 3R1 2 2R1 2 2R1 10
     28 7R1 2 7R1 10
     28 4R1 2 5R1 2 4R1 10
     28 2R1 2 9R1 2 2R1 10
     28 15R1 10
     28 3R1 2 3R1 2 3R1 2 3R1 10
     28 15R1 10
     28 2R1 2 9R1 2 2R1 10
     28 4R1 2 5R1 2 4R1 10
     28 7R1 2 7R1 10
     28 2R1 2 2R1 2 3R1 2 2R1 2 2R1 10
     28 15R1 10
     40 15R1 10
     30 15R11 12
     END FILL
ARA=4 NUX=17 NUY=17 NUZ=1
FILL
     15 15R16 18
     17 15R35 20
     17 15R35 20
     17 15R35 20
     17 15R35 20
     17 15R35 20
     17 15R35 20
     17 15R35 20
     17 15R35 20
     17 15R35 20
     17 15R35 20
     17 15R35 20
     17 15R35 20
     17 15R35 20
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     17 15R35 20
     17 15R35 20
     19 15R21 22
     END FILL
ARA=5 NUX=17 NUY=17 NUZ=1
FILL
     3 4 13R6 8 32
     5 15R34 10
     7 15R34 10
     7 15R34 10
     7 15R34 10
     7 15R34 10
     7 15R34 10
     7 15R34 10
     7 15R34 10
     7 15R34 10
     7 15R34 10
     7 15R34 10
     7 15R34 10
     7 15R34 10
     7 15R34 10
     9 15R34 10
     33 15R11 12
     END FILL
ARA=6 NUX=17 NUY=17 NUZ=1
FILL
     3 25 13R27 39 29
     26 15R34 10
     28 15R34 10
     28 15R34 10
     28 15R34 10
     28 15R34 10
     28 15R34 10
     28 15R34 10
     28 15R34 10
     28 15R34 10
     28 15R34 10
     28 15R34 10
     28 15R34 10
     28 15R34 10
     28 15R34 10
     28 15R34 10
     40 15R34 10
     30 15R11 12
     END FILL
ARA=7 NUX=1 NUY=1 NUZ=344
FILL
     7R36
     4R23
```

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     19R31
     267R24
     16R37
     20R38
     11R36
     END FILL
END ARRAY
READ BNDS -XY=MIRROR   END BNDS
READ GEOM
UNIT 1
CYLINDER 1 1 0.46482 2P0.635
CYLINDER 7 1 0.474472 2P0.635
CYLINDER 2 1 0.53594 2P0.635
CUBOID   3 1 4P0.71501 2P0.635
UNIT 2
CYLINDER 3 1 0.6502 2P0.635
CYLINDER 2 1 0.6934 2P0.635
CUBOID   3 1 4P0.71501 2P0.635
UNIT 3
CUBOID 5 1 4P0.381 2P0.635
UNIT 4
XHEMICYL+Y 4 1 0.5410 1.43002 1.31318
XHEMICYL+Y 0 1 0.5588 1.43002 0.29972
CUBOID     5 1 1.43002 0.0 0.762 0.0 2P0.635
UNIT 5
YHEMICYL+X 4 1 0.5410 1.43002 1.31318
YHEMICYL+X 0 1 0.5588 1.43002 0.29972
CUBOID     5 1 0.762 0.0 1.43002 0.0 2P0.635
UNIT 6
XHEMICYL+Y 4 1 0.5410 2P0.71501
XHEMICYL+Y 0 1 0.5588 2P0.71501
CUBOID     5 1 2P0.71501 0.762 0.0 2P0.635
UNIT 7
YHEMICYL+X 4 1 0.5410 2P0.71501
YHEMICYL+X 0 1 0.5588 2P0.71501
CUBOID     5 1 0.762 0.0 2P0.71501 2P0.635
UNIT 8
XHEMICYL+Y 4 1 0.5410 0.9271 0.0
XHEMICYL+Y 0 1 0.5588 0.9271 0.0
CUBOID     5 1 1.43002 0.0 0.762 0.0 2P0.635
UNIT 9
YHEMICYL+X 4 1 0.5410 0.9271 0.0
YHEMICYL+X 0 1 0.5588 0.9271 0.0
CUBOID     5 1 0.762 0.0 1.43002 0.0 2P0.635
UNIT 10
CUBOID 3 1 2P0.44577 2P0.71501 2P0.635
UNIT 11
CUBOID 3 1 2P0.71501 2P0.44577 2P0.635
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UNIT 12
CUBOID 3 1 4P0.44577 2P0.635
UNIT 13
CYLINDER 1 1 0.46482 2P0.3175
CYLINDER 7 1 0.474472 2P0.3175
CYLINDER 2 1 0.53594 2P0.3175
CUBOID   3 1 4P0.71501 2P0.3175
UNIT 14
CYLINDER 3 1 0.6502 2P0.3175
CYLINDER 2 1 0.6934 2P0.3175
CUBOID   3 1 4P0.71501 2P0.3175
UNIT 15
CUBOID 5 1 4P0.381 2P0.3175
UNIT 16
CUBOID 5 1 2P0.71501 2P0.381 2P0.3175
UNIT 17
CUBOID 5 1 2P0.381 2P0.71501 2P0.3175
UNIT 18
CUBOID 5 1 2P0.44577 2P0.381 2P0.3175
UNIT 19
CUBOID 5 1 2P0.381 2P0.44577 2P0.3175
UNIT 20
CUBOID 3 1 2P0.44577 2P0.71501 2P0.3175
UNIT 21
CUBOID 3 1 2P0.71501 2P0.44577 2P0.3175
UNIT 22
CUBOID 3 1 4P0.44577 2P0.3175
UNIT 23
ARRAY 1 0.0 0.0 -0.3175
UNIT 24
ARRAY 2 0.0 0.0 -0.635
UNIT 25
XHEMICYL+Y 4 1 0.35306 1.43002 0.45974
XHEMICYL+Y 0 1 0.37084 1.43002 0.22352
CUBOID     5 1 1.43002 0.0 0.762 0.0 2P0.635
UNIT 26
YHEMICYL+X 4 1 0.35306 1.43002 0.45974
YHEMICYL+X 0 1 0.37084 1.43002 0.22352
CUBOID     5 1 0.762 0.0 1.43002 0.0 2P0.635
UNIT 27
XHEMICYL+Y 4 1 0.35306 2P0.71501
XHEMICYL+Y 0 1 0.37084 2P0.71501
CUBOID     5 1 2P0.71501 0.762 0.0 2P0.635
UNIT 28
YHEMICYL+X 4 1 0.35306 2P0.71501
YHEMICYL+X 0 1 0.37084 2P0.71501
CUBOID     5 1 0.762 0.0 2P0.71501 2P0.635
UNIT 29
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CUBOID     5 1 0.89154 0.0 0.762 0.0 2P0.635
UNIT 30
CUBOID     5 1 0.762 0.0 0.89154 0.0 2P0.635
UNIT 31
ARRAY 3 0.0 0.0 -0.635
UNIT 32
CUBOID     5 1 0.89154 0.0 0.762 0.0 2P0.635
UNIT 33
CUBOID     5 1 0.762 0.0 0.89154 0.0 2P0.635
UNIT 34
CUBOID     3 1 4P0.71501 2P0.635
UNIT 35
CUBOID     3 1 4P0.71501 2P0.3175
UNIT 36
ARRAY 4  0.0 0.0 -0.3175
UNIT 37
ARRAY 5  0.0 0.0 -0.635
UNIT 38
ARRAY 6  0.0 0.0 -0.635
UNIT 39
XHEMICYL+Y 4 1 0.35306 0.9271 0.0
XHEMICYL+Y 0 1 0.37084 0.9271 0.0
CUBOID     5 1 1.43002 0.0 0.762 0.0 2P0.635
UNIT 40
YHEMICYL+X 4 1 0.35306 0.9271 0.0
YHEMICYL+X 0 1 0.37084 0.9271 0.0
CUBOID     5 1 0.762 0.0 1.43002 0.0 2P0.635
CORE 7 1 0.0 0.0 0.635
CUBOID 3 1 23.2029 0.0 23.2029 0.0 424.815 0.0
CUBOID 5 1 24.1554 0.0 24.1554 0.0 424.815 0.0
CUBOID 6 1 30.8864 0.0 30.8864 0.0 424.815 0.0
CUBOID 5 1 34.6964 0.0 34.6964 0.0 452.755 -24.13
CUBOID 8 1 100.0 0.0 100.0 0.0 510.0 -75.0
END GEOM
END DATA
END
```

den80

```
=CSAS25
4 PWR ASSEM. W(15X15) OFA, E=3.1, BU=00, H20 Den = 0.80
27BURNUPLIB  LATTICECELL
UO2  1 0.95 293 92235 3.15 92238 96.85 END
ZIRCALLOY  2 1.0 END
H2O  3 0.80 END
B4C  4 0.864 293.0 5010 96.0 5011 4.0 END
SS304  5 1.0 END
URANIUM  6 1.0 293.0 92235 0.3 92238 99.7 END
H2O  7 0.80 END
H2O  8 1.0 END
END COMP
SQUAREPITCH 1.43002 0.92964 1 3 1.07188 2 0.948944 7 END
FLAT FULL HEIGHT GA-4, 4/96, 90% FOR NRC WITH B4C
READ PARAM  TME=200.0 GEN=200 NPG=1000 FLX=NO FDN=NO
NUB=YES END PARAM
READ ARRAY
ARA=1 NUX=17 NUY=17 NUZ=1
FILL
     15 15R16 18
     17 15R13 20
     17 15R13 20
     17 2R13 14 2R13 14 3R13 14 2R13 14 2R13 20
     17 7R13 14 7R13 20
     17 4R13 14 5R13 14 4R13 20
     17 2R13 14 9R13 14 2R13 20
     17 15R13 20
     17 3R13 14 3R13 14 3R13 14 3R13 20
     17 15R13 20
     17 2R13 14 9R13 14 2R13 20
     17 4R13 14 5R13 14 4R13 20
     17 7R13 14 7R13 20
     17 2R13 14 2R13 14 3R13 14 2R13 14 2R13 20
     17 15R13 20
     17 15R13 20
     19 15R21 22
     END FILL
ARA=2 NUX=17 NUY=17 NUZ=1
FILL
     3 4 13R6 8 32
     5 15R1 10
     7 15R1 10
     7 2R1 2 2R1 2 3R1 2 2R1 2 2R1 10
     7 7R1 2 7R1 10
     7 4R1 2 5R1 2 4R1 10
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     7 2R1 2 9R1 2 2R1 10
     7 15R1 10
     7 3R1 2 3R1 2 3R1 2 3R1 10
     7 15R1 10
     7 2R1 2 9R1 2 2R1 10
     7 4R1 2 5R1 2 4R1 10
     7 7R1 2 7R1 10
     7 2R1 2 2R1 2 3R1 2 2R1 2 2R1 10
     7 15R1 10
     9 15R1 10
     33 15R11 12
     END FILL
ARA=3 NUX=17 NUY=17 NUZ=1
FILL
     3 25 13R27 39 29
     26 15R1 10
     28 15R1 10
     28 2R1 2 2R1 2 3R1 2 2R1 2 2R1 10
     28 7R1 2 7R1 10
     28 4R1 2 5R1 2 4R1 10
     28 2R1 2 9R1 2 2R1 10
     28 15R1 10
     28 3R1 2 3R1 2 3R1 2 3R1 10
     28 15R1 10
     28 2R1 2 9R1 2 2R1 10
     28 4R1 2 5R1 2 4R1 10
     28 7R1 2 7R1 10
     28 2R1 2 2R1 2 3R1 2 2R1 2 2R1 10
     28 15R1 10
     40 15R1 10
     30 15R11 12
     END FILL
ARA=4 NUX=17 NUY=17 NUZ=1
FILL
     15 15R16 18
     17 15R35 20
     17 15R35 20
     17 15R35 20
     17 15R35 20
     17 15R35 20
     17 15R35 20
     17 15R35 20
     17 15R35 20
     17 15R35 20
     17 15R35 20
     17 15R35 20
     17 15R35 20
     17 15R35 20
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     17 15R35 20
     17 15R35 20
     19 15R21 22
     END FILL
ARA=5 NUX=17 NUY=17 NUZ=1
FILL
     3 4 13R6 8 32
     5 15R34 10
     7 15R34 10
     7 15R34 10
     7 15R34 10
     7 15R34 10
     7 15R34 10
     7 15R34 10
     7 15R34 10
     7 15R34 10
     7 15R34 10
     7 15R34 10
     7 15R34 10
     7 15R34 10
     7 15R34 10
     9 15R34 10
     33 15R11 12
     END FILL
ARA=6 NUX=17 NUY=17 NUZ=1
FILL
     3 25 13R27 39 29
     26 15R34 10
     28 15R34 10
     28 15R34 10
     28 15R34 10
     28 15R34 10
     28 15R34 10
     28 15R34 10
     28 15R34 10
     28 15R34 10
     28 15R34 10
     28 15R34 10
     28 15R34 10
     28 15R34 10
     28 15R34 10
     28 15R34 10
     40 15R34 10
     30 15R11 12
     END FILL
ARA=7 NUX=1 NUY=1 NUZ=344
FILL
     7R36
     4R23
```

```
     19R31
     267R24
     16R37
     20R38
     11R36
     END FILL
END ARRAY
READ BNDS -XY=MIRROR   END BNDS
READ GEOM
UNIT 1
CYLINDER 1 1 0.46482 2P0.635
CYLINDER 7 1 0.474472 2P0.635
CYLINDER 2 1 0.53594 2P0.635
CUBOID   3 1 4P0.71501 2P0.635
UNIT 2
CYLINDER 3 1 0.6502 2P0.635
CYLINDER 2 1 0.6934 2P0.635
CUBOID   3 1 4P0.71501 2P0.635
UNIT 3
CUBOID 5 1 4P0.381 2P0.635
UNIT 4
XHEMICYL+Y 4 1 0.5410 1.43002 1.31318
XHEMICYL+Y 0 1 0.5588 1.43002 0.29972
CUBOID     5 1 1.43002 0.0 0.762 0.0 2P0.635
UNIT 5
YHEMICYL+X 4 1 0.5410 1.43002 1.31318
YHEMICYL+X 0 1 0.5588 1.43002 0.29972
CUBOID     5 1 0.762 0.0 1.43002 0.0 2P0.635
UNIT 6
XHEMICYL+Y 4 1 0.5410 2P0.71501
XHEMICYL+Y 0 1 0.5588 2P0.71501
CUBOID     5 1 2P0.71501 0.762 0.0 2P0.635
UNIT 7
YHEMICYL+X 4 1 0.5410 2P0.71501
YHEMICYL+X 0 1 0.5588 2P0.71501
CUBOID     5 1 0.762 0.0 2P0.71501 2P0.635
UNIT 8
XHEMICYL+Y 4 1 0.5410 0.9271 0.0
XHEMICYL+Y 0 1 0.5588 0.9271 0.0
CUBOID     5 1 1.43002 0.0 0.762 0.0 2P0.635
UNIT 9
YHEMICYL+X 4 1 0.5410 0.9271 0.0
YHEMICYL+X 0 1 0.5588 0.9271 0.0
CUBOID     5 1 0.762 0.0 1.43002 0.0 2P0.635
UNIT 10
CUBOID 3 1 2P0.44577 2P0.71501 2P0.635
UNIT 11
CUBOID 3 1 2P0.71501 2P0.44577 2P0.635
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```
UNIT 12
CUBOID 3 1 4P0.44577 2P0.635
UNIT 13
CYLINDER 1 1 0.46482 2P0.3175
CYLINDER 7 1 0.474472 2P0.3175
CYLINDER 2 1 0.53594 2P0.3175
CUBOID   3 1 4P0.71501 2P0.3175
UNIT 14
CYLINDER 3 1 0.6502 2P0.3175
CYLINDER 2 1 0.6934 2P0.3175
CUBOID   3 1 4P0.71501 2P0.3175
UNIT 15
CUBOID 5 1 4P0.381 2P0.3175
UNIT 16
CUBOID 5 1 2P0.71501 2P0.381 2P0.3175
UNIT 17
CUBOID 5 1 2P0.381 2P0.71501 2P0.3175
UNIT 18
CUBOID 5 1 2P0.44577 2P0.381 2P0.3175
UNIT 19
CUBOID 5 1 2P0.381 2P0.44577 2P0.3175
UNIT 20
CUBOID 3 1 2P0.44577 2P0.71501 2P0.3175
UNIT 21
CUBOID 3 1 2P0.71501 2P0.44577 2P0.3175
UNIT 22
CUBOID 3 1 4P0.44577 2P0.3175
UNIT 23
ARRAY 1 0.0 0.0 -0.3175
UNIT 24
ARRAY 2 0.0 0.0 -0.635
UNIT 25
XHEMICYL+Y 4 1 0.35306 1.43002 0.45974
XHEMICYL+Y 0 1 0.37084 1.43002 0.22352
CUBOID     5 1 1.43002 0.0 0.762 0.0 2P0.635
UNIT 26
YHEMICYL+X 4 1 0.35306 1.43002 0.45974
YHEMICYL+X 0 1 0.37084 1.43002 0.22352
CUBOID     5 1 0.762 0.0 1.43002 0.0 2P0.635
UNIT 27
XHEMICYL+Y 4 1 0.35306 2P0.71501
XHEMICYL+Y 0 1 0.37084 2P0.71501
CUBOID     5 1 2P0.71501 0.762 0.0 2P0.635
UNIT 28
YHEMICYL+X 4 1 0.35306 2P0.71501
YHEMICYL+X 0 1 0.37084 2P0.71501
CUBOID     5 1 0.762 0.0 2P0.71501 2P0.635
UNIT 29
```

```
CUBOID     5 1 0.89154 0.0 0.762 0.0 2P0.635
UNIT 30
CUBOID     5 1 0.762 0.0 0.89154 0.0 2P0.635
UNIT 31
ARRAY 3 0.0 0.0 -0.635
UNIT 32
CUBOID     5 1 0.89154 0.0 0.762 0.0 2P0.635
UNIT 33
CUBOID     5 1 0.762 0.0 0.89154 0.0 2P0.635
UNIT 34
CUBOID     3 1 4P0.71501 2P0.635
UNIT 35
CUBOID     3 1 4P0.71501 2P0.3175
UNIT 36
ARRAY 4  0.0 0.0 -0.3175
UNIT 37
ARRAY 5  0.0 0.0 -0.635
UNIT 38
ARRAY 6  0.0 0.0 -0.635
UNIT 39
XHEMICYL+Y 4 1 0.35306 0.9271 0.0
XHEMICYL+Y 0 1 0.37084 0.9271 0.0
CUBOID     5 1 1.43002 0.0 0.762 0.0 2P0.635
UNIT 40
YHEMICYL+X 4 1 0.35306 0.9271 0.0
YHEMICYL+X 0 1 0.37084 0.9271 0.0
CUBOID     5 1 0.762 0.0 1.43002 0.0 2P0.635
CORE 7 1 0.0 0.0 0.635
CUBOID 3 1 23.2029 0.0 23.2029 0.0 424.815 0.0
CUBOID 5 1 24.1554 0.0 24.1554 0.0 424.815 0.0
CUBOID 6 1 30.8864 0.0 30.8864 0.0 424.815 0.0
CUBOID 5 1 34.6964 0.0 34.6964 0.0 452.755 -24.13
CUBOID 8 1 100.0 0.0 100.0 0.0 510.0 -75.0
END GEOM
END DATA
END
```

den70

```
=CSAS25
4 PWR ASSEM. W(15X15) OFA, E=3.1, BU=00, H20 Den = 0.70
27BURNUPLIB  LATTICECELL
UO2  1 0.95 293 92235 3.15 92238 96.85 END
ZIRCALLOY  2 1.0 END
H2O  3 0.70 END
B4C  4 0.864 293.0 5010 96.0 5011 4.0 END
SS304  5 1.0 END
URANIUM  6 1.0 293.0 92235 0.3 92238 99.7 END
H2O  7 0.70 END
H2O  8 1.0 END
END COMP
SQUAREPITCH 1.43002 0.92964 1 3 1.07188 2 0.948944 7 END
FLAT FULL HEIGHT GA-4, 4/96, 90% FOR NRC WITH B4C
READ PARAM  TME=200.0 GEN=200 NPG=1000 FLX=NO FDN=NO
NUB=YES END PARAM
READ ARRAY
ARA=1 NUX=17 NUY=17 NUZ=1
FILL
     15 15R16 18
     17 15R13 20
     17 15R13 20
     17 2R13 14 2R13 14 3R13 14 2R13 14 2R13 20
     17 7R13 14 7R13 20
     17 4R13 14 5R13 14 4R13 20
     17 2R13 14 9R13 14 2R13 20
     17 15R13 20
     17 3R13 14 3R13 14 3R13 14 3R13 20
     17 15R13 20
     17 2R13 14 9R13 14 2R13 20
     17 4R13 14 5R13 14 4R13 20
     17 7R13 14 7R13 20
     17 2R13 14 2R13 14 3R13 14 2R13 14 2R13 20
     17 15R13 20
     17 15R13 20
     19 15R21 22
     END FILL
ARA=2 NUX=17 NUY=17 NUZ=1
FILL
     3 4 13R6 8 32
     5 15R1 10
     7 15R1 10
     7 2R1 2 2R1 2 3R1 2 2R1 2 2R1 10
     7 7R1 2 7R1 10
     7 4R1 2 5R1 2 4R1 10
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     7 2R1 2 9R1 2 2R1 10
     7 15R1 10
     7 3R1 2 3R1 2 3R1 2 3R1 10
     7 15R1 10
     7 2R1 2 9R1 2 2R1 10
     7 4R1 2 5R1 2 4R1 10
     7 7R1 2 7R1 10
     7 2R1 2 2R1 2 3R1 2 2R1 2 2R1 10
     7 15R1 10
     9 15R1 10
     33 15R11 12
     END FILL
ARA=3 NUX=17 NUY=17 NUZ=1
FILL
     3 25 13R27 39 29
     26 15R1 10
     28 15R1 10
     28 2R1 2 2R1 2 3R1 2 2R1 2 2R1 10
     28 7R1 2 7R1 10
     28 4R1 2 5R1 2 4R1 10
     28 2R1 2 9R1 2 2R1 10
     28 15R1 10
     28 3R1 2 3R1 2 3R1 2 3R1 10
     28 15R1 10
     28 2R1 2 9R1 2 2R1 10
     28 4R1 2 5R1 2 4R1 10
     28 7R1 2 7R1 10
     28 2R1 2 2R1 2 3R1 2 2R1 2 2R1 10
     28 15R1 10
     40 15R1 10
     30 15R11 12
     END FILL
ARA=4 NUX=17 NUY=17 NUZ=1
FILL
     15 15R16 18
     17 15R35 20
     17 15R35 20
     17 15R35 20
     17 15R35 20
     17 15R35 20
     17 15R35 20
     17 15R35 20
     17 15R35 20
     17 15R35 20
     17 15R35 20
     17 15R35 20
     17 15R35 20
     17 15R35 20
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     17 15R35 20
     17 15R35 20
     19 15R21 22
     END FILL
ARA=5 NUX=17 NUY=17 NUZ=1
FILL
     3 4 13R6 8 32
     5 15R34 10
     7 15R34 10
     7 15R34 10
     7 15R34 10
     7 15R34 10
     7 15R34 10
     7 15R34 10
     7 15R34 10
     7 15R34 10
     7 15R34 10
     7 15R34 10
     7 15R34 10
     7 15R34 10
     7 15R34 10
     7 15R34 10
     9 15R34 10
     33 15R11 12
     END FILL
ARA=6 NUX=17 NUY=17 NUZ=1
FILL
     3 25 13R27 39 29
     26 15R34 10
     28 15R34 10
     28 15R34 10
     28 15R34 10
     28 15R34 10
     28 15R34 10
     28 15R34 10
     28 15R34 10
     28 15R34 10
     28 15R34 10
     28 15R34 10
     28 15R34 10
     28 15R34 10
     28 15R34 10
     28 15R34 10
     40 15R34 10
     30 15R11 12
     END FILL
ARA=7 NUX=1 NUY=1 NUZ=344
FILL
     7R36
     4R23
```

```
     19R31
     267R24
     16R37
     20R38
     11R36
     END FILL
END ARRAY
READ BNDS -XY=MIRROR   END BNDS
READ GEOM
UNIT 1
CYLINDER 1 1 0.46482 2P0.635
CYLINDER 7 1 0.474472 2P0.635
CYLINDER 2 1 0.53594 2P0.635
CUBOID   3 1 4P0.71501 2P0.635
UNIT 2
CYLINDER 3 1 0.6502 2P0.635
CYLINDER 2 1 0.6934 2P0.635
CUBOID   3 1 4P0.71501 2P0.635
UNIT 3
CUBOID 5 1 4P0.381 2P0.635
UNIT 4
XHEMICYL+Y 4 1 0.5410 1.43002 1.31318
XHEMICYL+Y 0 1 0.5588 1.43002 0.29972
CUBOID     5 1 1.43002 0.0 0.762 0.0 2P0.635
UNIT 5
YHEMICYL+X 4 1 0.5410 1.43002 1.31318
YHEMICYL+X 0 1 0.5588 1.43002 0.29972
CUBOID     5 1 0.762 0.0 1.43002 0.0 2P0.635
UNIT 6
XHEMICYL+Y 4 1 0.5410 2P0.71501
XHEMICYL+Y 0 1 0.5588 2P0.71501
CUBOID     5 1 2P0.71501 0.762 0.0 2P0.635
UNIT 7
YHEMICYL+X 4 1 0.5410 2P0.71501
YHEMICYL+X 0 1 0.5588 2P0.71501
CUBOID     5 1 0.762 0.0 2P0.71501 2P0.635
UNIT 8
XHEMICYL+Y 4 1 0.5410 0.9271 0.0
XHEMICYL+Y 0 1 0.5588 0.9271 0.0
CUBOID     5 1 1.43002 0.0 0.762 0.0 2P0.635
UNIT 9
YHEMICYL+X 4 1 0.5410 0.9271 0.0
YHEMICYL+X 0 1 0.5588 0.9271 0.0
CUBOID     5 1 0.762 0.0 1.43002 0.0 2P0.635
UNIT 10
CUBOID 3 1 2P0.44577 2P0.71501 2P0.635
UNIT 11
CUBOID 3 1 2P0.71501 2P0.44577 2P0.635
```

```
UNIT 12
CUBOID 3 1 4P0.44577 2P0.635
UNIT 13
CYLINDER 1 1 0.46482 2P0.3175
CYLINDER 7 1 0.474472 2P0.3175
CYLINDER 2 1 0.53594 2P0.3175
CUBOID   3 1 4P0.71501 2P0.3175
UNIT 14
CYLINDER 3 1 0.6502 2P0.3175
CYLINDER 2 1 0.6934 2P0.3175
CUBOID   3 1 4P0.71501 2P0.3175
UNIT 15
CUBOID 5 1 4P0.381 2P0.3175
UNIT 16
CUBOID 5 1 2P0.71501 2P0.381 2P0.3175
UNIT 17
CUBOID 5 1 2P0.381 2P0.71501 2P0.3175
UNIT 18
CUBOID 5 1 2P0.44577 2P0.381 2P0.3175
UNIT 19
CUBOID 5 1 2P0.381 2P0.44577 2P0.3175
UNIT 20
CUBOID 3 1 2P0.44577 2P0.71501 2P0.3175
UNIT 21
CUBOID 3 1 2P0.71501 2P0.44577 2P0.3175
UNIT 22
CUBOID 3 1 4P0.44577 2P0.3175
UNIT 23
ARRAY 1 0.0 0.0 -0.3175
UNIT 24
ARRAY 2 0.0 0.0 -0.635
UNIT 25
XHEMICYL+Y 4 1 0.35306 1.43002 0.45974
XHEMICYL+Y 0 1 0.37084 1.43002 0.22352
CUBOID     5 1 1.43002 0.0 0.762 0.0 2P0.635
UNIT 26
YHEMICYL+X 4 1 0.35306 1.43002 0.45974
YHEMICYL+X 0 1 0.37084 1.43002 0.22352
CUBOID     5 1 0.762 0.0 1.43002 0.0 2P0.635
UNIT 27
XHEMICYL+Y 4 1 0.35306 2P0.71501
XHEMICYL+Y 0 1 0.37084 2P0.71501
CUBOID     5 1 2P0.71501 0.762 0.0 2P0.635
UNIT 28
YHEMICYL+X 4 1 0.35306 2P0.71501
YHEMICYL+X 0 1 0.37084 2P0.71501
CUBOID     5 1 0.762 0.0 2P0.71501 2P0.635
UNIT 29
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CUBOID     5 1 0.89154 0.0 0.762 0.0 2P0.635
UNIT 30
CUBOID     5 1 0.762 0.0 0.89154 0.0 2P0.635
UNIT 31
ARRAY 3 0.0 0.0 -0.635
UNIT 32
CUBOID     5 1 0.89154 0.0 0.762 0.0 2P0.635
UNIT 33
CUBOID     5 1 0.762 0.0 0.89154 0.0 2P0.635
UNIT 34
CUBOID     3 1 4P0.71501 2P0.635
UNIT 35
CUBOID     3 1 4P0.71501 2P0.3175
UNIT 36
ARRAY 4  0.0 0.0 -0.3175
UNIT 37
ARRAY 5  0.0 0.0 -0.635
UNIT 38
ARRAY 6  0.0 0.0 -0.635
UNIT 39
XHEMICYL+Y 4 1 0.35306 0.9271 0.0
XHEMICYL+Y 0 1 0.37084 0.9271 0.0
CUBOID     5 1 1.43002 0.0 0.762 0.0 2P0.635
UNIT 40
YHEMICYL+X 4 1 0.35306 0.9271 0.0
YHEMICYL+X 0 1 0.37084 0.9271 0.0
CUBOID     5 1 0.762 0.0 1.43002 0.0 2P0.635
CORE 7 1 0.0 0.0 0.635
CUBOID 3 1 23.2029 0.0 23.2029 0.0 424.815 0.0
CUBOID 5 1 24.1554 0.0 24.1554 0.0 424.815 0.0
CUBOID 6 1 30.8864 0.0 30.8864 0.0 424.815 0.0
CUBOID 5 1 34.6964 0.0 34.6964 0.0 452.755 -24.13
CUBOID 8 1 100.0 0.0 100.0 0.0 510.0 -75.0
END GEOM
END DATA
END
```

den60

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=CSAS25
4 PWR ASSEM. W(15X15) OFA, E=3.1, BU=00, H20 Den = 0.60
27BURNUPLIB  LATTICECELL
UO2  1 0.95 293 92235 3.15 92238 96.85 END
ZIRCALLOY  2 1.0 END
H2O  3 0.60 END
B4C  4 0.864 293.0 5010 96.0 5011 4.0 END
SS304  5 1.0 END
URANIUM  6 1.0 293.0 92235 0.3 92238 99.7 END
H2O  7 0.60 END
H2O  8 1.0 END
END COMP
SQUAREPITCH 1.43002 0.92964 1 3 1.07188 2 0.948944 7 END
FLAT FULL HEIGHT GA-4, 4/96, 90% FOR NRC WITH B4C
READ PARAM  TME=200.0 GEN=200 NPG=1000 FLX=NO FDN=NO
NUB=YES END PARAM
READ ARRAY
ARA=1 NUX=17 NUY=17 NUZ=1
FILL
     15 15R16 18
     17 15R13 20
     17 15R13 20
     17 2R13 14 2R13 14 3R13 14 2R13 14 2R13 20
     17 7R13 14 7R13 20
     17 4R13 14 5R13 14 4R13 20
     17 2R13 14 9R13 14 2R13 20
     17 15R13 20
     17 3R13 14 3R13 14 3R13 14 3R13 20
     17 15R13 20
     17 2R13 14 9R13 14 2R13 20
     17 4R13 14 5R13 14 4R13 20
     17 7R13 14 7R13 20
     17 2R13 14 2R13 14 3R13 14 2R13 14 2R13 20
     17 15R13 20
     17 15R13 20
     19 15R21 22
     END FILL
ARA=2 NUX=17 NUY=17 NUZ=1
FILL
     3 4 13R6 8 32
     5 15R1 10
     7 15R1 10
     7 2R1 2 2R1 2 3R1 2 2R1 2 2R1 10
     7 7R1 2 7R1 10
     7 4R1 2 5R1 2 4R1 10
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     7 2R1 2 9R1 2 2R1 10
     7 15R1 10
     7 3R1 2 3R1 2 3R1 2 3R1 10
     7 15R1 10
     7 2R1 2 9R1 2 2R1 10
     7 4R1 2 5R1 2 4R1 10
     7 7R1 2 7R1 10
     7 2R1 2 2R1 2 3R1 2 2R1 2 2R1 10
     7 15R1 10
     9 15R1 10
     33 15R11 12
     END FILL
ARA=3 NUX=17 NUY=17 NUZ=1
FILL
     3 25 13R27 39 29
     26 15R1 10
     28 15R1 10
     28 2R1 2 2R1 2 3R1 2 2R1 2 2R1 10
     28 7R1 2 7R1 10
     28 4R1 2 5R1 2 4R1 10
     28 2R1 2 9R1 2 2R1 10
     28 15R1 10
     28 3R1 2 3R1 2 3R1 2 3R1 10
     28 15R1 10
     28 2R1 2 9R1 2 2R1 10
     28 4R1 2 5R1 2 4R1 10
     28 7R1 2 7R1 10
     28 2R1 2 2R1 2 3R1 2 2R1 2 2R1 10
     28 15R1 10
     40 15R1 10
     30 15R11 12
     END FILL
ARA=4 NUX=17 NUY=17 NUZ=1
FILL
     15 15R16 18
     17 15R35 20
     17 15R35 20
     17 15R35 20
     17 15R35 20
     17 15R35 20
     17 15R35 20
     17 15R35 20
     17 15R35 20
     17 15R35 20
     17 15R35 20
     17 15R35 20
     17 15R35 20
     17 15R35 20
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     17 15R35 20
     17 15R35 20
     19 15R21 22
     END FILL
ARA=5 NUX=17 NUY=17 NUZ=1
FILL
     3 4 13R6 8 32
     5 15R34 10
     7 15R34 10
     7 15R34 10
     7 15R34 10
     7 15R34 10
     7 15R34 10
     7 15R34 10
     7 15R34 10
     7 15R34 10
     7 15R34 10
     7 15R34 10
     7 15R34 10
     7 15R34 10
     7 15R34 10
     9 15R34 10
     33 15R11 12
     END FILL
ARA=6 NUX=17 NUY=17 NUZ=1
FILL
     3 25 13R27 39 29
     26 15R34 10
     28 15R34 10
     28 15R34 10
     28 15R34 10
     28 15R34 10
     28 15R34 10
     28 15R34 10
     28 15R34 10
     28 15R34 10
     28 15R34 10
     28 15R34 10
     28 15R34 10
     28 15R34 10
     28 15R34 10
     28 15R34 10
     40 15R34 10
     30 15R11 12
     END FILL
ARA=7 NUX=1 NUY=1 NUZ=344
FILL
     7R36
     4R23
```

```
     19R31
     267R24
     16R37
     20R38
     11R36
     END FILL
END ARRAY
READ BNDS -XY=MIRROR   END BNDS
READ GEOM
UNIT 1
CYLINDER 1 1 0.46482 2P0.635
CYLINDER 7 1 0.474472 2P0.635
CYLINDER 2 1 0.53594 2P0.635
CUBOID   3 1 4P0.71501 2P0.635
UNIT 2
CYLINDER 3 1 0.6502 2P0.635
CYLINDER 2 1 0.6934 2P0.635
CUBOID   3 1 4P0.71501 2P0.635
UNIT 3
CUBOID 5 1 4P0.381 2P0.635
UNIT 4
XHEMICYL+Y 4 1 0.5410 1.43002 1.31318
XHEMICYL+Y 0 1 0.5588 1.43002 0.29972
CUBOID     5 1 1.43002 0.0 0.762 0.0 2P0.635
UNIT 5
YHEMICYL+X 4 1 0.5410 1.43002 1.31318
YHEMICYL+X 0 1 0.5588 1.43002 0.29972
CUBOID     5 1 0.762 0.0 1.43002 0.0 2P0.635
UNIT 6
XHEMICYL+Y 4 1 0.5410 2P0.71501
XHEMICYL+Y 0 1 0.5588 2P0.71501
CUBOID     5 1 2P0.71501 0.762 0.0 2P0.635
UNIT 7
YHEMICYL+X 4 1 0.5410 2P0.71501
YHEMICYL+X 0 1 0.5588 2P0.71501
CUBOID     5 1 0.762 0.0 2P0.71501 2P0.635
UNIT 8
XHEMICYL+Y 4 1 0.5410 0.9271 0.0
XHEMICYL+Y 0 1 0.5588 0.9271 0.0
CUBOID     5 1 1.43002 0.0 0.762 0.0 2P0.635
UNIT 9
YHEMICYL+X 4 1 0.5410 0.9271 0.0
YHEMICYL+X 0 1 0.5588 0.9271 0.0
CUBOID     5 1 0.762 0.0 1.43002 0.0 2P0.635
UNIT 10
CUBOID 3 1 2P0.44577 2P0.71501 2P0.635
UNIT 11
CUBOID 3 1 2P0.71501 2P0.44577 2P0.635
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```
UNIT 12
CUBOID 3 1 4P0.44577 2P0.635
UNIT 13
CYLINDER 1 1 0.46482 2P0.3175
CYLINDER 7 1 0.474472 2P0.3175
CYLINDER 2 1 0.53594 2P0.3175
CUBOID   3 1 4P0.71501 2P0.3175
UNIT 14
CYLINDER 3 1 0.6502 2P0.3175
CYLINDER 2 1 0.6934 2P0.3175
CUBOID   3 1 4P0.71501 2P0.3175
UNIT 15
CUBOID 5 1 4P0.381 2P0.3175
UNIT 16
CUBOID 5 1 2P0.71501 2P0.381 2P0.3175
UNIT 17
CUBOID 5 1 2P0.381 2P0.71501 2P0.3175
UNIT 18
CUBOID 5 1 2P0.44577 2P0.381 2P0.3175
UNIT 19
CUBOID 5 1 2P0.381 2P0.44577 2P0.3175
UNIT 20
CUBOID 3 1 2P0.44577 2P0.71501 2P0.3175
UNIT 21
CUBOID 3 1 2P0.71501 2P0.44577 2P0.3175
UNIT 22
CUBOID 3 1 4P0.44577 2P0.3175
UNIT 23
ARRAY 1 0.0 0.0 -0.3175
UNIT 24
ARRAY 2 0.0 0.0 -0.635
UNIT 25
XHEMICYL+Y 4 1 0.35306 1.43002 0.45974
XHEMICYL+Y 0 1 0.37084 1.43002 0.22352
CUBOID     5 1 1.43002 0.0 0.762 0.0 2P0.635
UNIT 26
YHEMICYL+X 4 1 0.35306 1.43002 0.45974
YHEMICYL+X 0 1 0.37084 1.43002 0.22352
CUBOID     5 1 0.762 0.0 1.43002 0.0 2P0.635
UNIT 27
XHEMICYL+Y 4 1 0.35306 2P0.71501
XHEMICYL+Y 0 1 0.37084 2P0.71501
CUBOID     5 1 2P0.71501 0.762 0.0 2P0.635
UNIT 28
YHEMICYL+X 4 1 0.35306 2P0.71501
YHEMICYL+X 0 1 0.37084 2P0.71501
CUBOID     5 1 0.762 0.0 2P0.71501 2P0.635
UNIT 29
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```
CUBOID     5 1 0.89154 0.0 0.762 0.0 2P0.635
UNIT 30
CUBOID     5 1 0.762 0.0 0.89154 0.0 2P0.635
UNIT 31
ARRAY 3 0.0 0.0 -0.635
UNIT 32
CUBOID     5 1 0.89154 0.0 0.762 0.0 2P0.635
UNIT 33
CUBOID     5 1 0.762 0.0 0.89154 0.0 2P0.635
UNIT 34
CUBOID     3 1 4P0.71501 2P0.635
UNIT 35
CUBOID     3 1 4P0.71501 2P0.3175
UNIT 36
ARRAY 4  0.0 0.0 -0.3175
UNIT 37
ARRAY 5  0.0 0.0 -0.635
UNIT 38
ARRAY 6  0.0 0.0 -0.635
UNIT 39
XHEMICYL+Y 4 1 0.35306 0.9271 0.0
XHEMICYL+Y 0 1 0.37084 0.9271 0.0
CUBOID     5 1 1.43002 0.0 0.762 0.0 2P0.635
UNIT 40
YHEMICYL+X 4 1 0.35306 0.9271 0.0
YHEMICYL+X 0 1 0.37084 0.9271 0.0
CUBOID     5 1 0.762 0.0 1.43002 0.0 2P0.635
CORE 7 1 0.0 0.0 0.635
CUBOID 3 1 23.2029 0.0 23.2029 0.0 424.815 0.0
CUBOID 5 1 24.1554 0.0 24.1554 0.0 424.815 0.0
CUBOID 6 1 30.8864 0.0 30.8864 0.0 424.815 0.0
CUBOID 5 1 34.6964 0.0 34.6964 0.0 452.755 -24.13
CUBOID 8 1 100.0 0.0 100.0 0.0 510.0 -75.0
END GEOM
END DATA
END
```

den50

```
=CSAS25
4 PWR ASSEM. W(15X15) OFA, E=3.1, BU=00, H20 Den = 0.50
27BURNUPLIB  LATTICECELL
UO2  1 0.95 293 92235 3.15 92238 96.85 END
ZIRCALLOY  2 1.0 END
H2O  3 0.50 END
B4C  4 0.864 293.0 5010 96.0 5011 4.0 END
SS304  5 1.0 END
URANIUM  6 1.0 293.0 92235 0.3 92238 99.7 END
H2O  7 0.50 END
H2O  8 1.0 END
END COMP
SQUAREPITCH 1.43002 0.92964 1 3 1.07188 2 0.948944 7 END
FLAT FULL HEIGHT GA-4, 4/96, 90% FOR NRC WITH B4C
READ PARAM  TME=200.0 GEN=200 NPG=1000 FLX=NO FDN=NO
NUB=YES END PARAM
READ ARRAY
ARA=1 NUX=17 NUY=17 NUZ=1
FILL
     15 15R16 18
     17 15R13 20
     17 15R13 20
     17 2R13 14 2R13 14 3R13 14 2R13 14 2R13 20
     17 7R13 14 7R13 20
     17 4R13 14 5R13 14 4R13 20
     17 2R13 14 9R13 14 2R13 20
     17 15R13 20
     17 3R13 14 3R13 14 3R13 14 3R13 20
     17 15R13 20
     17 2R13 14 9R13 14 2R13 20
     17 4R13 14 5R13 14 4R13 20
     17 7R13 14 7R13 20
     17 2R13 14 2R13 14 3R13 14 2R13 14 2R13 20
     17 15R13 20
     17 15R13 20
     19 15R21 22
     END FILL
ARA=2 NUX=17 NUY=17 NUZ=1
FILL
     3 4 13R6 8 32
     5 15R1 10
     7 15R1 10
     7 2R1 2 2R1 2 3R1 2 2R1 2 2R1 10
     7 7R1 2 7R1 10
     7 4R1 2 5R1 2 4R1 10
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     7 2R1 2 9R1 2 2R1 10
     7 15R1 10
     7 3R1 2 3R1 2 3R1 2 3R1 10
     7 15R1 10
     7 2R1 2 9R1 2 2R1 10
     7 4R1 2 5R1 2 4R1 10
     7 7R1 2 7R1 10
     7 2R1 2 2R1 2 3R1 2 2R1 2 2R1 10
     7 15R1 10
     9 15R1 10
     33 15R11 12
     END FILL
ARA=3 NUX=17 NUY=17 NUZ=1
FILL
     3 25 13R27 39 29
     26 15R1 10
     28 15R1 10
     28 2R1 2 2R1 2 3R1 2 2R1 2 2R1 10
     28 7R1 2 7R1 10
     28 4R1 2 5R1 2 4R1 10
     28 2R1 2 9R1 2 2R1 10
     28 15R1 10
     28 3R1 2 3R1 2 3R1 2 3R1 10
     28 15R1 10
     28 2R1 2 9R1 2 2R1 10
     28 4R1 2 5R1 2 4R1 10
     28 7R1 2 7R1 10
     28 2R1 2 2R1 2 3R1 2 2R1 2 2R1 10
     28 15R1 10
     40 15R1 10
     30 15R11 12
     END FILL
ARA=4 NUX=17 NUY=17 NUZ=1
FILL
     15 15R16 18
     17 15R35 20
     17 15R35 20
     17 15R35 20
     17 15R35 20
     17 15R35 20
     17 15R35 20
     17 15R35 20
     17 15R35 20
     17 15R35 20
     17 15R35 20
     17 15R35 20
     17 15R35 20
     17 15R35 20
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     17 15R35 20
     17 15R35 20
     19 15R21 22
     END FILL
ARA=5 NUX=17 NUY=17 NUZ=1
FILL
     3 4 13R6 8 32
     5 15R34 10
     7 15R34 10
     7 15R34 10
     7 15R34 10
     7 15R34 10
     7 15R34 10
     7 15R34 10
     7 15R34 10
     7 15R34 10
     7 15R34 10
     7 15R34 10
     7 15R34 10
     7 15R34 10
     7 15R34 10
     7 15R34 10
     9 15R34 10
     33 15R11 12
     END FILL
ARA=6 NUX=17 NUY=17 NUZ=1
FILL
     3 25 13R27 39 29
     26 15R34 10
     28 15R34 10
     28 15R34 10
     28 15R34 10
     28 15R34 10
     28 15R34 10
     28 15R34 10
     28 15R34 10
     28 15R34 10
     28 15R34 10
     28 15R34 10
     28 15R34 10
     28 15R34 10
     28 15R34 10
     28 15R34 10
     40 15R34 10
     30 15R11 12
     END FILL
ARA=7 NUX=1 NUY=1 NUZ=344
FILL
     7R36
     4R23
```

```
     19R31
     267R24
     16R37
     20R38
     11R36
     END FILL
END ARRAY
READ BNDS -XY=MIRROR   END BNDS
READ GEOM
UNIT 1
CYLINDER 1 1 0.46482 2P0.635
CYLINDER 7 1 0.474472 2P0.635
CYLINDER 2 1 0.53594 2P0.635
CUBOID   3 1 4P0.71501 2P0.635
UNIT 2
CYLINDER 3 1 0.6502 2P0.635
CYLINDER 2 1 0.6934 2P0.635
CUBOID   3 1 4P0.71501 2P0.635
UNIT 3
CUBOID 5 1 4P0.381 2P0.635
UNIT 4
XHEMICYL+Y 4 1 0.5410 1.43002 1.31318
XHEMICYL+Y 0 1 0.5588 1.43002 0.29972
CUBOID     5 1 1.43002 0.0 0.762 0.0 2P0.635
UNIT 5
YHEMICYL+X 4 1 0.5410 1.43002 1.31318
YHEMICYL+X 0 1 0.5588 1.43002 0.29972
CUBOID     5 1 0.762 0.0 1.43002 0.0 2P0.635
UNIT 6
XHEMICYL+Y 4 1 0.5410 2P0.71501
XHEMICYL+Y 0 1 0.5588 2P0.71501
CUBOID     5 1 2P0.71501 0.762 0.0 2P0.635
UNIT 7
YHEMICYL+X 4 1 0.5410 2P0.71501
YHEMICYL+X 0 1 0.5588 2P0.71501
CUBOID     5 1 0.762 0.0 2P0.71501 2P0.635
UNIT 8
XHEMICYL+Y 4 1 0.5410 0.9271 0.0
XHEMICYL+Y 0 1 0.5588 0.9271 0.0
CUBOID     5 1 1.43002 0.0 0.762 0.0 2P0.635
UNIT 9
YHEMICYL+X 4 1 0.5410 0.9271 0.0
YHEMICYL+X 0 1 0.5588 0.9271 0.0
CUBOID     5 1 0.762 0.0 1.43002 0.0 2P0.635
UNIT 10
CUBOID 3 1 2P0.44577 2P0.71501 2P0.635
UNIT 11
CUBOID 3 1 2P0.71501 2P0.44577 2P0.635
```

```
UNIT 12
CUBOID 3 1 4P0.44577 2P0.635
UNIT 13
CYLINDER 1 1 0.46482 2P0.3175
CYLINDER 7 1 0.474472 2P0.3175
CYLINDER 2 1 0.53594 2P0.3175
CUBOID   3 1 4P0.71501 2P0.3175
UNIT 14
CYLINDER 3 1 0.6502 2P0.3175
CYLINDER 2 1 0.6934 2P0.3175
CUBOID   3 1 4P0.71501 2P0.3175
UNIT 15
CUBOID 5 1 4P0.381 2P0.3175
UNIT 16
CUBOID 5 1 2P0.71501 2P0.381 2P0.3175
UNIT 17
CUBOID 5 1 2P0.381 2P0.71501 2P0.3175
UNIT 18
CUBOID 5 1 2P0.44577 2P0.381 2P0.3175
UNIT 19
CUBOID 5 1 2P0.381 2P0.44577 2P0.3175
UNIT 20
CUBOID 3 1 2P0.44577 2P0.71501 2P0.3175
UNIT 21
CUBOID 3 1 2P0.71501 2P0.44577 2P0.3175
UNIT 22
CUBOID 3 1 4P0.44577 2P0.3175
UNIT 23
ARRAY 1 0.0 0.0 -0.3175
UNIT 24
ARRAY 2 0.0 0.0 -0.635
UNIT 25
XHEMICYL+Y 4 1 0.35306 1.43002 0.45974
XHEMICYL+Y 0 1 0.37084 1.43002 0.22352
CUBOID     5 1 1.43002 0.0 0.762 0.0 2P0.635
UNIT 26
YHEMICYL+X 4 1 0.35306 1.43002 0.45974
YHEMICYL+X 0 1 0.37084 1.43002 0.22352
CUBOID     5 1 0.762 0.0 1.43002 0.0 2P0.635
UNIT 27
XHEMICYL+Y 4 1 0.35306 2P0.71501
XHEMICYL+Y 0 1 0.37084 2P0.71501
CUBOID     5 1 2P0.71501 0.762 0.0 2P0.635
UNIT 28
YHEMICYL+X 4 1 0.35306 2P0.71501
YHEMICYL+X 0 1 0.37084 2P0.71501
CUBOID     5 1 0.762 0.0 2P0.71501 2P0.635
UNIT 29
```

```
CUBOID     5 1 0.89154 0.0 0.762 0.0 2P0.635
UNIT 30
CUBOID     5 1 0.762 0.0 0.89154 0.0 2P0.635
UNIT 31
ARRAY 3 0.0 0.0 -0.635
UNIT 32
CUBOID     5 1 0.89154 0.0 0.762 0.0 2P0.635
UNIT 33
CUBOID     5 1 0.762 0.0 0.89154 0.0 2P0.635
UNIT 34
CUBOID     3 1 4P0.71501 2P0.635
UNIT 35
CUBOID     3 1 4P0.71501 2P0.3175
UNIT 36
ARRAY 4  0.0 0.0 -0.3175
UNIT 37
ARRAY 5  0.0 0.0 -0.635
UNIT 38
ARRAY 6  0.0 0.0 -0.635
UNIT 39
XHEMICYL+Y 4 1 0.35306 0.9271 0.0
XHEMICYL+Y 0 1 0.37084 0.9271 0.0
CUBOID     5 1 1.43002 0.0 0.762 0.0 2P0.635
UNIT 40
YHEMICYL+X 4 1 0.35306 0.9271 0.0
YHEMICYL+X 0 1 0.37084 0.9271 0.0
CUBOID     5 1 0.762 0.0 1.43002 0.0 2P0.635
CORE 7 1 0.0 0.0 0.635
CUBOID 3 1 23.2029 0.0 23.2029 0.0 424.815 0.0
CUBOID 5 1 24.1554 0.0 24.1554 0.0 424.815 0.0
CUBOID 6 1 30.8864 0.0 30.8864 0.0 424.815 0.0
CUBOID 5 1 34.6964 0.0 34.6964 0.0 452.755 -24.13
CUBOID 8 1 100.0 0.0 100.0 0.0 510.0 -75.0
END GEOM
END DATA
END
```

den40

```
=CSAS25
4 PWR ASSEM. W(15X15) OFA, E=3.1, BU=00, H20 Den = 0.40
27BURNUPLIB  LATTICECELL
UO2  1 0.95 293 92235 3.15 92238 96.85 END
ZIRCALLOY  2 1.0 END
H2O  3 0.40 END
B4C  4 0.864 293.0 5010 96.0 5011 4.0 END
SS304  5 1.0 END
URANIUM  6 1.0 293.0 92235 0.3 92238 99.7 END
H2O  7 0.40 END
H2O  8 1.0 END
END COMP
SQUAREPITCH 1.43002 0.92964 1 3 1.07188 2 0.948944 7 END
FLAT FULL HEIGHT GA-4, 4/96, 90% FOR NRC WITH B4C
READ PARAM  TME=200.0 GEN=200 NPG=1000 FLX=NO FDN=NO
NUB=YES END PARAM
READ ARRAY
ARA=1 NUX=17 NUY=17 NUZ=1
FILL
     15 15R16 18
     17 15R13 20
     17 15R13 20
     17 2R13 14 2R13 14 3R13 14 2R13 14 2R13 20
     17 7R13 14 7R13 20
     17 4R13 14 5R13 14 4R13 20
     17 2R13 14 9R13 14 2R13 20
     17 15R13 20
     17 3R13 14 3R13 14 3R13 14 3R13 20
     17 15R13 20
     17 2R13 14 9R13 14 2R13 20
     17 4R13 14 5R13 14 4R13 20
     17 7R13 14 7R13 20
     17 2R13 14 2R13 14 3R13 14 2R13 14 2R13 20
     17 15R13 20
     17 15R13 20
     19 15R21 22
     END FILL
ARA=2 NUX=17 NUY=17 NUZ=1
FILL
     3 4 13R6 8 32
     5 15R1 10
     7 15R1 10
     7 2R1 2 2R1 2 3R1 2 2R1 2 2R1 10
     7 7R1 2 7R1 10
     7 4R1 2 5R1 2 4R1 10
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     7 2R1 2 9R1 2 2R1 10
     7 15R1 10
     7 3R1 2 3R1 2 3R1 2 3R1 10
     7 15R1 10
     7 2R1 2 9R1 2 2R1 10
     7 4R1 2 5R1 2 4R1 10
     7 7R1 2 7R1 10
     7 2R1 2 2R1 2 3R1 2 2R1 2 2R1 10
     7 15R1 10
     9 15R1 10
     33 15R11 12
     END FILL
ARA=3 NUX=17 NUY=17 NUZ=1
FILL
     3 25 13R27 39 29
     26 15R1 10
     28 15R1 10
     28 2R1 2 2R1 2 3R1 2 2R1 2 2R1 10
     28 7R1 2 7R1 10
     28 4R1 2 5R1 2 4R1 10
     28 2R1 2 9R1 2 2R1 10
     28 15R1 10
     28 3R1 2 3R1 2 3R1 2 3R1 10
     28 15R1 10
     28 2R1 2 9R1 2 2R1 10
     28 4R1 2 5R1 2 4R1 10
     28 7R1 2 7R1 10
     28 2R1 2 2R1 2 3R1 2 2R1 2 2R1 10
     28 15R1 10
     40 15R1 10
     30 15R11 12
     END FILL
ARA=4 NUX=17 NUY=17 NUZ=1
FILL
     15 15R16 18
     17 15R35 20
     17 15R35 20
     17 15R35 20
     17 15R35 20
     17 15R35 20
     17 15R35 20
     17 15R35 20
     17 15R35 20
     17 15R35 20
     17 15R35 20
     17 15R35 20
     17 15R35 20
     17 15R35 20
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     17 15R35 20
     17 15R35 20
     19 15R21 22
     END FILL
ARA=5 NUX=17 NUY=17 NUZ=1
FILL
     3 4 13R6 8 32
     5 15R34 10
     7 15R34 10
     7 15R34 10
     7 15R34 10
     7 15R34 10
     7 15R34 10
     7 15R34 10
     7 15R34 10
     7 15R34 10
     7 15R34 10
     7 15R34 10
     7 15R34 10
     7 15R34 10
     7 15R34 10
     7 15R34 10
     9 15R34 10
     33 15R11 12
     END FILL
ARA=6 NUX=17 NUY=17 NUZ=1
FILL
     3 25 13R27 39 29
     26 15R34 10
     28 15R34 10
     28 15R34 10
     28 15R34 10
     28 15R34 10
     28 15R34 10
     28 15R34 10
     28 15R34 10
     28 15R34 10
     28 15R34 10
     28 15R34 10
     28 15R34 10
     28 15R34 10
     28 15R34 10
     28 15R34 10
     40 15R34 10
     30 15R11 12
     END FILL
ARA=7 NUX=1 NUY=1 NUZ=344
FILL
     7R36
     4R23
```

```
     19R31
     267R24
     16R37
     20R38
     11R36
     END FILL
END ARRAY
READ BNDS -XY=MIRROR   END BNDS
READ GEOM
UNIT 1
CYLINDER 1 1 0.46482 2P0.635
CYLINDER 7 1 0.474472 2P0.635
CYLINDER 2 1 0.53594 2P0.635
CUBOID   3 1 4P0.71501 2P0.635
UNIT 2
CYLINDER 3 1 0.6502 2P0.635
CYLINDER 2 1 0.6934 2P0.635
CUBOID   3 1 4P0.71501 2P0.635
UNIT 3
CUBOID 5 1 4P0.381 2P0.635
UNIT 4
XHEMICYL+Y 4 1 0.5410 1.43002 1.31318
XHEMICYL+Y 0 1 0.5588 1.43002 0.29972
CUBOID     5 1 1.43002 0.0 0.762 0.0 2P0.635
UNIT 5
YHEMICYL+X 4 1 0.5410 1.43002 1.31318
YHEMICYL+X 0 1 0.5588 1.43002 0.29972
CUBOID     5 1 0.762 0.0 1.43002 0.0 2P0.635
UNIT 6
XHEMICYL+Y 4 1 0.5410 2P0.71501
XHEMICYL+Y 0 1 0.5588 2P0.71501
CUBOID     5 1 2P0.71501 0.762 0.0 2P0.635
UNIT 7
YHEMICYL+X 4 1 0.5410 2P0.71501
YHEMICYL+X 0 1 0.5588 2P0.71501
CUBOID     5 1 0.762 0.0 2P0.71501 2P0.635
UNIT 8
XHEMICYL+Y 4 1 0.5410 0.9271 0.0
XHEMICYL+Y 0 1 0.5588 0.9271 0.0
CUBOID     5 1 1.43002 0.0 0.762 0.0 2P0.635
UNIT 9
YHEMICYL+X 4 1 0.5410 0.9271 0.0
YHEMICYL+X 0 1 0.5588 0.9271 0.0
CUBOID     5 1 0.762 0.0 1.43002 0.0 2P0.635
UNIT 10
CUBOID 3 1 2P0.44577 2P0.71501 2P0.635
UNIT 11
CUBOID 3 1 2P0.71501 2P0.44577 2P0.635
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```
UNIT 12
CUBOID 3 1 4P0.44577 2P0.635
UNIT 13
CYLINDER 1 1 0.46482 2P0.3175
CYLINDER 7 1 0.474472 2P0.3175
CYLINDER 2 1 0.53594 2P0.3175
CUBOID   3 1 4P0.71501 2P0.3175
UNIT 14
CYLINDER 3 1 0.6502 2P0.3175
CYLINDER 2 1 0.6934 2P0.3175
CUBOID   3 1 4P0.71501 2P0.3175
UNIT 15
CUBOID 5 1 4P0.381 2P0.3175
UNIT 16
CUBOID 5 1 2P0.71501 2P0.381 2P0.3175
UNIT 17
CUBOID 5 1 2P0.381 2P0.71501 2P0.3175
UNIT 18
CUBOID 5 1 2P0.44577 2P0.381 2P0.3175
UNIT 19
CUBOID 5 1 2P0.381 2P0.44577 2P0.3175
UNIT 20
CUBOID 3 1 2P0.44577 2P0.71501 2P0.3175
UNIT 21
CUBOID 3 1 2P0.71501 2P0.44577 2P0.3175
UNIT 22
CUBOID 3 1 4P0.44577 2P0.3175
UNIT 23
ARRAY 1 0.0 0.0 -0.3175
UNIT 24
ARRAY 2 0.0 0.0 -0.635
UNIT 25
XHEMICYL+Y 4 1 0.35306 1.43002 0.45974
XHEMICYL+Y 0 1 0.37084 1.43002 0.22352
CUBOID     5 1 1.43002 0.0 0.762 0.0 2P0.635
UNIT 26
YHEMICYL+X 4 1 0.35306 1.43002 0.45974
YHEMICYL+X 0 1 0.37084 1.43002 0.22352
CUBOID     5 1 0.762 0.0 1.43002 0.0 2P0.635
UNIT 27
XHEMICYL+Y 4 1 0.35306 2P0.71501
XHEMICYL+Y 0 1 0.37084 2P0.71501
CUBOID     5 1 2P0.71501 0.762 0.0 2P0.635
UNIT 28
YHEMICYL+X 4 1 0.35306 2P0.71501
YHEMICYL+X 0 1 0.37084 2P0.71501
CUBOID     5 1 0.762 0.0 2P0.71501 2P0.635
UNIT 29
```

```
CUBOID     5 1 0.89154 0.0 0.762 0.0 2P0.635
UNIT 30
CUBOID     5 1 0.762 0.0 0.89154 0.0 2P0.635
UNIT 31
ARRAY 3 0.0 0.0 -0.635
UNIT 32
CUBOID     5 1 0.89154 0.0 0.762 0.0 2P0.635
UNIT 33
CUBOID     5 1 0.762 0.0 0.89154 0.0 2P0.635
UNIT 34
CUBOID     3 1 4P0.71501 2P0.635
UNIT 35
CUBOID     3 1 4P0.71501 2P0.3175
UNIT 36
ARRAY 4  0.0 0.0 -0.3175
UNIT 37
ARRAY 5  0.0 0.0 -0.635
UNIT 38
ARRAY 6  0.0 0.0 -0.635
UNIT 39
XHEMICYL+Y 4 1 0.35306 0.9271 0.0
XHEMICYL+Y 0 1 0.37084 0.9271 0.0
CUBOID     5 1 1.43002 0.0 0.762 0.0 2P0.635
UNIT 40
YHEMICYL+X 4 1 0.35306 0.9271 0.0
YHEMICYL+X 0 1 0.37084 0.9271 0.0
CUBOID     5 1 0.762 0.0 1.43002 0.0 2P0.635
CORE 7 1 0.0 0.0 0.635
CUBOID 3 1 23.2029 0.0 23.2029 0.0 424.815 0.0
CUBOID 5 1 24.1554 0.0 24.1554 0.0 424.815 0.0
CUBOID 6 1 30.8864 0.0 30.8864 0.0 424.815 0.0
CUBOID 5 1 34.6964 0.0 34.6964 0.0 452.755 -24.13
CUBOID 8 1 100.0 0.0 100.0 0.0 510.0 -75.0
END GEOM
END DATA
END
```

den30

```
=CSAS25
4 PWR ASSEM. W(15X15) OFA, E=3.1, BU=00, H20 Den = 0.30
27BURNUPLIB  LATTICECELL
UO2  1 0.95 293 92235 3.15 92238 96.85 END
ZIRCALLOY  2 1.0 END
H2O  3 0.30 END
B4C  4 0.864 293.0 5010 96.0 5011 4.0 END
SS304  5 1.0 END
URANIUM  6 1.0 293.0 92235 0.3 92238 99.7 END
H2O  7 0.30 END
H2O  8 1.0 END
END COMP
SQUAREPITCH 1.43002 0.92964 1 3 1.07188 2 0.948944 7 END
FLAT FULL HEIGHT GA-4, 4/96, 90% FOR NRC WITH B4C
READ PARAM  TME=200.0 GEN=200 NPG=1000 FLX=NO FDN=NO
NUB=YES END PARAM
READ ARRAY
ARA=1 NUX=17 NUY=17 NUZ=1
FILL
     15 15R16 18
     17 15R13 20
     17 15R13 20
     17 2R13 14 2R13 14 3R13 14 2R13 14 2R13 20
     17 7R13 14 7R13 20
     17 4R13 14 5R13 14 4R13 20
     17 2R13 14 9R13 14 2R13 20
     17 15R13 20
     17 3R13 14 3R13 14 3R13 14 3R13 20
     17 15R13 20
     17 2R13 14 9R13 14 2R13 20
     17 4R13 14 5R13 14 4R13 20
     17 7R13 14 7R13 20
     17 2R13 14 2R13 14 3R13 14 2R13 14 2R13 20
     17 15R13 20
     17 15R13 20
     19 15R21 22
     END FILL
ARA=2 NUX=17 NUY=17 NUZ=1
FILL
     3 4 13R6 8 32
     5 15R1 10
     7 15R1 10
     7 2R1 2 2R1 2 3R1 2 2R1 2 2R1 10
     7 7R1 2 7R1 10
     7 4R1 2 5R1 2 4R1 10
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     7 2R1 2 9R1 2 2R1 10
     7 15R1 10
     7 3R1 2 3R1 2 3R1 2 3R1 10
     7 15R1 10
     7 2R1 2 9R1 2 2R1 10
     7 4R1 2 5R1 2 4R1 10
     7 7R1 2 7R1 10
     7 2R1 2 2R1 2 3R1 2 2R1 2 2R1 10
     7 15R1 10
     9 15R1 10
     33 15R11 12
     END FILL
ARA=3 NUX=17 NUY=17 NUZ=1
FILL
     3 25 13R27 39 29
     26 15R1 10
     28 15R1 10
     28 2R1 2 2R1 2 3R1 2 2R1 2 2R1 10
     28 7R1 2 7R1 10
     28 4R1 2 5R1 2 4R1 10
     28 2R1 2 9R1 2 2R1 10
     28 15R1 10
     28 3R1 2 3R1 2 3R1 2 3R1 10
     28 15R1 10
     28 2R1 2 9R1 2 2R1 10
     28 4R1 2 5R1 2 4R1 10
     28 7R1 2 7R1 10
     28 2R1 2 2R1 2 3R1 2 2R1 2 2R1 10
     28 15R1 10
     40 15R1 10
     30 15R11 12
     END FILL
ARA=4 NUX=17 NUY=17 NUZ=1
FILL
     15 15R16 18
     17 15R35 20
     17 15R35 20
     17 15R35 20
     17 15R35 20
     17 15R35 20
     17 15R35 20
     17 15R35 20
     17 15R35 20
     17 15R35 20
     17 15R35 20
     17 15R35 20
     17 15R35 20
     17 15R35 20
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     17 15R35 20
     17 15R35 20
     19 15R21 22
     END FILL
ARA=5 NUX=17 NUY=17 NUZ=1
FILL
     3 4 13R6 8 32
     5 15R34 10
     7 15R34 10
     7 15R34 10
     7 15R34 10
     7 15R34 10
     7 15R34 10
     7 15R34 10
     7 15R34 10
     7 15R34 10
     7 15R34 10
     7 15R34 10
     7 15R34 10
     7 15R34 10
     7 15R34 10
     7 15R34 10
     9 15R34 10
     33 15R11 12
     END FILL
ARA=6 NUX=17 NUY=17 NUZ=1
FILL
     3 25 13R27 39 29
     26 15R34 10
     28 15R34 10
     28 15R34 10
     28 15R34 10
     28 15R34 10
     28 15R34 10
     28 15R34 10
     28 15R34 10
     28 15R34 10
     28 15R34 10
     28 15R34 10
     28 15R34 10
     28 15R34 10
     28 15R34 10
     28 15R34 10
     40 15R34 10
     30 15R11 12
     END FILL
ARA=7 NUX=1 NUY=1 NUZ=344
FILL
     7R36
     4R23
```

```
     19R31
     267R24
     16R37
     20R38
     11R36
     END FILL
END ARRAY
READ BNDS -XY=MIRROR   END BNDS
READ GEOM
UNIT 1
CYLINDER 1 1 0.46482 2P0.635
CYLINDER 7 1 0.474472 2P0.635
CYLINDER 2 1 0.53594 2P0.635
CUBOID   3 1 4P0.71501 2P0.635
UNIT 2
CYLINDER 3 1 0.6502 2P0.635
CYLINDER 2 1 0.6934 2P0.635
CUBOID   3 1 4P0.71501 2P0.635
UNIT 3
CUBOID 5 1 4P0.381 2P0.635
UNIT 4
XHEMICYL+Y 4 1 0.5410 1.43002 1.31318
XHEMICYL+Y 0 1 0.5588 1.43002 0.29972
CUBOID     5 1 1.43002 0.0 0.762 0.0 2P0.635
UNIT 5
YHEMICYL+X 4 1 0.5410 1.43002 1.31318
YHEMICYL+X 0 1 0.5588 1.43002 0.29972
CUBOID     5 1 0.762 0.0 1.43002 0.0 2P0.635
UNIT 6
XHEMICYL+Y 4 1 0.5410 2P0.71501
XHEMICYL+Y 0 1 0.5588 2P0.71501
CUBOID     5 1 2P0.71501 0.762 0.0 2P0.635
UNIT 7
YHEMICYL+X 4 1 0.5410 2P0.71501
YHEMICYL+X 0 1 0.5588 2P0.71501
CUBOID     5 1 0.762 0.0 2P0.71501 2P0.635
UNIT 8
XHEMICYL+Y 4 1 0.5410 0.9271 0.0
XHEMICYL+Y 0 1 0.5588 0.9271 0.0
CUBOID     5 1 1.43002 0.0 0.762 0.0 2P0.635
UNIT 9
YHEMICYL+X 4 1 0.5410 0.9271 0.0
YHEMICYL+X 0 1 0.5588 0.9271 0.0
CUBOID     5 1 0.762 0.0 1.43002 0.0 2P0.635
UNIT 10
CUBOID 3 1 2P0.44577 2P0.71501 2P0.635
UNIT 11
CUBOID 3 1 2P0.71501 2P0.44577 2P0.635
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UNIT 12
CUBOID 3 1 4P0.44577 2P0.635
UNIT 13
CYLINDER 1 1 0.46482 2P0.3175
CYLINDER 7 1 0.474472 2P0.3175
CYLINDER 2 1 0.53594 2P0.3175
CUBOID   3 1 4P0.71501 2P0.3175
UNIT 14
CYLINDER 3 1 0.6502 2P0.3175
CYLINDER 2 1 0.6934 2P0.3175
CUBOID   3 1 4P0.71501 2P0.3175
UNIT 15
CUBOID 5 1 4P0.381 2P0.3175
UNIT 16
CUBOID 5 1 2P0.71501 2P0.381 2P0.3175
UNIT 17
CUBOID 5 1 2P0.381 2P0.71501 2P0.3175
UNIT 18
CUBOID 5 1 2P0.44577 2P0.381 2P0.3175
UNIT 19
CUBOID 5 1 2P0.381 2P0.44577 2P0.3175
UNIT 20
CUBOID 3 1 2P0.44577 2P0.71501 2P0.3175
UNIT 21
CUBOID 3 1 2P0.71501 2P0.44577 2P0.3175
UNIT 22
CUBOID 3 1 4P0.44577 2P0.3175
UNIT 23
ARRAY 1 0.0 0.0 -0.3175
UNIT 24
ARRAY 2 0.0 0.0 -0.635
UNIT 25
XHEMICYL+Y 4 1 0.35306 1.43002 0.45974
XHEMICYL+Y 0 1 0.37084 1.43002 0.22352
CUBOID     5 1 1.43002 0.0 0.762 0.0 2P0.635
UNIT 26
YHEMICYL+X 4 1 0.35306 1.43002 0.45974
YHEMICYL+X 0 1 0.37084 1.43002 0.22352
CUBOID     5 1 0.762 0.0 1.43002 0.0 2P0.635
UNIT 27
XHEMICYL+Y 4 1 0.35306 2P0.71501
XHEMICYL+Y 0 1 0.37084 2P0.71501
CUBOID     5 1 2P0.71501 0.762 0.0 2P0.635
UNIT 28
YHEMICYL+X 4 1 0.35306 2P0.71501
YHEMICYL+X 0 1 0.37084 2P0.71501
CUBOID     5 1 0.762 0.0 2P0.71501 2P0.635
UNIT 29
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CUBOID     5 1 0.89154 0.0 0.762 0.0 2P0.635
UNIT 30
CUBOID     5 1 0.762 0.0 0.89154 0.0 2P0.635
UNIT 31
ARRAY 3 0.0 0.0 -0.635
UNIT 32
CUBOID     5 1 0.89154 0.0 0.762 0.0 2P0.635
UNIT 33
CUBOID     5 1 0.762 0.0 0.89154 0.0 2P0.635
UNIT 34
CUBOID     3 1 4P0.71501 2P0.635
UNIT 35
CUBOID     3 1 4P0.71501 2P0.3175
UNIT 36
ARRAY 4  0.0 0.0 -0.3175
UNIT 37
ARRAY 5  0.0 0.0 -0.635
UNIT 38
ARRAY 6  0.0 0.0 -0.635
UNIT 39
XHEMICYL+Y 4 1 0.35306 0.9271 0.0
XHEMICYL+Y 0 1 0.37084 0.9271 0.0
CUBOID     5 1 1.43002 0.0 0.762 0.0 2P0.635
UNIT 40
YHEMICYL+X 4 1 0.35306 0.9271 0.0
YHEMICYL+X 0 1 0.37084 0.9271 0.0
CUBOID     5 1 0.762 0.0 1.43002 0.0 2P0.635
CORE 7 1 0.0 0.0 0.635
CUBOID 3 1 23.2029 0.0 23.2029 0.0 424.815 0.0
CUBOID 5 1 24.1554 0.0 24.1554 0.0 424.815 0.0
CUBOID 6 1 30.8864 0.0 30.8864 0.0 424.815 0.0
CUBOID 5 1 34.6964 0.0 34.6964 0.0 452.755 -24.13
CUBOID 8 1 100.0 0.0 100.0 0.0 510.0 -75.0
END GEOM
END DATA
END
```

pit01

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=CSAS25
4 PWR ASSEM. W(15X15) OFA, E=3.1, BU=00,
27BURNUPLIB  LATTICECELL
UO2  1 0.95 293 92235 3.15 92238 96.85 END
ZIRCALLOY  2 1.0 END
H2O  3 1.0 END
B4C  4 0.864 293.0 5010 96.0 5011 4.0 END
SS304  5 1.0 END
URANIUM  6 1.0 293.0 92235 0.3 92238 99.7 END
H2O  7 1.0 END
END COMP
SQUAREPITCH 1.43002 0.92964 1 3 1.07188 2 0.948944 7 END
FLAT FULL HEIGHT GA-4 MAX PITCH, 4/96, 90% FOR NRC WITH B4C
READ PARAM  TME=200.0 GEN=200 NPG=1000 FLX=NO FDN=NO
NUB=YES END PARAM
READ ARRAY
ARA=1 NUX=17 NUY=17 NUZ=1
FILL
     15 18 15R16
     19 22 15R21
     17 20 15R13
     17 20 15R13
     17 20 2R13 14 2R13 14 3R13 14 2R13 14 2R13
     17 20 7R13 14 7R13
     17 20 4R13 14 5R13 14 4R13
     17 20 2R13 14 9R13 14 2R13
     17 20 15R13
     17 20 3R13 14 3R13 14 3R13 14 3R13
     17 20 15R13
     17 20 2R13 14 9R13 14 2R13
     17 20 4R13 14 5R13 14 4R13
     17 20 7R13 14 7R13
     17 20 2R13 14 2R13 14 3R13 14 2R13 14 2R13
     17 20 15R13
     17 20 15R13
     END FILL
ARA=2 NUX=17 NUY=17 NUZ=1
FILL
     3 32 4 13R6 8
     33 12 15R11
     5 10 15R1
     7 10 15R1
     7 10 2R1 2 2R1 2 3R1 2 2R1 2 2R1
     7 10 7R1 2 7R1
     7 10 4R1 2 5R1 2 4R1
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     7 10 2R1 2 9R1 2 2R1
     7 10 15R1
     7 10 3R1 2·3R1 2 3R1 2 3R1
     7 10 15R1
     7 10 2R1 2 9R1 2 2R1
     7 10 4R1 2 5R1 2 4R1
     7 10 7R1 2 7R1
     7 10 2R1 2 2R1 2 3R1 2 2R1 2 2R1
     7 10 15R1
     9 10 15R1
     END FILL
ARA=3 NUX=17 NUY=17 NUZ=1
FILL
     3 29 27 13R27 39
     30 12 15R11
     28 10 15R1
     28 10 15R1
     28 10 2R1 2 2R1 2 3R1 2 2R1 2 2R1
     28 10 7R1 2 7R1
     28 10 4R1 2 5R1 2 4R1
     28 10 2R1 2 9R1 2 2R1
     28 10 15R1
     28 10 3R1 2 3R1 2 3R1 2 3R1
     28 10 15R1
     28 10 2R1 2 9R1 2 2R1
     28 10 4R1 2 5R1 2 4R1
     28 10 7R1 2 7R1
     28 10 2R1 2 2R1 2 3R1 2 2R1 2 2R1
     28 10 15R1
     40 10 15R1
     END FILL
ARA=4 NUX=17 NUY=17 NUZ=1
FILL
     15 18 15R16
     19 22 15R21
     17 20 15R35
     17 20 15R35
     17 20 15R35
     17 20 15R35
     17 20 15R35
     17 20 15R35
     17 20 15R35
     17 20 15R35
     17 20 15R35
     17 20 15R35
     17 20 15R35
     17 20 15R35
     17 20 15R35
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     17 20 15R35
     17 20 15R35
     END FILL
ARA=5 NUX=17 NUY=17 NUZ=1
FILL
     3 32 4 13R6 8
     33 12 15R11
     5 10 15R34
     7 10 15R34
     7 10 15R34
     7 10 15R34
     7 10 15R34
     7 10 15R34
     7 10 15R34
     7 10 15R34
     7 10 15R34
     7 10 15R34
     7 10 15R34
     7 10 15R34
     7 10 15R34
     7 10 15R34
     9 10 15R34
     END FILL
ARA=6 NUX=17 NUY=17 NUZ=1
FILL
     3 29 14R27 39
     30 12 15R11
     28 10 15R34
     28 10 15R34
     28 10 15R34
     28 10 15R34
     28 10 15R34
     28 10 15R34
     28 10 15R34
     28 10 15R34
     28 10 15R34
     28 10 15R34
     28 10 15R34
     28 10 15R34
     28 10 15R34
     28 10 15R34
     40 10 15R34
     END FILL
ARA=7 NUX=1 NUY=1 NUZ=344
FILL
     7R36
     4R23
     19R31
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     267R24
     16R37
     20R38
     11R36
     END FILL
END ARRAY
READ BNDS -XY=MIRROR   END BNDS
READ GEOM
UNIT 1
CYLINDER 1 1 0.46482 2P0.635
CYLINDER 7 1 0.474472 2P0.635
CYLINDER 2 1 0.53594 2P0.635
CUBOID   3 1 4P0.71501 2P0.635
UNIT 2
CYLINDER 3 1 0.6502 2P0.635
CYLINDER 2 1 0.6934 2P0.635
CUBOID   3 1 4P0.71501 2P0.635
UNIT 3
CUBOID 5 1 4P0.381 2P0.635
UNIT 4
XHEMICYL+Y 4 1 0.5410 1.43002 0.42164
XHEMICYL+Y 0 1 0.5588 1.43002 0.0
CUBOID     5 1 1.43002 0.0 0.762 0.0 2P0.635
UNIT 5
YHEMICYL+X 4 1 0.5410 1.43002 0.42164
YHEMICYL+X 0 1 0.5588 1.43002 0.0
CUBOID     5 1 0.762 0.0 1.43002 0.0 2P0.635
UNIT 6
XHEMICYL+Y 4 1 0.5410 2P0.71501
XHEMICYL+Y 0 1 0.5588 2P0.71501
CUBOID     5 1 2P0.71501 0.762 0.0 2P0.635
UNIT 7
YHEMICYL+X 4 1 0.5410 2P0.71501
YHEMICYL+X 0 1 0.5588 2P0.71501
CUBOID     5 1 0.762 0.0 2P0.71501 2P0.635
UNIT 8
XHEMICYL+Y 4 1 0.5410 0.03556 0.0
XHEMICYL+Y 0 1 0.5588 0.03556 0.0
CUBOID     5 1 1.43002 0.0 0.762 0.0 2P0.635
UNIT 9
YHEMICYL+X 4 1 0.5410 0.03556 0.0
YHEMICYL+X 0 1 0.5588 0.03556 0.0
CUBOID     5 1 0.762 0.0 1.43002 0.0 2P0.635
UNIT 10
CUBOID 3 1 2P0.44577 2P0.71501 2P0.635
UNIT 11
CUBOID 3 1 2P0.71501 2P0.44577 2P0.635
UNIT 12
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CUBOID 3 1 4P0.44577 2P0.635
UNIT 13
CYLINDER 1 1 0.46482 2P0.3175
CYLINDER 7 1 0.474472 2P0.3175
CYLINDER 2 1 0.53594 2P0.3175
CUBOID   3 1 4P0.71501 2P0.3175
UNIT 14
CYLINDER 3 1 0.6502 2P0.3175
CYLINDER 2 1 0.6934 2P0.3175
CUBOID   3 1 4P0.71501 2P0.3175
UNIT 15
CUBOID 5 1 4P0.381 2P0.3175
UNIT 16
CUBOID 5 1 2P0.71501 2P0.381 2P0.3175
UNIT 17
CUBOID 5 1 2P0.381 2P0.71501 2P0.3175
UNIT 18
CUBOID 5 1 2P0.44577 2P0.381 2P0.3175
UNIT 19
CUBOID 5 1 2P0.381 2P0.44577 2P0.3175
UNIT 20
CUBOID 3 1 2P0.44577 2P0.71501 2P0.3175
UNIT 21
CUBOID 3 1 2P0.71501 2P0.44577 2P0.3175
UNIT 22
CUBOID 3 1 4P0.44577 2P0.3175
UNIT 23
ARRAY 1 0.0 0.0 -0.3175
UNIT 24
ARRAY 2 0.0 0.0 -0.635
UNIT 25
XHEMICYL+Y 4 1 0.35306 1.43002 0.45974
XHEMICYL+Y 0 1 0.37084 1.43002 0.22352
CUBOID     5 1 1.43002 0.0 0.762 0.0 2P0.635
UNIT 26
YHEMICYL+X 4 1 0.35306 1.43002 0.45974
YHEMICYL+X 0 1 0.37084 1.43002 0.22352
CUBOID     5 1 0.762 0.0 1.43002 0.0 2P0.635
UNIT 27
XHEMICYL+Y 4 1 0.35306 2P0.71501
XHEMICYL+Y 0 1 0.37084 2P0.71501
CUBOID     5 1 2P0.71501 0.762 0.0 2P0.635
UNIT 28
YHEMICYL+X 4 1 0.35306 2P0.71501
YHEMICYL+X 0 1 0.37084 2P0.71501
CUBOID     5 1 0.762 0.0 2P0.71501 2P0.635
UNIT 29
XHEMICYL+Y 4 1 0.35306 0.89154 0.45974
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XHEMICYL+Y 0 1 0.37084 0.89154 0.22352
CUBOID     5 1 0.89154 0.0 0.762 0.0 2P0.635
UNIT 30
YHEMICYL+X 4 1 0.35306 0.89154 0.45974
YHEMICYL+X 0 1 0.37084 0.89154 0.22352
CUBOID     5 1 0.762 0.0 0.89154 0.0 2P0.635
UNIT 31
ARRAY 3 0.0 0.0 -0.635
UNIT 32
XHEMICYL+Y 0 1 0.5588 0.89154 0.29972
CUBOID     5 1 0.89154 0.0 0.762 0.0 2P0.635
UNIT 33
YHEMICYL+X 0 1 0.5588 0.89154 0.29972
CUBOID     5 1 0.762 0.0 0.89154 0.0 2P0.635
UNIT 34
CUBOID     3 1 4P0.71501 2P0.635
UNIT 35
CUBOID     3 1 4P0.71501 2P0.3175
UNIT 36
ARRAY 4  0.0 0.0 -0.3175
UNIT 37
ARRAY 5  0.0 0.0 -0.635
UNIT 38
ARRAY 6  0.0 0.0 -0.635
UNIT 39
XHEMICYL+Y 4 1 0.35306 0.03556 0.0
XHEMICYL+Y 0 1 0.37084 0.03556 0.0
CUBOID     5 1 1.43002 0.0 0.762 0.0 2P0.635
UNIT 40
YHEMICYL+X 4 1 0.35306 0.03556 0.0
YHEMICYL+X 0 1 0.37084 0.03556 0.0
CUBOID     5 1 0.762 0.0 1.43002 0.0 2P0.635
CORE 7 1 0.0 0.0 0.635
CUBOID 3 1 23.2029 0.0 23.2029 0.0 424.815 0.0
CUBOID 5 1 24.1554 0.0 24.1554 0.0 424.815 0.0
CUBOID 6 1 30.8864 0.0 30.8864 0.0 424.815 0.0
CUBOID 5 1 34.6964 0.0 34.6964 0.0 452.755 -24.13
CUBOID 3 1 100.0 0.0 100.0 0.0 510.0 -75.0
END GEOM
END DATA
END
```

pit02

```
=CSAS25
4 PWR ASSEM. W(15X15) OFA, E=3.1, BU=00,
27BURNUPLIB  LATTICECELL
UO2  1 0.95 293 92235 3.15 92238 96.85 END
ZIRCALLOY  2 1.0 END
H2O  3 1.0 END
B4C  4 0.864 293.0 5010 96.0 5011 4.0 END
SS304  5 1.0 END
URANIUM  6 1.0 293.0 92235 0.3 92238 99.7 END
H2O  7 1.0 END
END COMP
SQUAREPITCH 1.43002 0.92964 1 3 1.07188 2 0.948944 7 END
FLAT FULL HEIGHT GA-4 MID PITCH, 4/96, 90% FOR NRC WITH B4C
READ PARAM  TME=200.0 GEN=200 NPG=1000 FLX=NO FDN=NO
NUB=YES END PARAM
READ ARRAY
ARA=1 NUX=18 NUY=18 NUZ=1
FILL
     15 18 15R16 18
     19 22 15R21 22
     17 20 15R13 20
     17 20 15R13 20
     17 20 2R13 14 2R13 14 3R13 14 2R13 14 2R13 20
     17 20 7R13 14 7R13 20
     17 20 4R13 14 5R13 14 4R13 20
     17 20 2R13 14 9R13 14 2R13 20
     17 20 15R13 20
     17 20 3R13 14 3R13 14 3R13 14 3R13 20
     17 20 15R13 20
     17 20 2R13 14 9R13 14 2R13 20
     17 20 4R13 14 5R13 14 4R13 20
     17 20 7R13 14 7R13 20
     17 20 2R13 14 2R13 14 3R13 14 2R13 14 2R13 20
     17 20 15R13 20
     17 20 15R13 20
     19 22 15R21 22
     END FILL
ARA=2 NUX=18 NUY=18 NUZ=1
FILL
     3 32 4 13R6 8 42
     33 12 15R11 12
     5 10 15R1 10
     7 10 15R1 10
     7 10 2R1 2 2R1 2 3R1 2 2R1 2 2R1 10
     7 10 7R1 2 7R1 10
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     7 10 4R1 2 5R1 2 4R1 10
     7 10 2R1 2 9R1 2 2R1 10
     7 10 15R1 10
     7 10 3R1 2 3R1 2 3R1 2 3R1 10
     7 10 15R1 10
     7 10 2R1 2 9R1 2 2R1 10
     7 10 4R1 2 5R1 2 4R1 10
     7 10 7R1 2 7R1 10
     7 10 2R1 2 2R1 2 3R1 2 2R1 2 2R1 10
     7 10 15R1 10
     9 10 15R1 10
     41 12 15R11 12
     END FILL
ARA=3 NUX=18 NUY=18 NUZ=1
FILL
     3 29 43 13R27 39 42
     30 12 15R11 12
     44 10 15R1 10
     28 10 15R1 10
     28 10 2R1 2 2R1 2 3R1 2 2R1 2 2R1 10
     28 10 7R1 2 7R1 10
     28 10 4R1 2 5R1 2 4R1 10
     28 10 2R1 2 9R1 2 2R1 10
     28 10 15R1 10
     28 10 3R1 2 3R1 2 3R1 2 3R1 10
     28 10 15R1 10
     28 10 2R1 2 9R1 2 2R1 10
     28 10 4R1 2 5R1 2 4R1 10
     28 10 7R1 2 7R1 10
     28 10 2R1 2 2R1 2 3R1 2 2R1 2 2R1 10
     28 10 15R1 10
     40 10 15R1 10
     41 12 15R11 12
     END FILL
ARA=4 NUX=18 NUY=18 NUZ=1
FILL
     15 18 15R16 18
     19 22 15R21 22
     17 20 15R35 20
     17 20 15R35 20
     17 20 15R35 20
     17 20 15R35 20
     17 20 15R35 20
     17 20 15R35 20
     17 20 15R35 20
     17 20 15R35 20
     17 20 15R35 20
     17 20 15R35 20
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     17 20 15R35 20
     17 20 15R35 20
     17 20 15R35 20
     17 20 15R35 20
     17 20 15R35 20
     19 22 15R21 22
     END FILL
ARA=5 NUX=18 NUY=18 NUZ=1
FILL
     3 32 4 13R6 8 42
     33 12 15R11 12
     5 10 15R34 10
     7 10 15R34 10
     7 10 15R34 10
     7 10 15R34 10
     7 10 15R34 10
     7 10 15R34 10
     7 10 15R34 10
     7 10 15R34 10
     7 10 15R34 10
     7 10 15R34 10
     7 10 15R34 10
     7 10 15R34 10
     7 10 15R34 10
     7 10 15R34 10
     7 10 15R34 10
     9 10 15R34 10
     41 12 15R11 12
     END FILL
ARA=6 NUX=18 NUY=18 NUZ=1
FILL
     3 29 43 13R27 39 42
     30 12 15R11 12
     44 10 15R34 10
     28 10 15R34 10
     28 10 15R34 10
     28 10 15R34 10
     28 10 15R34 10
     28 10 15R34 10
     28 10 15R34 10
     28 10 15R34 10
     28 10 15R34 10
     28 10 15R34 10
     28 10 15R34 10
     28 10 15R34 10
     28 10 15R34 10
     28 10 15R34 10
     28 10 15R34 10
     40 10 15R34 10
     41 12 15R11 12
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     END FILL
ARA=7 NUX=1 NUY=1 NUZ=344
FILL
     7R36
     4R23
     19R31
     267R24
     16R37
     20R38
     11R36
     END FILL
END ARRAY
READ BNDS -XY=MIRROR   END BNDS
READ GEOM
UNIT 1
CYLINDER 1 1 0.46482 2P0.635
CYLINDER 7 1 0.474472 2P0.635
CYLINDER 2 1 0.53594 2P0.635
CUBOID   3 1 4P0.71501 2P0.635
UNIT 2
CYLINDER 3 1 0.6502 2P0.635
CYLINDER 2 1 0.6934 2P0.635
CUBOID   3 1 4P0.71501 2P0.635
UNIT 3
CUBOID 5 1 4P0.381 2P0.635
UNIT 4
XHEMICYL+Y 4 1 0.5410 1.43002 0.86741
XHEMICYL+Y 0 1 0.5588 1.43002 0.0
CUBOID     5 1 1.43002 0.0 0.762 0.0 2P0.635
UNIT 5
YHEMICYL+X 4 1 0.5410 1.43002 0.86741
YHEMICYL+X 0 1 0.5588 1.43002 0.0
CUBOID     5 1 0.762 0.0 1.43002 0.0 2P0.635
UNIT 6
XHEMICYL+Y 4 1 0.5410 2P0.71501
XHEMICYL+Y 0 1 0.5588 2P0.71501
CUBOID     5 1 2P0.71501 0.762 0.0 2P0.635
UNIT 7
YHEMICYL+X 4 1 0.5410 2P0.71501
YHEMICYL+X 0 1 0.5588 2P0.71501
CUBOID     5 1 0.762 0.0 2P0.71501 2P0.635
UNIT 8
XHEMICYL+Y 4 1 0.5410 0.48133 0.0
XHEMICYL+Y 0 1 0.5588 0.48133 0.0
CUBOID     5 1 1.43002 0.0 0.762 0.0 2P0.635
UNIT 9
YHEMICYL+X 4 1 0.5410 0.48133 0.0
YHEMICYL+X 0 1 0.5588 0.48133 0.0
```

```
CUBOID     5 1 0.762 0.0 1.43002 0.0 2P0.635
UNIT 10
CUBOID 3 1 2P0.222885 2P0.71501 2P0.635
UNIT 11
CUBOID 3 1 2P0.71501 2P0.222885 2P0.635
UNIT 12
CUBOID 3 1 4P0.222885 2P0.635
UNIT 13
CYLINDER 1 1 0.46482 2P0.3175
CYLINDER 7 1 0.474472 2P0.3175
CYLINDER 2 1 0.53594 2P0.3175
CUBOID   3 1 4P0.71501 2P0.3175
UNIT 14
CYLINDER 3 1 0.6502 2P0.3175
CYLINDER 2 1 0.6934 2P0.3175
CUBOID   3 1 4P0.71501 2P0.3175
UNIT 15
CUBOID 5 1 4P0.381 2P0.3175
UNIT 16
CUBOID 5 1 2P0.71501 2P0.381 2P0.3175
UNIT 17
CUBOID 5 1 2P0.381 2P0.71501 2P0.3175
UNIT 18
CUBOID 5 1 2P0.222885 2P0.381 2P0.3175
UNIT 19
CUBOID 5 1 2P0.381 2P0.222885 2P0.3175
UNIT 20
CUBOID 3 1 2P0.222885 2P0.71501 2P0.3175
UNIT 21
CUBOID 3 1 2P0.71501 2P0.222885 2P0.3175
UNIT 22
CUBOID 3 1 4P0.222885 2P0.3175
UNIT 23
ARRAY 1 0.0 0.0 -0.3175
UNIT 24
ARRAY 2 0.0 0.0 -0.635
UNIT 25
XHEMICYL+Y 4 1 0.35306 1.43002 0.45974
XHEMICYL+Y 0 1 0.37084 1.43002 0.22352
CUBOID     5 1 1.43002 0.0 0.762 0.0 2P0.635
UNIT 26
YHEMICYL+X 4 1 0.35306 1.43002 0.45974
YHEMICYL+X 0 1 0.37084 1.43002 0.22352
CUBOID     5 1 0.762 0.0 1.43002 0.0 2P0.635
UNIT 27
XHEMICYL+Y 4 1 0.35306 2P0.71501
XHEMICYL+Y 0 1 0.37084 2P0.71501
CUBOID     5 1 2P0.71501 0.762 0.0 2P0.635
```

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UNIT 28
YHEMICYL+X 4 1 0.35306 2P0.71501
YHEMICYL+X 0 1 0.37084 2P0.71501
CUBOID     5 1 0.762 0.0 2P0.71501 2P0.635
UNIT 29
XHEMICYL+Y 0 1 0.37084 0.44577 0.22352
CUBOID     5 1 0.44577 0.0 0.762 0.0 2P0.635
UNIT 30
YHEMICYL+X 0 1 0.37084 0.44577 0.22352
CUBOID     5 1 0.762 0.0 0.44577 0.0 2P0.635
UNIT 31
ARRAY 3 0.0 0.0 -0.635
UNIT 32
XHEMICYL+Y 0 1 0.5588 0.44577 0.29972
CUBOID     5 1 0.44577 0.0 0.762 0.0 2P0.635
UNIT 33
YHEMICYL+X 0 1 0.5588 0.44577 0.29972
CUBOID     5 1 0.762 0.0 0.44577 0.0 2P0.635
UNIT 34
CUBOID     3 1 4P0.71501 2P0.635
UNIT 35
CUBOID     3 1 4P0.71501 2P0.3175
UNIT 36
ARRAY 4  0.0 0.0 -0.3175
UNIT 37
ARRAY 5  0.0 0.0 -0.635
UNIT 38
ARRAY 6  0.0 0.0 -0.635
UNIT 39
XHEMICYL+Y 4 1 0.35306 0.48133 0.0
XHEMICYL+Y 0 1 0.37084 0.48133 0.0
CUBOID     5 1 1.43002 0.0 0.762 0.0 2P0.635
UNIT 40
YHEMICYL+X 4 1 0.35306 0.48133 0.0
YHEMICYL+X 0 1 0.37084 0.48133 0.0
CUBOID     5 1 0.762 0.0 1.43002 0.0 2P0.635
UNIT 41
CUBOID     5 1 2P0.381 2P0.222885 2P0.635
UNIT 42
CUBOID     5 1 2P0.222885 2P0.381 2P0.635
UNIT 43
XHEMICYL+Y 4 1 0.35306 1.43002 0.01397
XHEMICYL+Y 0 1 0.37084 1.43002 0.0
CUBOID     5 1 1.43002 0.0 0.762 0.0 2P0.635
UNIT 44
YHEMICYL+X 4 1 0.35306 1.43002 0.01397
YHEMICYL+X 0 1 0.37084 1.43002 0.0
CUBOID     5 1 0.762 0.0 1.43002 0.0 2P0.635
```

```
CORE 7 1 0.0 0.0 0.635
CUBOID 3 1 23.2029 0.0 23.2029 0.0 424.815 0.0
CUBOID 5 1 24.1554 0.0 24.1554 0.0 424.815 0.0
CUBOID 6 1 30.8864 0.0 30.8864 0.0 424.815 0.0
CUBOID 5 1 34.6964 0.0 34.6964 0.0 452.755 -24.13
CUBOID 3 1 100.0 0.0 100.0 0.0 510.0 -75.0
END GEOM
END DATA
END
```

B_4C01

```
=CSAS25
4 PWR ASSEM. W(15X15) OFA, E=3.1, BU=00,
27BURNUPLIB  LATTICECELL
UO2  1 0.95 293 92235 3.15 92238 96.85 END
ZIRCALLOY  2 1.0 END
H2O  3 1.0 END
B4C  4 0.864 293.0 5010 96.0 5011 4.0 END
SS304  5 1.0 END
URANIUM  6 1.0 293.0 92235 0.3 92238 99.7 END
H2O  7 1.0 END
END COMP
SQUAREPITCH 1.43002 0.92964 1 3 1.07188 2 0.948944 7 END
FLAT FULL HEIGHT GA-4 with gap in B4C, 4/96, 90% FOR NRC WITH B4C
READ PARAM  TME=200.0 GEN=200 NPG=1000 FLX=NO FDN=NO
NUB=YES END PARAM
READ ARRAY
ARA=1 NUX=17 NUY=17 NUZ=1
FILL
     15 15R16 18
     17 15R13 20
     17 15R13 20
     17 2R13 14 2R13 14 3R13 14 2R13 14 2R13 20
     17 7R13 14 7R13 20
     17 4R13 14 5R13 14 4R13 20
     17 2R13 14 9R13 14 2R13 20
     17 15R13 20
     17 3R13 14 3R13 14 3R13 14 3R13 20
     17 15R13 20
     17 2R13 14 9R13 14 2R13 20
     17 4R13 14 5R13 14 4R13 20
     17 7R13 14 7R13 20
     17 2R13 14 2R13 14 3R13 14 2R13 14 2R13 20
     17 15R13 20
     17 15R13 20
     19 15R21 22
     END FILL
ARA=2 NUX=17 NUY=17 NUZ=1
FILL
     3 4 13R6 8 32
     5 15R1 10
     7 15R1 10
     7 2R1 2 2R1 2 3R1 2 2R1 2 2R1 10
     7 7R1 2 7R1 10
     7 4R1 2 5R1 2 4R1 10
     7 2R1 2 9R1 2 2R1 10
```

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     7 15R1 10
     7 3R1 2 3R1 2 3R1 2 3R1 10
     7 15R1 10
     7 2R1 2 9R1 2 2R1 10
     7 4R1 2 5R1 2 4R1 10
     7 7R1 2 7R1 10
     7 2R1 2 2R1 2 3R1 2 2R1 2 2R1 10
     7 15R1 10
     9 15R1 10
     33 15R11 12
     END FILL
ARA=3 NUX=17 NUY=17 NUZ=1
FILL
     3 25 13R27 39 29
     26 15R1 10
     28 15R1 10
     28 2R1 2 2R1 2 3R1 2 2R1 2 2R1 10
     28 7R1 2 7R1 10
     28 4R1 2 5R1 2 4R1 10
     28 2R1 2 9R1 2 2R1 10
     28 15R1 10
     28 3R1 2 3R1 2 3R1 2 3R1 10
     28 15R1 10
     28 2R1 2 9R1 2 2R1 10
     28 4R1 2 5R1 2 4R1 10
     28 7R1 2 7R1 10
     28 2R1 2 2R1 2 3R1 2 2R1 2 2R1 10
     28 15R1 10
     40 15R1 10
     30 15R11 12
     END FILL
ARA=4 NUX=17 NUY=17 NUZ=1
FILL
     15 15R16 18
     17 15R35 20
     17 15R35 20
     17 15R35 20
     17 15R35 20
     17 15R35 20
     17 15R35 20
     17 15R35 20
     17 15R35 20
     17 15R35 20
     17 15R35 20
     17 15R35 20
     17 15R35 20
     17 15R35 20 —
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     17 15R35 20
     19 15R21 22
     END FILL
ARA=5 NUX=17 NUY=17 NUZ=1
FILL
     3 4 13R6 8 32
     5 15R34 10
     7 15R34 10
     7 15R34 10
     7 15R34 10
     7 15R34 10
     7 15R34 10
     7 15R34 10
     7 15R34 10
     7 15R34 10
     7 15R34 10
     7 15R34 10
     7 15R34 10
     7 15R34 10
     7 15R34 10
     7 15R34 10
     9 15R34 10
     33 15R11 12
     END FILL
ARA=6 NUX=17 NUY=17 NUZ=1
FILL
     3 25 13R27 39 29
     26 15R34 10
     28 15R34 10
     28 15R34 10
     28 15R34 10
     28 15R34 10
     28 15R34 10
     28 15R34 10
     28 15R34 10
     28 15R34 10
     28 15R34 10
     28 15R34 10
     28 15R34 10
     28 15R34 10
     28 15R34 10
     28 15R34 10
     40 15R34 10
     30 15R11 12
     END FILL
ARA=7 NUX=1 NUY=1 NUZ=344
FILL
     7R36
     4R23
     19R31
```

```
     132R24
     23
     24
     23
     133R24
     15R37
     20R38
     11R36
     END FILL
END ARRAY
READ BNDS -XY=MIRROR   END BNDS
READ GEOM
UNIT 1
CYLINDER 1 1 0.46482 2P0.635
CYLINDER 7 1 0.474472 2P0.635
CYLINDER 2 1 0.53594 2P0.635
CUBOID   3 1 4P0.71501 2P0.635
UNIT 2
CYLINDER 3 1 0.6502 2P0.635
CYLINDER 2 1 0.6934 2P0.635
CUBOID   3 1 4P0.71501 2P0.635
UNIT 3
CUBOID 5 1 4P0.381 2P0.635
UNIT 4
XHEMICYL+Y 4 1 0.5410 1.43002 1.31318
XHEMICYL+Y 0 1 0.5588 1.43002 0.29972
CUBOID     5 1 1.43002 0.0 0.762 0.0 2P0.635
UNIT 5
YHEMICYL+X 4 1 0.5410 1.43002 1.31318
YHEMICYL+X 0 1 0.5588 1.43002 0.29972
CUBOID     5 1 0.762 0.0 1.43002 0.0 2P0.635
UNIT 6
XHEMICYL+Y 4 1 0.5410 2P0.71501
XHEMICYL+Y 0 1 0.5588 2P0.71501
CUBOID     5 1 2P0.71501 0.762 0.0 2P0.635
UNIT 7
YHEMICYL+X 4 1 0.5410 2P0.71501
YHEMICYL+X 0 1 0.5588 2P0.71501
CUBOID     5 1 0.762 0.0 2P0.71501 2P0.635
UNIT 8
XHEMICYL+Y 4 1 0.5410 0.9271 0.0
XHEMICYL+Y 0 1 0.5588 0.9271 0.0
CUBOID     5 1 1.43002 0.0 0.762 0.0 2P0.635
UNIT 9
YHEMICYL+X 4 1 0.5410 0.9271 0.0
YHEMICYL+X 0 1 0.5588 0.9271 0.0
CUBOID     5 1 0.762 0.0 1.43002 0.0 2P0.635
UNIT 10
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CUBOID 3 1 2P0.44577 2P0.71501 2P0.635
UNIT 11
CUBOID 3 1 2P0.71501 2P0.44577 2P0.635
UNIT 12
CUBOID 3 1 4P0.44577 2P0.635
UNIT 13
CYLINDER 1 1 0.46482 2P0.3175
CYLINDER 7 1 0.474472 2P0.3175
CYLINDER 2 1 0.53594 2P0.3175
CUBOID   3 1 4P0.71501 2P0.3175
UNIT 14
CYLINDER 3 1 0.6502 2P0.3175
CYLINDER 2 1 0.6934 2P0.3175
CUBOID   3 1 4P0.71501 2P0.3175
UNIT 15
CUBOID 5 1 4P0.381 2P0.3175
UNIT 16
CUBOID 5 1 2P0.71501 2P0.381 2P0.3175
UNIT 17
CUBOID 5 1 2P0.381 2P0.71501 2P0.3175
UNIT 18
CUBOID 5 1 2P0.44577 2P0.381 2P0.3175
UNIT 19
CUBOID 5 1 2P0.381 2P0.44577 2P0.3175
UNIT 20
CUBOID 3 1 2P0.44577 2P0.71501 2P0.3175
UNIT 21
CUBOID 3 1 2P0.71501 2P0.44577 2P0.3175
UNIT 22
CUBOID 3 1 4P0.44577 2P0.3175
UNIT 23
ARRAY 1 0.0 0.0 -0.3175
UNIT 24
ARRAY 2 0.0 0.0 -0.635
UNIT 25
XHEMICYL+Y 4 1 0.35306 1.43002 0.45974
XHEMICYL+Y 0 1 0.37084 1.43002 0.22352
CUBOID     5 1 1.43002 0.0 0.762 0.0 2P0.635
UNIT 26
YHEMICYL+X 4 1 0.35306 1.43002 0.45974
YHEMICYL+X 0 1 0.37084 1.43002 0.22352
CUBOID     5 1 0.762 0.0 1.43002 0.0 2P0.635
UNIT 27
XHEMICYL+Y 4 1 0.35306 2P0.71501
XHEMICYL+Y 0 1 0.37084 2P0.71501
CUBOID     5 1 2P0.71501 0.762 0.0 2P0.635
UNIT 28
YHEMICYL+X 4 1 0.35306 2P0.71501
```

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YHEMICYL+X 0 1 0.37084 2P0.71501
CUBOID     5 1 0.762 0.0 2P0.71501 2P0.635
UNIT 29
CUBOID     5 1 0.89154 0.0 0.762 0.0 2P0.635
UNIT 30
CUBOID     5 1 0.762 0.0 0.89154 0.0 2P0.635
UNIT 31
ARRAY 3 0.0 0.0 -0.635
UNIT 32
CUBOID     5 1 0.89154 0.0 0.762 0.0 2P0.635
UNIT 33
CUBOID     5 1 0.762 0.0 0.89154 0.0 2P0.635
UNIT 34
CUBOID     3 1 4P0.71501 2P0.635
UNIT 35
CUBOID     3 1 4P0.71501 2P0.3175
UNIT 36
ARRAY 4  0.0 0.0 -0.3175
UNIT 37
ARRAY 5  0.0 0.0 -0.635
UNIT 38
ARRAY 6  0.0 0.0 -0.635
UNIT 39
XHEMICYL+Y 4 1 0.35306 0.9271 0.0
XHEMICYL+Y 0 1 0.37084 0.9271 0.0
CUBOID     5 1 1.43002 0.0 0.762 0.0 2P0.635
UNIT 40
YHEMICYL+X 4 1 0.35306 0.9271 0.0
YHEMICYL+X 0 1 0.37084 0.9271 0.0
CUBOID     5 1 0.762 0.0 1.43002 0.0 2P0.635
CORE 7 1 0.0 0.0 0.635
CUBOID 3 1 23.2029 0.0 23.2029 0.0 424.815 0.0
CUBOID 5 1 24.1554 0.0 24.1554 0.0 424.815 0.0
CUBOID 6 1 30.8864 0.0 30.8864 0.0 424.815 0.0
CUBOID 5 1 34.6964 0.0 34.6964 0.0 452.755 -24.13
CUBOID 3 1 100.0 0.0 100.0 0.0 510.0 -75.0
END GEOM
END DATA
END
```

6.6.2 CSAS25 Input Data for Benchmark Calculations

Case 1

```
=CSAS25
SCALE BENCHMARK FOR CRITICALITY ANALYSIS NUREG/CR-0073
27BURNUPLIB  LATTICECELL
UO2  1 0.949 293.0 92235 4.31 92238 95.69 END
AL  2 1.0 END
H2O  3 1.0 END
CARBONSTEEL  4 1.0 END
END COMP
SQUAREPITCH 2.54 1.2649 1 3 1.4147 2 1.2827 0 END
EXPLICIT FULL GEOMETRY OF EXPERIMENT 004
READ PARAM  TME=200 GEN=103 NPG=1000 FLX=YES FDN=YES FAR=YES
NUB=YES END PARAM
READ ARRAY NUX=8 NUY=47 NUZ=1
LOOP
1 1 8 1 1 15 1 1 1 1
2 1 8 1 16 16 1 1 1 1
1 1 8 1 17 31 1 1 1 1
2 1 8 1 32 32 1 1 1 1
1 1 8 1 33 47 1 1 1 1
END ARRAY
READ BNDS ALL=VAC END BNDS
READ GEOM
UNIT 1
CYLINDER 1 1 0.63245 91.44 0
CYLINDER 0 1 0.64135 91.44 0
CYLINDER 2 1 0.70735 91.44 0
CUBOID 3 1 4P1.270 91.44 0
UNIT 2
CUBOID 3 1 2P1.27 2P5.85 91.44 0.0
CORE 1 1 79.84 81.15 21.332
CUBOID 3 1 179.048 0.952 299.048 0.952 130.512 0.952
CUBOID 4 1 180.0 0.0 300.0 0.0 130.512 0.0
END GEOM
END DATA
END
```

Case 2

```
=CSAS25
SCALE BENCHMARK FOR CRITICALITY ANALYSIS NUREG/CR-0073
27BURNUPLIB  LATTICECELL
UO2  1 0.949 293.0 92235 4.31 92238 95.69 END
AL  2 1.0 END
H2O  3 1.0 END
AL  4 0 3.4638-2 END
B-10  4 0 7.9196-3 END
B-11  4 0 3.1878-2 END
C  4 0 9.9557-3 END
CARBONSTEEL  5 1.0 END
END COMP
SQUAREPITCH 2.54 1.2649 1 3 1.4147 2 1.2827 0 END
EXPLICIT FULL GEOMETRY OF BORAL EXPERIMENT 4.31% ENRICHED FUEL
READ PARAM  GEN=103 NPG=1000 FLX=YES FDN=YES FAR=YES
TME=200 NUB=YES END PARAM
READ ARRAY NUX=10 NUY=47 NUZ=1
LOOP
6 1 10 9 1 15 1 1 1 1
1 2 9 1 1 15 1 1 1 1
5 1 10 9 16 16 1 1 1 1
3 2 9 1 16 16 1 1 1 1
6 1 10 9 17 31 1 1 1 1
1 2 9 1 17 31 1 1 1 1
4 1 10 9 32 32 1 1 1 1
2 2 9 1 32 32 1 1 1 1
6 1 10 9 33 47 1 1 1 1
1 2 9 1 33 47 1 1 1 1
END ARRAY
READ BNDS ALL=VAC END BNDS
READ GEOM
UNIT 1
CYLINDER 1 1 0.63245 91.44 0
CYLINDER 0 1 0.64135 91.44 0
CYLINDER 2 1 0.70735 91.44 0
CUBOID 3 1 4P1.270 91.50 0
UNIT 2
CUBOID 4 1 2.54 0.0 3.99 3.277 91.50 0.0
CUBOID 3 1 2.54 0.0 6.72 0.0 91.50 0.0
UNIT 3
CUBOID 4 1 2.54 0.0 3.443 2.730 91.50 0.0
CUBOID 3 1 2.54 0.0 6.72 0.0 91.50 0.0
UNIT 4
CUBOID 4 1 8.09 0.0 3.99 3.277 91.50 0.0
CUBOID 3 1 8.09 0.0 6.72 0.0 91.50 0.0
```

```
UNIT 5
CUBOID 4 1 8.09 0.0 3.443 2.730 91.50 0.0
CUBOID 3 1 8.09 0.0 6.72 0.0 91.50 0.0
UNIT 6
CUBOID 3 1 8.09 0.0 2P1.27 91.50 0.0
CORE 1 1 79.84 86.13 21.332
CUBOID 3 1 179.048 0.952 299.048 0.952 130.512 0.952
CUBOID 5 1 180.0 0.0 300.0 0.0 130.512 0.0
END GEOM
END DATA
END
```

Case 3

```
=CSAS25
SCALE BENCHMARK FOR CRITICALITY ANALYSIS NUREG/CR-0073
27BURNUPLIB  LATTICECELL
UO2  1 0.949 293.0 92235 4.31 92238 95.69 END
AL  2 1.0 END
H2O  3 1.0 END
B-10  4 0 9.2388-4 END
B-11  4 0 3.6955-3 END
CR  4 0 1.7406-2 END
CU  4 0 2.0955-4 END
FE  4 0 5.7941-2 END
MN  4 0 1.3678-3 END
MO  4 0 2.4290-4 END
NI  4 0 7.7211-3 END
CARBONSTEEL  5 1.0 END
END COMP
SQUAREPITCH 2.54 1.2649 1 3 1.4147 2 1.2827 0 END
EXPLICIT FULL GEOM. MIN SS304L 1.05% BORON 4.31% ENRICHED FUEL
READ PARAM  NUB=YES GEN=103 NPG=1000 FLX=YES FDN=YES FAR=YES
TME=200 END PARAM
READ ARRAY NUX=10 NUY=47 NUZ=1
LOOP
6 1 10 9 1 15 1 1 1 1
1 2 9 1 1 15 1 1 1 1
5 1 10 9 16 16 1 1 1 1
3 2 9 1 16 16 1 1 1 1
6 1 10 9 17 31 1 1 1 1
1 2 9 1 17 31 1 1 1 1
4 1 10 9 32 32 1 1 1 1
2 2 9 1 32 32 1 1 1 1
6 1 10 9 33 47 1 1 1 1
1 2 9 1 33 47 1 1 1 1
END ARRAY
READ BNDS ALL=VAC END BNDS
READ GEOM
UNIT 1
CYLINDER 1 1 0.63245 91.44 0
CYLINDER 0 1 0.64135 91.44 0
CYLINDER 2 1 0.70735 91.44 0
CUBOID 3 1 4P1.270 91.50 0
UNIT 2
CUBOID 4 1 2.54 0.0 0.73 0.432 91.50 0.0
CUBOID 3 1 2.54 0.0 6.10 0.0 91.50 0.0
UNIT 3
CUBOID 4 1 2.54 0.0 5.668 5.370 91.50 0.0
```

```
CUBOID 3 1 2.54 0.0 6.10 0.0 91.50 0.0
UNIT 4
CUBOID 4 1 7.64 0.0 0.73 0.432 91.50 0.0
CUBOID 3 1 7.64 0.0 6.10 0.0 91.50 0.0
UNIT 5
CUBOID 4 1 7.64 0.0 5.668 5.370 91.50 0.0
CUBOID 3 1 7.64 0.0 6.10 0.0 91.50 0.0
UNIT 6
CUBOID 3 1 7.64 0.0 2P1.27 91.50 0.0
CORE 1 1 72.20 86.75 21.332
CUBOID 3 1 179.048 0.952 299.048 0.952 130.512 0.952
CUBOID 5 1 180.0 0.0 300.0 0.0 130.512 0.0
END GEOM
END DATA
END
```

Case 4

```
=CSAS25
SCALE BENCHMARK FOR CRITICALITY ANALYSIS NUREG/CR-0073
27BURNUPLIB  LATTICECELL
UO2  1 0.949 293.0 92235 4.31 92238 95.69 END
AL  2 1.0 END
H2O  3 1.0 END
B-10  4 0 9.2388-4 END
B-11  4 0 3.6955-3 END
CR  4 0 1.7406-2 END
CU  4 0 2.0955-4 END
FE  4 0 5.7941-2 END
MN  4 0 1.3678-3 END
MO  4 0 2.4290-4 END
NI  4 0 7.7211-3 END
CARBONSTEEL  5 1.0 END
END COMP
SQUAREPITCH 2.54 1.2649 1 3 1.4147 2 1.2827 0 END
EXPLICIT FULL GEOM. MAX SS304L 1.05% BORON 4.31% ENRICHED FUEL
READ PARAM  NUB=YES GEN=103 NPG=1000 FLX=YES FDN=YES FAR=YES
TME=200 END PARAM
READ ARRAY NUX=10 NUY=47 NUZ=1
LOOP
6 1 10 9 1 15 1 1 1 1
1 2 9 1 1 15 1 1 1 1
5 1 10 9 16 16 1 1 1 1
3 2 9 1 16 16 1 1 1 1
6 1 10 9 17 31 1 1 1 1
1 2 9 1 17 31 1 1 1 1
4 1 10 9 32 32 1 1 1 1
2 2 9 1 32 32 1 1 1 1
6 1 10 9 33 47 1 1 1 1
1 2 9 1 33 47 1 1 1 1
END ARRAY
READ BNDS ALL=VAC END BNDS
READ GEOM
UNIT 1
CYLINDER 1 1 0.63245 91.44 0
CYLINDER 0 1 0.64135 91.44 0
CYLINDER 2 1 0.70735 91.44 0
CUBOID 3 1 4P1.270 91.50 0
UNIT 2
CUBOID 4 1 2.54 0.0 3.575 3.277 91.50 0.0
CUBOID 3 1 2.54 0.0 8.08 0.0 91.50 0.0
UNIT 3
CUBOID 4 1 2.54 0.0 4.803 4.505 91.50 0.0
```

```
CUBOID 3 1 2.54 0.0 8.08 0.0 91.50 0.0
UNIT 4
CUBOID 4 1 7.64 0.0 3.575 3.277 91.50 0.0
CUBOID 3 1 7.64 0.0 8.08 0.0 91.50 0.0
UNIT 5
CUBOID 4 1 7.64 0.0 4.803 4.505 91.50 0.0
CUBOID 3 1 7.64 0.0 8.08 0.0 91.50 0.0
UNIT 6
CUBOID 3 1 7.64 0.0 2P1.27 91.50 0.0
CORE 1 1 72.20 84.77 21.332
CUBOID 3 1 179.048 0.952 299.048 0.952 130.512 0.952
CUBOID 5 1 180.0 0.0 300.0 0.0 130.512 0.0
END GEOM
END DATA
END
```

Case 5

```
=CSAS25
SCALE BENCHMARK FOR CRITICALITY ANALYSIS NUREG/CR-0073
27BURNUPLIB  LATTICECELL
UO2  1 0.949 293.0 92235 4.31 92238 95.69 END
AL  2 1.0 END
H2O  3 1.0 END
B-10  4 0 1.4020-3 END
B-11  4 0 5.6079-3 END
CR  4 0 1.7632-2 END
CU  4 0 1.9138-4 END
FE  4 0 5.5614-2 END
MN  4 0 1.4389-3 END
MO  4 0 1.5114-4 END
NI  4 0 8.0642-3 END
CARBONSTEEL  5 1.0 END
END COMP
SQUAREPITCH 2.54 1.2649 1 3 1.4147 2 1.2827 0 END
EXPLICIT FULL GEOM. MIN SS304L 1.62% BORON 4.31% ENRICHED FUEL
READ PARAM  NUB=YES GEN=103 NPG=1000 FLX=YES FDN=YES FAR=YES
TME=200 END PARAM
READ ARRAY NUX=10 NUY=47 NUZ=1
LOOP
6 1 10 9 1 15 1 1 1 1
1 2 9 1 1 15 1 1 1 1
5 1 10 9 16 16 1 1 1 1
3 2 9 1 16 16 1 1 1 1
6 1 10 9 17 31 1 1 1 1
1 2 9 1 17 31 1 1 1 1
4 1 10 9 32 32 1 1 1 1
2 2 9 1 32 32 1 1 1 1
6 1 10 9 33 47 1 1 1 1
1 2 9 1 33 47 1 1 1 1
END ARRAY
READ BNDS ALL=VAC END BNDS
READ GEOM
UNIT 1
CYLINDER 1 1 0.63245 91.44 0
CYLINDER 0 1 0.64135 91.44 0
CYLINDER 2 1 0.70735 91.44 0
CUBOID 3 1 4P1.270 91.50 0
UNIT 2
CUBOID 4 1 2.54 0.0 0.73 0.432 91.50 0.0
CUBOID 3 1 2.54 0.0 5.76 0.0 91.50 0.0
UNIT 3
CUBOID 4 1 2.54 0.0 5.328 5.030 91.50 0.0
```

```
CUBOID 3 1 2.54 0.0 5.76 0.0 91.50 0.0
UNIT 4
CUBOID 4 1 7.64 0.0 0.73 0.432 91.50 0.0
CUBOID 3 1 7.64 0.0 5.76 0.0 91.50 0.0
UNIT 5
CUBOID 4 1 7.64 0.0 5.328 5.030 91.50 0.0
CUBOID 3 1 7.64 0.0 5.76 0.0 91.50 0.0
UNIT 6
CUBOID 3 1 7.64 0.0 2P1.27 91.50 0.0
CORE 1 1 72.20 87.09 21.332
CUBOID 3 1 179.048 0.952 299.048 0.952 130.512 0.952
CUBOID 5 1 180.0 0.0 300.0 0.0 130.512 0.0
END GEOM
END DATA
END
```

Case 6

```
=CSAS25
SCALE BENCHMARK FOR CRITICALITY ANALYSIS NUREG/CR-0073
27BURNUPLIB  LATTICECELL
UO2  1 0.949 293.0 92235 4.31 92238 95.69 END
AL  2 1.0 END
H2O  3 1.0 END
B-10  4 0 1.4020-3 END
B-11  4 0 5.6079-3 END
CR  4 0 1.7632-2 END
CU  4 0 1.9138-4 END
FE  4 0 5.5614-2 END
MN  4 0 1.4389-3 END
MO  4 0 1.5114-4 END
NI  4 0 8.0642-3 END
CARBONSTEEL  5 1.0 END
END COMP
SQUAREPITCH 2.54 1.2649 1 3 1.4147 2 1.2827 0 END
EXPLICIT FULL GEOM. MAX SS304L 1.62% BORON 4.31% ENRICHED FUEL
READ PARAM  NUB=YES GEN=103 NPG=1000 FLX=YES FDN=YES FAR=YES
TME=200 END PARAM
READ ARRAY NUX=10 NUY=47 NUZ=1
LOOP
6 1 10 9 1 15 1 1 1 1
1 2 9 1 1 15 1 1 1 1
5 1 10 9 16 16 1 1 1 1
3 2 9 1 16 16 1 1 1 1
6 1 10 9 17 31 1 1 1 1
1 2 9 1 17 31 1 1 1 1
4 1 10 9 32 32 1 1 1 1
2 2 9 1 32 32 1 1 1 1
6 1 10 9 33 47 1 1 1 1
1 2 9 1 33 47 1 1 1 1
END ARRAY
READ BNDS ALL=VAC END BNDS
READ GEOM
UNIT 1
CYLINDER 1 1 0.63245 91.44 0
CYLINDER 0 1 0.64135 91.44 0
CYLINDER 2 1 0.70735 91.44 0
CUBOID 3 1 4P1.270 91.50 0
UNIT 2
CUBOID 4 1 2.54 0.0 3.575 3.277 91.50 0.0
CUBOID 3 1 2.54 0.0 7.90 0.0 91.50 0.0
UNIT 3
CUBOID 4 1 2.54 0.0 4.623 4.325 91.50 0.0
```

```
CUBOID 3 1 2.54 0.0 7.90 0.0 91.50 0.0
UNIT 4
CUBOID 4 1 7.64 0.0 3.575 3.277 91.50 0.0
CUBOID 3 1 7.64 0.0 7.90 0.0 91.50 0.0
UNIT 5
CUBOID 4 1 7.64 0.0 4.623 4.325 91.50 0.0
CUBOID 3 1 7.64 0.0 7.90 0.0 91.50 0.0
UNIT 6
CUBOID 3 1 7.64 0.0 2P1.27 91.50 0.0
CORE 1 1 72.20 84.95 21.332
CUBOID 3 1 179.048 0.952 299.048 0.952 130.512 0.952
CUBOID 5 1 180.0 0.0 300.0 0.0 130.512 0.0
END GEOM
END DATA
END
```

Case 7

```
=CSAS25
SCALE BENCHMARK FOR CRITICALITY ANALYSIS NUREG/CR-0796
27BURNUPLIB  LATTICECELL
UO2  1 0.949 293.0 92235 4.31 92238 95.69 END
AL  2 1.0 END
H2O  3 1.0 END
URANIUM  4 0.982 293.0 92235 0.199 92238 99.801 END
CARBONSTEEL  5 1.0 END
END COMP
SQUAREPITCH 2.54 1.2649 1 3 1.4147 2 1.2827 0 END
EXPLICIT FULL GEOM. DU REFLECTED 0.0CM FROM 4.31% ENRICHED FUEL
READ PARAM  NUB=YES GEN=103 NPG=1000 FLX=YES FDN=YES FAR=YES
TME=200 END PARAM
READ ARRAY NUX=8 NUY=41 NUZ=1
LOOP
1 1 8 1 1 13 1 1 1 1
2 1 8 1 14 28 14 1 1 1
1 1 8 1 15 27 1 1 1 1
1 1 8 1 29 41 1 1 1 1
END ARRAY
READ BNDS ALL=VAC END BNDS
READ GEOM
UNIT 1
CYLINDER 1 1 0.63245 91.44 0.0
CYLINDER 0 1 0.64135 91.44 0.0
CYLINDER 2 1 0.70735 91.44 0.0
CUBOID 3 1 4P1.27 91.44 0.0
UNIT 2
CUBOID 3 1 2P1.27 15.38 0.0 91.44 0.0
CORE 1 1 79.84 85.09 21.332
CUBOID 3 1 100.16 79.84 226.15 73.85 122.852 0.952
CUBOID 4 1 107.81 72.19 226.15 73.85 122.852 0.952
CUBOID 3 1 179.048 0.952 299.048 0.952 130.512 0.952
CUBOID 5 1 180.0 0.0 300.0 0.0 130.512 0.0
END GEOM
END DATA
END
```

Case 8

```
=CSAS25
SCALE BENCHMARK FOR CRITICALITY ANALYSIS NUREG/CR-0796
27BURNUPLIB  LATTICECELL
UO2  1 0.949 293.0 92235 4.31 92238 95.69 END
AL  2 1.0 END
H2O  3 1.0 END
URANIUM  4 0.982 293.0 92235 0.199 92238 99.801 END
CARBONSTEEL  5 1.0 END
END COMP
SQUAREPITCH 2.54 1.2649 1 3 1.4147 2 1.2827 0 END
EXPLICIT FULL GEOM. DU REFLECTED 1.956CM FROM 4.31% ENRICHED FUEL
READ PARAM  NUB=YES GEN=103 NPG=1000 FLX=YES FDN=YES FAR=YES
TME=200 END PARAM
READ ARRAY NUX=8 NUY=38 NUZ=1
LOOP
1 1 8 1 1 12 1 1 1 1
2 1 8 1 13 26 13 1 1 1
1 1 8 1 14 25 1 1 1 1
1 1 8 1 27 38 1 1 1 1
END ARRAY
READ BNDS ALL=VAC END BNDS
READ GEOM
UNIT 1
CYLINDER 1 1 0.63245 91.44 0.0
CYLINDER 0 1 0.64135 91.44 0.0
CYLINDER 2 1 0.70735 91.44 0.0
CUBOID 3 1 4P1.27 91.44 0.0
UNIT 2
CUBOID 3 1 2P1.27 15.38 0.0 91.44 0.0
CORE 1 1 79.84 88.96 21.332
CUBOID 3 1 101.116 77.884 226.15 73.85 122.852 0.952
CUBOID 4 1 109.766 70.234 226.15 73.85 122.852 0.952
CUBOID 3 1 179.048 0.952 299.048 0.952 130.512 0.952
CUBOID 5 1 180.0 0.0 300.0 0.0 130.512 0.0
END GEOM
END DATA
END
```

Case 9

```
=CSAS25
SCALE BENCHMARK FOR CRITICALITY ANALYSIS NUREG/CR-0073
27BURNUPLIB  LATTICECELL
UO2  1 0.8394 293.0 92235 2.35 92238 97.65 END
AL  2 1.0 END
H2O  3 1.0 END
AL  4 0 3.4638-2 END
B-10  4 0 7.9196-3 END
B-11  4 0 3.1878-2 END
C  4 0 9.9557-3 END
CARBONSTEEL  5 1.0 END
END COMP
SQUAREPITCH 2.032 1.1176 1 3 1.270 2 END
EXPLICIT FULL GEOMETRY OF BORAL EXPERIMENT 2.35% ENRICHED FUEL
READ PARAM  NUB=YES GEN=103 NPG=1000 FLX=YES FDN=YES FAR=YES
TME=200 END PARAM
READ ARRAY NUX=19 NUY=62 NUZ=1
LOOP
6 1 19 18 1 20 1 1 1 1
1 2 18 1 1 20 1 1 1 1
5 1 19 18 21 21 1 1 1 1
4 2 18 1 21 21 1 1 1 1
6 1 19 18 22 41 1 1 1 1
1 2 18 1 22 41 1 1 1 1
3 1 19 18 42 42 1 1 1 1
2 2 18 1 42 42 1 1 1 1
6 1 19 18 43 62 1 1 1 1
1 2 18 1 43 62 1 1 1 1
END ARRAY
READ BNDS ALL=VAC END BNDS
READ GEOM
UNIT 1
CYLINDER 1 1 0.5588 92.71 1.27
CYLINDER 2 1 0.63500 97.79 0.0
CUBOID 3 1 4P1.016 97.79 0.0
UNIT 2
CUBOID 4 1 2.032 0.0 1.358 0.645 92.77 1.27
CUBOID 3 1 2.032 0.0 6.34 0.0 97.79 0.0
UNIT 3
CUBOID 4 1 0.978 0.0 5.695 4.982 92.77 1.27
CUBOID 3 1 0.978 0.0 6.34 0.0 97.79 0.0
UNIT 4
CUBOID 4 1 2.032 0.0 1.358 0.645 92.77 1.27
CUBOID 3 1 2.032 0.0 6.34 0.0 97.79 0.0
UNIT 5
```

```
CUBOID 4 1 0.978 0.0 5.695 4.982 92.77 1.27
CUBOID 3 1 0.978 0.0 6.34 0.0 97.79 0.0
UNIT 6
CUBOID 3 1 0.978 0.0 2P1.016 97.79 0.0
CORE 1 1 71.75 82.70 21.332
CUBOID 3 1 179.048 0.952 299.048 0.952 135.512 0.952
CUBOID 5 1 180.0 0.0 300.0 0.0 135.512 0.0
END GEOM
END DATA
END
```

Case 10

```
=CSAS25
SCALE BENCHMARK FOR CRITICALITY ANALYSIS NUREG/CR-0073
27BURNUPLIB  LATTICECELL
UO2  1 0.8394 293.0 92235 2.35 92238 97.65 END
AL  2 1.0 END
H2O  3 1.0 END
AL  4 0 3.4638-2 END
B-10  4 0 7.9196-3 END
B-11  4 0 3.1878-2 END
C  4 0 9.9557-3 END
CARBONSTEEL  5 1.0 END
END COMP
SQUAREPITCH 2.032 1.1176 1 3 1.270 2 END
EXPLICIT FULL GEOMETRY OF BORAL EXPERIMENT 2.35% ENRICHED FUEL
READ PARAM  NUB=YES GEN=103 NPG=1000 FLX=YES FDN=YES FAR=YES
TME=200 END PARAM
READ ARRAY NUX=19 NUY=62 NUZ=1
LOOP
6 1 19 18 1 20 1 1 1 1
1 2 18 1 1 20 1 1 1 1
5 1 19 18 21 21 1 1 1 1
4 2 18 1 21 21 1 1 1 1
6 1 19 18 22 41 1 1 1 1
1 2 18 1 22 41 1 1 1 1
3 1 19 18 42 42 1 1 1 1
2 2 18 1 42 42 1 1 1 1
6 1 19 18 43 62 1 1 1 1
1 2 18 1 43 62 1 1 1 1
END ARRAY
READ BNDS ALL=VAC END BNDS
READ GEOM
UNIT 1
CYLINDER 1 1 0.5588 92.71 1.27
CYLINDER 2 1 0.63500 97.79 0.0
CUBOID 3 1 4P1.016 97.79 0.0
UNIT 2
CUBOID 4 1 2.032 0.0 5.155 4.442 92.77 1.27
CUBOID 3 1 2.032 0.0 9.03 0.0 97.79 0.0
UNIT 3
CUBOID 4 1 0.978 0.0 4.588 3.875 92.77 1.27
CUBOID 3 1 0.978 0.0 9.03 0.0 97.79 0.0
UNIT 4
CUBOID 4 1 2.032 0.0 5.155 4.442 92.77 1.27
CUBOID 3 1 2.032 0.0 9.03 0.0 97.79 0.0
UNIT 5
```

```
CUBOID 4 1 0.978 0.0 4.588 3.875 92.77 1.27
CUBOID 3 1 0.978 0.0 9.03 0.0 97.79 0.0
UNIT 6
CUBOID 3 1 0.978 0.0 2P1.016 97.79 0.0
CORE 1 1 71.75 80.01 21.332
CUBOID 3 1 179.048 0.952 299.048 0.952 135.512 0.952
CUBOID 5 1 180.0 0.0 300.0 0.0 135.512 0.0
END GEOM
END DATA
END
```

Case 11

```
=CSAS25
SCALE BENCHMARK FOR CRITICALITY ANALYSIS NUREG/CR-0796
27BURNUPLIB  LATTICECELL
UO2  1 0.8394 293.0 92235 2.35 92238 97.65 END
AL  2 1.0 END
H2O  3 1.0 END
URANIUM  4 0.982 293.0 92235 0.199 92238 99.801 END
CARBONSTEEL  5 1.0 END
END COMP
SQUAREPITCH 2.032 1.1176 1 3 1.270 2 END
EXPLICIT FULL GEOM. DU REFLECTED 0.0CM FROM 2.35% ENRICHED FUEL
READ PARAM  NUB=YES GEN=103 NPG=1000 FLX=YES FDN=YES FAR=YES
TME=200 END PARAM
READ ARRAY NUX=16 NUY=59 NUZ=1
LOOP
1 1 16 1 1 19 1 1 1 1
2 1 16 1 20 40 20 1 1 1
1 1 16 1 21 39 1 1 1 1
1 1 16 1 41 59 1 1 1 1
END ARRAY
READ BNDS ALL=VAC END BNDS
READ GEOM
UNIT 1
CYLINDER 1 1 0.5588 92.71 1.27
CYLINDER 2 1 0.635 97.79 0.0
CUBOID 3 1 4P1.016 97.79 0.0
UNIT 2
CUBOID 3 1 2P1.016 11.83 0.0 97.79 0.0
CORE 1 1 73.744 80.268 21.332
CUBOID 3 1 106.257 73.743 226.15 73.85 122.852 0.952
CUBOID 4 1 113.906 66.094 226.15 73.85 122.852 0.952
CUBOID 3 1 179.048 0.952 299.048 0.952 130.512 0.952
CUBOID 5 1 180.0 0.0 300.0 0.0 130.512 0.0
END GEOM
END DATA
END
```

Case 12

```
=CSAS25
SCALE BENCHMARK FOR CRITICALITY ANALYSIS NUREG/CR-0796
27BURNUPLIB  LATTICECELL
UO2  1 0.8394 293.0 92235 2.35 92238 97.65 END
AL  2 1.0 END
H2O  3 1.0 END
URANIUM  4 0.982 293.0 92235 0.199 92238 99.801 END
CARBONSTEEL  5 1.0 END
END COMP
SQUAREPITCH 2.032 1.1176 1 3 1.27 2 END
EXPLICIT FULL GEOM. DU REFLECTED 1.956CM FROM 2.35% ENRICHED FUEL
READ PARAM  NUB=YES GEN=103 NPG=1000 FLX=YES FDN=YES FAR=YES
TME=200 END PARAM
READ ARRAY NUX=16 NUY=59 NUZ=1
LOOP
1 1 16 1 1 19 1 1 1 1
2 1 16 1 20 40 20 1 1 1
1 1 16 1 21 39 1 1 1 1
1 1 16 1 41 59 1 1 1 1
END ARRAY
READ BNDS ALL=VAC END BNDS
READ GEOM
UNIT 1
CYLINDER 1 1 0.5588 92.71 1.27
CYLINDER 2 1 0.635 97.79 0.0
CUBOID 3 1 4P1.016 97.79 0.0
UNIT 2
CUBOID 3 1 2P1.016 11.83 0.0 97.79 0.0
CORE 1 1 73.744 77.978 21.332
CUBOID 3 1 108.212 71.788 226.15 73.85 122.852 0.952
CUBOID 4 1 115.862 64.138 226.15 73.85 122.852 0.952
CUBOID 3 1 179.048 0.952 299.048 0.952 130.512 0.952
CUBOID 5 1 180.0 0.0 300.0 0.0 130.512 0.0
END GEOM
END DATA
END
```

Case 13

```
=CSAS25
CRIT. EXP/NO POISON 438 RODS IN CYLINDRICAL PATERN/CORE 1
27BURNUPLIB  LATTICECELL
U-235  1 0 5.67505-4 END
U-238  1 0 2.22265-2 END
O      1 0 4.55881-2 END
CU     2 0 1.02328-4 END
FE     2 0 2.03741-4 END
SI     2 0 4.63000-4 END
MN     2 0 4.43813-5 END
MG     2 0 5.34873-4 END
CR     2 0 1.09416-4 END
AL     2 0 5.80754-2 END
H      3 0 6.67755-2 END
O      3 0 3.33877-2 END
END COMP
SQUAREPITCH 1.636 1.03 1 3 1.206 2 1.044 0 END
EXPLICIT GEOMETRY FOR COREI IN CRITICAL EXPERIMENT FROM BAW-1487-7 (7/79)
READ PARAM  NUB=YES GEN=153 NPG=1000 FLX=YES FDN=YES FAR=YES
TME=200 END PARAM
READ ARRAY NUX=19 NUY=38 NUZ=3
LOOP
4 1 19 1 1 38 1 1 1 1
5 1 19 1 1 38 1 2 2 1
6 1 19 1 1 38 1 3 3 1
1 1 3 1 8 31 1 1 1 1
2 1 3 1 8 31 1 2 2 1
3 1 3 2 8 31 1 3 3 1
1 4 5 1 9 30 1 1 1 1
2 4 5 1 9 30 1 2 2 1
3 4 5 1 9 30 1 3 3 1
1 6 7 1 10 29 1 1 1 1
2 6 7 1 10 29 1 2 2 1
3 6 7 1 10 29 1 3 3 1
1 8 8 1 11 28 1 1 1 1
2 8 8 1 11 28 1 2 2 1
3 8 8 1 11 28 1 3 3 1
1 9 9 1 12 27 1 1 1 1
2 9 9 1 12 27 1 2 2 1
3 9 9 1 12 27 1 3 3 1
1 10 10 1 13 26 1 1 1 1
2 10 10 1 13 26 1 2 2 1
3 10 10 1 13 26 1 3 3 1
1 11 11 1 15 24 1 1 1 1
2 11 11 1 15 24 1 2 2 1
```

```
3 11 11 1 15 24 1 3 3 1
1 12 12 1 18 22 1 1 1 1
2 12 12 1 18 22 1 2 2 1
3 12 12 1 18 22 1 3 3 1
END ARRAY
READ BNDS +XB=VAC -XB=MIR YFC=VAC ZFC=VAC END BNDS
READ GEOM
BOX TYPE 1
CYLINDER 2 1 0.602996 0.3175 0.0
CUBOID   3 1 0.81788 -0.81788 0.81788 -0.81788 0.3175 0.0
BOX TYPE 2
CYLINDER 1 1 0.514858 2.54 0.0
CYLINDER 0 1 0.521716 2.54 0.0
CYLINDER 2 1 0.602996 2.54 0.0
CUBOID   3 1 0.615 -0.615 0.615 -0.615 2.54 0.0
CUBOID   2 1 0.81788 -0.81788 0.81788 -0.81788 2.54 0.0
BOX TYPE 3
CYLINDER 1 1 0.514858 142.1425 0.0
CYLINDER 0 1 0.521716 142.1425 0.0
CYLINDER 2 1 0.602996 142.1425 0.0
CUBOID   3 1 0.81788 -0.81788 0.81788 -0.81788 142.1425 0.0
BOX TYPE 4
CUBOID   3 1 0.81788 -0.81788 0.81788 -0.81788 0.3175 0.0
BOX TYPE 5
CUBOID   3 1 0.615 -0.615 0.615 -0.615 2.54 0.0
CUBOID   2 1 0.81788 -0.81788 0.81788 -0.81788 2.54 0.0
BOX TYPE 6
CUBOID   3 1 0.81788 -0.81788 0.81788 -0.81788 142.1425 0.0
CORE     0 1 0.0 0.0 0.0
ZHEMICYL+X  3 1 73.66 145.0 0.0
ZHEMICYL+X  2 1 73.66 145.0 -5.08
ZHEMICYL+X  3 1 76.20 145.0 -7.62
ZHEMICYL+X  0 1 76.20 190.38 -7.62
ZHEMICYL+X  2 1 77.47 190.38 -8.89
CUBOID   0 1 77.47 0.0 77.47 -77.47 190.38 -8.89
END GEOM
END DATA
END
```

Case 14

```
=CSAS25
CRIT. EXP/84 B4C PINS/1 PTH SEP/0 PPM/17C/CORE IV/
27BURNUPLIB  LATTICECELL
U-235  1 0 5.67505-4 END
U-238  1 0 2.22265-2 END
O      1 0 4.55881-2 END
CU     2 0 1.02328-4 END
FE     2 0 2.03741-4 END
SI     2 0 4.63000-4 END
MN     2 0 4.43813-5 END
MG     2 0 5.34873-4 END
CR     2 0 1.09416-4 END
AL     2 0 5.80754-2 END
H      3 0 6.67755-2 END
O      3 0 3.33877-2 END
B-10   4 0 1.104414-2 END
B-11   4 0 4.445405-2 END
C      4 0 1.334967-2 END
O      4 0 3.32183-5 END
H      5 0 6.67755-2 END
O      5 0 3.33877-2 END
END COMP
SQUAREPITCH 1.636 1.03 1 3 1.206 2 1.044 0 END
EXPLICIT GEOMETRY FOR COREIV IN CRITICAL EXPERIMENT FROM BAW-1487-7 (7/79)
READ PARAM  NUB=YES GEN=153 NPG=1000 FLX=YES FDN=YES FAR=YES
TME=200 END PARAM
READ ARRAY NUX=22 NUY=44 NUZ=3
LOOP
1 1 22 1 1 44 1 1 1 1
2 1 22 1 1 44 1 2 2 1
3 1 22 1 1 44 1 3 3 1
10 1 22 1 1 31 15 2 2 1
11 1 22 1 1 31 15 3 3 1
10 1 22 1 14 44 15 2 2 1
11 1 22 1 14 44 15 3 3 1
10 7 9 2 1 44 1 2 2 1
11 7 9 2 1 44 1 3 3 1
10 22 22 1 1 44 1 2 2 1
11 22 22 1 1 44 1 3 3 1
12 7 9 2 1 31 15 2 2 1
13 7 9 2 1 31 15 3 3 1
12 7 9 2 14 44 15 2 2 1
13 7 9 2 14 44 15 3 3 1
12 22 22 1 1 31 15 2 2 1
13 22 22 1 1 31 15 3 3 1
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12 22 22 1 14 44 15 2 2 1
13 22 22 1 14 44 15 3 3 1
4 8 8 1 1 44 1 1 1 1
5 8 8 1 1 44 1 2 2 1
6 8 8 1 1 44 1 3 3 1
4 1 22 1 15 30 15 1 1 1
5 1 22 1 15 30 15 2 2 1
6 1 22 1 15 30 15 3 3 1
7 2 22 2 15 30 15 1 1 1
8 2 22 2 15 30 15 2 2 1
9 2 22 2 15 30 15 3 3 1
7 8 8 1 2 42 2 1 1 1
8 8 8 1 2 42 2 2 2 1
9 8 8 1 2 42 2 3 3 1
END ARRAY
READ BNDS +XB=VAC -XB=MIR YFC=VAC ZFC=VAC END BNDS
READ GEOM
BOX TYPE 1
CYLINDER 2 1 0.602996 0.3175 0.0
CUBOID   3 1 0.81788 -0.81788 0.81788 -0.81788 0.3175 0.0
BOX TYPE 2
CYLINDER 1 1 0.514858 2.54 0.0
CYLINDER 0 1 0.521716 2.54 0.0
CYLINDER 2 1 0.602996 2.54 0.0
CUBOID   3 1 0.615 -0.615 0.615 -0.615 2.54 0.0
CUBOID   2 1 0.81788 -0.81788 0.81788 -0.81788 2.54 0.0
BOX TYPE 3
CYLINDER 1 1 0.514858 142.1425 0.0
CYLINDER 0 1 0.521716 142.1425 0.0
CYLINDER 2 1 0.602996 142.1425 0.0
CUBOID   3 1 0.81788 -0.81788 0.81788 -0.81788 142.1425 0.0
BOX TYPE 4
CUBOID   3 1 0.81788 -0.81788 0.81788 -0.81788 0.3175 0.0
BOX TYPE 5
CUBOID   3 1 0.615 -0.615 0.615 -0.615 2.54 0.0
CUBOID   2 1 0.81788 -0.81788 0.81788 -0.81788 2.54 0.0
BOX TYPE 6
CUBOID   3 1 0.81788 -0.81788 0.81788 -0.81788 142.1425 0.0
BOX TYPE 7
CYLINDER 2 1 0.5565 0.3175 0.0
CUBOID   3 1 0.81788 -0.81788 0.81788 -0.81788 0.3175 0.0
BOX TYPE 8
CYLINDER 4 1 0.4675 2.54 0.6349
CYLINDER 2 1 0.5565 2.54 0.0
CUBOID   3 1 0.615 -0.615 0.615 -0.615 2.54 0.0
CUBOID   2 1 0.81788 -0.81788 0.81788 -0.81788 2.54 0.0
BOX TYPE 9
CYLINDER 4 1 0.4675 142.1425 0.0
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CYLINDER 2 1 0.5565 142.1425 0.0
CUBOID   3 1 0.81788 -0.81788 0.81788 -0.81788 142.1425 0.0
BOX TYPE 10
CYLINDER 1 1 0.514858 2.54 0.0
CYLINDER 0 1 0.521716 2.54 0.0
CYLINDER 2 1 0.602996 2.54 0.0
CUBOID   3 1 0.615 -0.615 0.615 -0.615 2.54 0.0
CUBOID   2 1 0.81788 -0.81788 0.81788 -0.81788 2.54 0.0
BOX TYPE 11
CYLINDER 1 1 0.514858 142.1425 0.0
CYLINDER 0 1 0.521716 142.1425 0.0
CYLINDER 2 1 0.602996 142.1425 0.0
CUBOID   3 1 0.81788 -0.81788 0.81788 -0.81788 142.1425 0.0
BOX TYPE 12
CYLINDER 1 1 0.514858 2.54 0.0
CYLINDER 0 1 0.521716 2.54 0.0
CYLINDER 2 1 0.602996 2.54 0.0
CUBOID   3 1 0.615 -0.615 0.615 -0.615 2.54 0.0
CUBOID   2 1 0.81788 -0.81788 0.81788 -0.81788 2.54 0.0
BOX TYPE 13
CYLINDER 1 1 0.514858 142.1425 0.0
CYLINDER 0 1 0.521716 142.1425 0.0
CYLINDER 2 1 0.602996 142.1425 0.0
CUBOID   3 1 0.81788 -0.81788 0.81788 -0.81788 142.1425 0.0
CORE     0 1 0.0 -35.98672  0.0
ZHEMICYL+X  5 1 73.66 145.0 0.0
ZHEMICYL+X  2 1 73.66 145.0 -5.08
ZHEMICYL+X  5 1 76.20 145.0 -7.62
ZHEMICYL+X  0 1 76.20 190.38 -7.62
ZHEMICYL+X  2 1 77.47 190.38 -8.89
CUBOID   0 1 77.47 0.0 77.47 -77.47 190.38 -8.89
END GEOM
END DATA
END
```

Case 15

```
=CSAS25
CRIT. EXP/64 B4C PINS/2 PTH SEP/0 PPM/17C/CORE V/
27BURNUPLIB  LATTICECELL
U-235  1 0 5.67505-4 END
U-238  1 0 2.22265-2 END
O      1 0 4.55881-2 END
CU     2 0 1.02328-4 END
FE     2 0 2.03741-4 END
SI     2 0 4.63000-4 END
MN     2 0 4.43813-5 END
MG     2 0 5.34873-4 END
CR     2 0 1.09416-4 END
AL     2 0 5.80754-2 END
H      3 0 6.67755-2 END
O      3 0 3.33877-2 END
B-10   4 0 1.104414-2 END
B-11   4 0 4.445405-2 END
C      4 0 1.334967-2 END
O      4 0 3.32183-5 END
H      5 0 6.67755-2 END
O      5 0 3.33877-2 END
END COMP
SQUAREPITCH 1.636 1.03 1 3 1.206 2 1.044 0 END
EXPLICIT GEOMETRY FOR CORE V IN CRITICAL EXPERIMENT FROM BAW-1487-7 (7/79)
READ PARAM  NUB=YES GEN=153 NPG=1000 FLX=YES FDN=YES FAR=YES
TME=200 END PARAM
READ ARRAY NUX=23 NUY=46 NUZ=3
LOOP
1 1 23 1 1 46 1 1 1 1
2 1 23 1 1 46 1 2 2 1
3 1 23 1 1 46 1 3 3 1
10 1 23 1 1 33 16 2 2 1
11 1 23 1 1 33 16 3 3 1
10 1 23 1 14 46 16 2 2 1
11 1 23 1 14 46 16 3 3 1
10 7 10 3 1 46 1 2 2 1
11 7 10 3 1 46 1 3 3 1
10 23 23 1 1 46 1 2 2 1
11 23 23 1 1 46 1 3 3 1
12 7 10 3 1 33 16 2 2 1
13 7 10 3 1 33 16 3 3 1
12 7 10 3 14 46 16 2 2 1
13 7 10 3 14 46 16 3 3 1
12 23 23 1 1 33 16 2 2 1
13 23 23 1 1 33 16 3 3 1
```

```
12 23 23 1 14 46 16 2 2 1
13 23 23 1 14 46 16 3 3 1
4 8 9 1 1 46 1 1 1 1
5 8 9 1 1 46 1 2 2 1
6 8 9 1 1 46 1 3 3 1
4 1 23 1 15 16 1 1 1 1
5 1 23 1 15 16 1 2 2 1
6 1 23 1 15 16 1 3 3 1
4 1 23 1 31 32 1 1 1 1
5 1 23 1 31 32 1 2 2 1
6 1 23 1 31 32 1 3 3 1
7 2 8 3 16 31 15 1 1 1
8 2 8 3 16 31 15 2 2 1
9 2 8 3 16 31 15 3 3 1
7 10 22 3 16 31 15 1 1 1
8 10 22 3 16 31 15 2 2 1
9 10 22 3 16 31 15 3 3 1
7 8 8 1 2 12 5 1 1 1
8 8 8 1 2 12 5 2 2 1
9 8 8 1 2 12 5 3 3 1
7 8 8 1 4 19 5 1 1 1
8 8 8 1 4 19 5 2 2 1
9 8 8 1 4 19 5 3 3 1
7 8 8 1 22 28 3 1 1 1
8 8 8 1 22 28 3 2 2 1
9 8 8 1 22 28 3 3 3 1
7 8 8 1 33 43 5 1 1 1
8 8 8 1 33 43 5 2 2 1
9 8 8 1 33 43 5 3 3 1
7 8 8 1 35 45 5 1 1 1
8 8 8 1 35 45 5 2 2 1
9 8 8 1 35 45 5 3 3 1
END ARRAY
READ BNDS +XB=VAC -XB=MIR YFC=VAC ZFC=VAC END BNDS
READ GEOM
BOX TYPE 1
CYLINDER 2 1 0.602996 0.3175 0.0
CUBOID   3 1 0.81788 -0.81788 0.81788 -0.81788 0.3175 0.0
BOX TYPE 2
CYLINDER 1 1 0.514858 2.54 0.0
CYLINDER 0 1 0.521716 2.54 0.0
CYLINDER 2 1 0.602996 2.54 0.0
CUBOID   3 1 0.615 -0.615 0.615 -0.615 2.54 0.0
CUBOID   2 1 0.81788 -0.81788 0.81788 -0.81788 2.54 0.0
BOX TYPE 3
CYLINDER 1 1 0.514858 142.1425 0.0
CYLINDER 0 1 0.521716 142.1425 0.0
CYLINDER 2 1 0.602996 142.1425 0.0
```

```
CUBOID   3 1 0.81788 -0.81788 0.81788 -0.81788 142.1425 0.0
BOX TYPE 4
CUBOID   3 1 0.81788 -0.81788 0.81788 -0.81788 0.3175 0.0
BOX TYPE 5
CUBOID   3 1 0.615 -0.615 0.615 -0.615 2.54 0.0
CUBOID   2 1 0.81788 -0.81788 0.81788 -0.81788 2.54 0.0
BOX TYPE 6
CUBOID   3 1 0.81788 -0.81788 0.81788 -0.81788 142.1425 0.0
BOX TYPE 7
CYLINDER 2 1 0.5565 0.3175 0.0
CUBOID   3 1 0.81788 -0.81788 0.81788 -0.81788 0.3175 0.0
BOX TYPE 8
CYLINDER 4 1 0.4675 2.54 0.6349
CYLINDER 2 1 0.5565 2.54 0.0
CUBOID   3 1 0.615 -0.615 0.615 -0.615 2.54 0.0
CUBOID   2 1 0.81788 -0.81788 0.81788 -0.81788 2.54 0.0
BOX TYPE 9
CYLINDER 4 1 0.4675 142.1425 0.0
CYLINDER 2 1 0.5565 142.1425 0.0
CUBOID   3 1 0.81788 -0.81788 0.81788 -0.81788 142.1425 0.0
BOX TYPE 10
CYLINDER 1 1 0.514858 2.54 0.0
CYLINDER 0 1 0.521716 2.54 0.0
CYLINDER 2 1 0.602996 2.54 0.0
CUBOID   3 1 0.615 -0.615 0.615 -0.615 2.54 0.0
CUBOID   2 1 0.81788 -0.81788 0.81788 -0.81788 2.54 0.0
BOX TYPE 11
CYLINDER 1 1 0.514858 142.1425 0.0
CYLINDER 0 1 0.521716 142.1425 0.0
CYLINDER 2 1 0.602996 142.1425 0.0
CUBOID   3 1 0.81788 -0.81788 0.81788 -0.81788 142.1425 0.0
BOX TYPE 12
CYLINDER 1 1 0.514858 2.54 0.0
CYLINDER 0 1 0.521716 2.54 0.0
CYLINDER 2 1 0.602996 2.54 0.0
CUBOID   3 1 0.615 -0.615 0.615 -0.615 2.54 0.0
CUBOID   2 1 0.81788 -0.81788 0.81788 -0.81788 2.54 0.0
BOX TYPE 13
CYLINDER 1 1 0.514858 142.1425 0.0
CYLINDER 0 1 0.521716 142.1425 0.0
CYLINDER 2 1 0.602996 142.1425 0.0
CUBOID   3 1 0.81788 -0.81788 0.81788 -0.81788 142.1425 0.0
CORE     0 1 0.0 -37.62248  0.0
ZHEMICYL+X  5 1 73.66 145.0 0.0
ZHEMICYL+X  2 1 73.66 145.0 -5.08
ZHEMICYL+X  5 1 76.20 145.0 -7.62
ZHEMICYL+X  0 1 76.20 190.38 -7.62
ZHEMICYL+X  2 1 77.47 190.38 -8.89
```

```
CUBOID   0 1 77.47 0.0 77.47 -77.47 190.38 -8.89
END GEOM
END DATA
END



T 37
ARRAY 5  0.0 0.0 -0.635
UNIT 38
ARRAY 6  0.0 0.0 -0.635
UNIT 39
XHEMICYL+Y 4 1 0.35306 0.9271 0.0
XHEMICYL+Y 0 1 0.37084 0.9271 0.0
CUBOID     5 1 1.43002 0.0 0.762 0.0 2P0.635
UNIT 40
YHEMICYL+X 4 1 0.35306 0.9271 0.0
YHEMICYL+X 0 1 0.37084 0.9271 0.0
CUBOID     5 1 0.762 0.0 1.43002 0.0 2P0.635
CORE 7 1 0.0 0.0 0.635
CUBOID 3 1 23.2029 0.0 23.2029 0.0 424.815 0.0
CUBOID 5 1 24.1554 0.0 24.1554 0.0 424.815 0.0
CUBOID 6 1 30.8864 0.0 30.8864 0.0 424.815 0.0
CUBOID 5 1 34.6964 0.0 34.6964 0.0 452.755 -24.13
CUBOID 3 1 100.0 0.0 100.0 0.0 510.0 -75.0
END GEOM
END DATA
END
```

6.6.3 References for Sections 6.1 through 6.5

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6.3-1 "Characteristics of Spent Fuel, High-Level Waste and Other Radioactive Wastes Which May Require Long-Term Isolation," DOE/RW-0184, December 1987.

6.5-1 Bierman, S.R., B. M. Durst, and E.D. Clayton, "Critical Separation between Subcritical Clusters of 4.29 wt% ^{235}U-Enriched UO_2 Rods in Water with Fixed Neutron Poisons," NUREG/CR-0073, U.S. Nuclear Regulatory Commission, May 1978.

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6.5-5 Bierman, S.R., B. M. Durst, and E.D. Clayton, "Critical Separation between Subcritical Clusters of Low-Enriched UO_2 Rods in Water with Fixed Neutron Poisons," *Nuclear Technology*, Vol. 42, March 1979.

CHAPTER 7
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7. OPERATING PROCEDURES

7.1 Procedure for Loading the Packaging

This section describes the general procedure for loading spent fuel into the casks. Any non-compliances as defined in 10 CFR Part 71.95 shall be reported within 30 days to the Director, Office of Nuclear Material Safety and Safeguards, US NRC, Washington, DC 20555.

7.1.1 Wet Loading at the Reactor Site

Each reactor site will normally use wet loading. Each site has different facilities, pool size, handling procedures, and administrative requirements.

7.1.1.1 Receipt Inspection

1. Document the receipt of the empty cask.

2. Conduct a radiation dose survey to verify compliance with 10 CFR Part 71.47. Conduct a contamination survey of the trailer to verify compliance with 10 CFR Part 71.87(i).

3. Perform contamination survey of accessible cask surfaces; complete the survey as the remaining areas become accessible to verify compliance with 10 CFR Part 71.87(i).

4. Inspect cask and trailer for damage.

7.1.1.2 Remove Cask from Trailer

1. Drive trailer into facility. Set brakes and block wheels during uprighting of the cask if the facility crane can be moved toward the rear tiedowns. If the crane cannot move all the way above the rear tiedowns, the trailer will have to move during uprighting.

2. Install a lifting sling on the impact limiters. Loosen the impact limiter attachment bolts and remove bottom and top impact limiters, using a crane, and store them on the trailer. Each impact limiter weighs about 2000 lb. Use a load cell to ensure that only the weight of the impact limiter is being raised.

3. Remove the front and rear tiedowns by loosening the tiedown bolts and rotating the tiedown clamp out of the way.

4. Engage the cask lifting yoke and the cask lifting trunnion sockets near the top of the cask.

5. Raise the cask to a vertical position on the rear trailer supports. Keep the crane cables vertical over the lifting trunnions while hoisting. The trailer may have to be moved during hoisting to keep the crane cables vertical.

6. Remove the cask from the trailer and set it down on the decontamination and service pad. For utilities that require redundant lifting when transferring the cask to the refueling floor, use the redundant lifting fixture which connects the sister hook to the redundant lift sockets. Disengage the lifting yoke.

7.1.1.3 Preparation for Transferring Cask to Pool

1. Clean the cask of road dirt in preparation for loading into pool.

2. Verify that the primary seals for the closure, gas sample port, and drain valve have been replaced within the previous 12-month period. If they have not, replace the seals.

3. Remove the gas sample port and drain valve covers. Remove the gas sample port and drain valve and inspect the seals. The seals shall be replaced if they have nicks, cuts, scratches, or other damage that would adversely affect their performance. Replace the gas sample port and drain valve. Remove the drain port plug and install a drain port valve in the closed position. Open the drain valve. Back out the gas sample port until it hits the stop and install a vent with a drain line. (See Section 1.2.2.2 for detailed descriptions of the drain valve, drain port valve, and gas sample port.)

4. Loosen and remove the closure bolts; inspect bolts and replace if damaged. Insert the two yoke guide pins into the appropriate bolt holes.

5.[a] Using a lifting sling, remove closure and set it down. Sometime before or during cask loading, inspect the seals and seal surface on the cask closure flange for damage. The seals shall be replaced if they have nicks, cuts, scratches, or other damage that would adversely affect seal performance.

6. Sometime before cask loading, inspect the interior of the cask for debris and damage. Also ensure that the correct fuel spacers at the bottom of the cask cavity are in place (if needed).

7.1.1.4 Cask Loading

1. Engage the lifting yoke to the cask lifting trunnion sockets. For utilities that require redundant lifting, attach the redundant lifting fixture to the yoke and the sister hook. Engage the redundant lifting fixture and the redundant lift sockets. Lift cask and slowly lower it to the bottom of the pool, filling it with water as it is lowered.

2. Disengage the lifting yoke (and redundant lifting fixture, if applicable) and remove from the pool.

(a) Alternatively, the cask may be filled with water before the closure is removed on the refueling floor, or the closure may be removed after the cask is lowered into the pool.

3.[b] Load fuel elements into the cask. Carefully lower the fuel elements into the cask to avoid damaging the sealing surface or the FSS.

4. Attach the closure to the lifting yoke and engage the lifting yoke in the cask lifting trunnion sockets (and the redundant lifting fixture in the redundant lift sockets, if applicable). The yoke pins guide both the yoke and the closure onto the cask. Verify full yoke engagement by observation of the black indicator rod on each arm of the yoke. Visually confirm that the closure is seated in the cask body with the top of the closure approximately 1/8 in. above the top of the cask.

5. Raise the cask so that the closure is just above the pool surface. Verify that the closure is properly seated with the top surface of the closure just above the top of the cask.

6. Lubricate the threads, install and hand-tighten at least two of the closure bolts.

7. Raise the cask out of the pool, rinsing the yoke and the outside of the cask with clean water as it is being raised.

8. Set the cask down on the decontamination and service pad.

9. Disengage lifting yoke and closure lifting sling (and redundant lifting fixture, if applicable).

10. Remove the yoke guide pins. Lubricate the threads and install the remainder of closure bolts. Tighten all bolts in a star pattern of three passes to a torque of 235 ± 15 ft-lb. Verify that each bolt head is 1/4 in. below the closure surface to ensure proper bolt engagement.

11. Perform contamination survey and decontaminate cask to acceptable shipping levels, following 10 CFR Part 71.87(i).

12. [**Proprietary Information**]

13.[c] Remove the vent and connect an air supply (not to exceed 10 psig) to the gas sample port. Connect a drain line to the drain port valve. Drain the cask into the pool, using the air supply to assist in draining the cask and to ensure that all the water has drained. Remove the air supply connection from the gas sample port. Close the drain valve. Remove the drain line and drain port valve and install the drain port plug. (See Section 1.2.2.2 for detailed descriptions of the drain valve, drain port valve, and gas sample port.)

(b) Identify the fuel to be loaded and verify that it has been established that the fuel meets the requirements of the Certificate of Compliance.

(c) Alternatively, the cask may be drained as it is being removed from the pool.

14. Connect a vacuum system to the gas sample port. Evacuate the cask to a pressure of 0.2 psia (10 mm Hg) or less. Boiling is ensured since this pressure is below the saturation pressure of water at 70°F. Pump for 1 hr thereafter. After stopping the pumping, monitor the cask pressure for 10 min. If the pressure rise during this time is less than 0.1 psi, the cask is sufficiently dry. If the pressure rise is unacceptable, repeat the evacuation procedure until the pressure rise is acceptable (< 0.1 psi in 10 min).

15. Use the vacuum pump to pull a vacuum. Attach a helium supply to the gas sample port. Fill the cask with helium to atmospheric pressure. Disengage the helium supply. Fully engage the gas sample port plug handtight.

16. Perform a leakage test on the gas sample port and closure primary seals. If either of these seals has been replaced, the leakage test must be performed to a sensitivity of 5×10^{-8} std-cm^3/sec. The pressure rise test outlined below cannot be used and a helium mass spectrometer leak detector is required (see Section 8.1.3.2). If neither seal has been replaced, connect a vacuum and leakage testing system to the quick-disconnect on the gas sample port, as shown in Fig. 7.1-1. Evacuate to 0.02 psia (1 mm Hg) or less. Isolate the vacuum pump from the system and monitor the pressure rise (P1 in Fig. 7.1-1) for a period of between 3 and 5 minutes. For an assembly verification test utilizing a pressure rise, the allowable leak rate is 1/2 the sensitivity of 0.001 std-cm^3/sec (ANSI N14.5-1987 Sections 6.5.2, B13, B15). The maximum acceptable pressure rise is then given by the following formula:

$$\Delta p = t\left(\frac{T + 460}{V + V'}\right)\left(\frac{0.0005 * 60 * 14.7}{16.39 * 537}\right) \text{ psi,}$$

where

t = hold time (min),
T = test temperature (°F),
V = volume of tubing communicating between quick-disconnect, pressure gauge, and isolation valve (in.^{3}), and
V′ = test volume upstream of tubing = 1.03 in.^{3}

Reinstall the port cover after the test.

17. Repeat the above procedure for the drain valve. If the drain valve primary seal has been replaced, a leakage test with a sensitivity of 5×10^{-8} std-cm^3/sec is required (see Section 8.1.3.2) and the pressure rise test cannot be used. For the pressure rise formula, V′ = 0.06 in.^{3}. Reinstall the drain valve cover after the test.

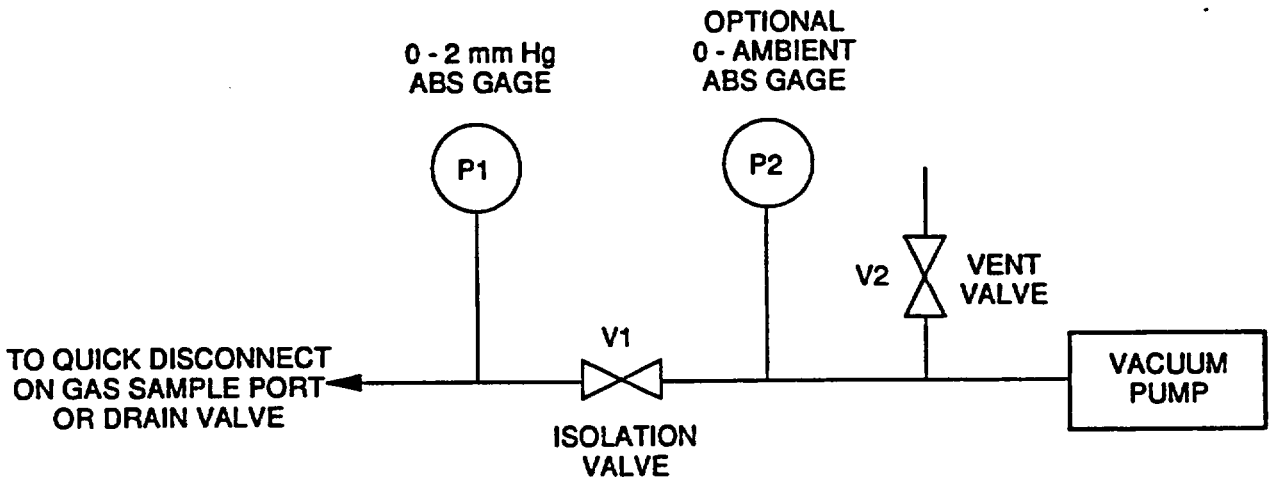

Fig. 7.1-1. Assembly verification testing of seals

7.1.1.5 Cask Shipment

1. Engage the lifting yoke to the lifting trunnion sockets. (If redundant lifting is required, attach the yoke to the lifting trunnion sockets and the redundant lifting fixture to the redundant lift sockets.)

2. Verify that the trailer has "GA-4 Trailer" stenciled on the main beam. Lift the cask and move it to the trailer loading area. (Remove the redundant lifting fixture, if applicable.) Set the cask down on the rear tiedowns of the trailer as indicated by the "bottom of cask" stenciled on the vertical support tube. Verify that "bottom of cask" is stenciled on the side of the cask that will rest on the trailer.

3. Lower the cask to a horizontal position on the trailer. Keep the crane cables vertical over the lifting trunnions while setting the cask down on the front tiedowns. The trailer may have to be moved during lowering to keep the crane cables vertical. Disengage the lifting yoke.

4. Engage the front and rear tiedowns.

5. Using a crane and lifting slings, install each impact limiter on the cask. Use the alignment marks on the cask and impact limiter to assist installation.

6. Tighten the impact limiter attachment bolts to a torque of 230 ± 15 ft-lb. Install tamper-indicating seals between tabs both on the impact limiters and on the cask body; apply appropriate labels.

7. Conduct a radiation dose survey to ensure compliance with 10 CFR Part 71.47. The survey shall measure all energies of both gamma and neutrons and shall be taken at enough points to ensure that any streaming doses are measured. Conduct a contamination survey of the trailer and accessible cask surfaces to ensure compliance with 10 CFR Part 71.87(i). Calculate the transport index (10 CFR Part 71.4), which is the maximum dose rate at 1 meter from the package surface, expressed as mSv/hr x 100 (= mR/hr). Also verify that the dose rate meets the following formula from Section 5.4.8:

   3.4 x (peak neutron dose rate at any point on the cask surface at its midlength)

   + 1.0 x (gamma dose rate at that location)

   ≤ 1000 mR/hr.

8. Complete shipping documents and apply the required placards.

7.1.2 Dry Cask Loading

These procedures are for a facility where a hot cell is available for dry loading. For dry loading at a reactor, a transfer cask would be used to remove the spent fuel from the pool or dry storage cask and transfer it to the GA-4 cask for loading. The transfer cask would be designed to interface with the cask.

7.1.2.1 Receipt Inspection

1. Document the receipt of the empty cask.

2. Conduct a radiation dose survey to ensure compliance with 10 CFR Part 71.47. Conduct a contamination survey of the trailer to ensure compliance with 10 CFR Part 71.87(i).

3. Perform contamination survey of accessible cask surfaces, complete the survey as the remaining areas become accessible to ensure compliance with 10 CFR Part 71.87(i).

4. Inspect the cask and trailer for damage.

7.1.2.2 Remove Cask from Trailer

1. Drive trailer into facility. Set brakes, and block wheels during uprighting of the cask if the facility crane can be moved toward the rear tiedowns. If the crane cannot move all the way above the rear tiedowns, the trailer will have to move during uprighting.

2. Install a lifting sling on the impact limiters. Loosen the impact limiter attachment bolts and remove bottom and top impact limiters; store them on the trailer. Each impact limiter weighs about 2000 lb. Use a load cell to ensure that only the weight of the impact limiter is being raised.

3. Remove the front and rear tiedowns by loosening the tiedown bolts and rotating the tiedown clamp out of the way.

4. Engage the cask lifting yoke and the cask lifting trunnion sockets near the top of the cask.

5. Raise the cask to a vertical position on the rear trailer supports. Keep the crane cables vertical over the lifting trunnions while hoisting. The trailer may have to be moved during hoisting to keep the crane cables vertical.

6. Remove the cask from the trailer and set it down on the facility transfer cart. Disengage the lifting yoke.

7.1.2.3 Preparation for Loading the Cask

1. Move the cask and transfer cart to the cask preparation area.

2. Clean the cask of road dirt in preparation for unloading.

3. Verify that the primary seals for the closure, gas sample port, and drain valve have been replaced within the previous 12-month period. If they have not, replace the seals.

4. Remove the cover of the gas sample port. Remove the gas sample port and inspect the seals. The seals shall be replaced if they have nicks, cuts, scratches, or other damage that would adversely affect their performance. Replace the gas sample port. Back out the gas sample port until it hits the stop.

5. Loosen and remove the closure bolts; inspect bolts and replace if damaged.

6. Install a closure lifting sling or lifting fixture, remove closure, and set it down. Sometime before or during cask loading, inspect the seals and seal surface on the cask closure flange for damage. The seals shall be replaced if they have nicks, cuts, scratches, or other damage that would adversely affect seal performance.

7. Sometime before cask loading, inspect the interior of the cask for debris and damage. Also ensure that the correct fuel spacers at the bottom of the cask cavity are in place (if needed).

8. Re-install closure on the cask.

9. Move cask to the loading area under the hot cell.

7.1.2.4 Cask Loading

1. Position the cask under the hot cell loading port.

2. Mate the hot cell port collar to the cask.

3. Open the loading port after the seal between the port collar and the cask surface seal is confirmed.

4. Remove the closure with the facility grapple.

5.[d] Load the fuel elements into the cask cavity. Carefully lower the fuel elements into the cask to avoid damaging the sealing surface and FSS.

6. Install the closure on the cask, taking care not to damage the cask sealing surface.

7. Close the loading port.

8. Disengage the hot cell port collar.

9. Perform a radiation dose survey.

10. Move the cask to the preparation area.

11. Remove the closure lifting sling and/or lifting fixture.

12. Lubricate the closure bolt threads. Install and tighten the closure bolts in a star pattern of three passes to a torque of 235 ± 15 ft-lb. Verify that the bolt heads are 1/4 in. below the closure surface to ensure proper bolt engagement.

13. [**Proprietary Information**]

14. Attach a vacuum pump to the gas sample port and pull a vacuum. Attach a helium supply to the gas sample port. Fill the cask with helium to atmospheric pressure. Disengage the helium supply. Fully engage the gas sample port plug handtight.

15. Perform a leakage test on the gas sample port and closure primary seals. If either of these seals has been replaced, the leakage test must be performed to a sensitivity of 5×10^{-8} std-cm^3/sec. The pressure rise test outlined below cannot be used and a helium mass spectrometer leak detector is required (see Section 8.1.3.2). If neither seal has been replaced, connect a vacuum and leakage testing system to the quick-disconnect on the gas sample port, as shown in Fig. 7.1-1. Evacuate to 0.02 psia (1 mm Hg) or less. Isolate the vacuum pump from the system and monitor the pressure rise (P1 in Fig. 7.1-1) for a period of between 3 and 5 minutes. For an assembly verification test utilizing a pressure rise, the allowable leak rate is 1/2 the sensitivity of 0.001 std-cm^3/sec (ANSI N14.5-1987 Sections 6.5.2, B13, B15). The maximum acceptable pressure rise is then given by the following formula:

$$\Delta p = t\left(\frac{T + 460}{V + V'}\right)\left(\frac{0.0005 * 60 * 14.7}{16.39 * 537}\right) \text{ psi,}$$

[d] Identify the fuel to be loaded and verify that it has been established that the fuel meets the requirements of the Certificate of Compliance.

where

t = hold time (min),
T = test temperature (°F),
V = volume of tubing communicating between quick-disconnect, pressure gauge, and isolation valve (in.^{3}), and
V′ = test volume upstream of tubing = 1.03 in.^{3}

Reinstall the port cover after the test.

16. Repeat the above procedure for the drain valve. If the drain valve primary seal has been replaced, a leakage test with a sensitivity of 5×10^{-8} std-cm^3/sec is required (see Section 8.1.3.2) and the pressure rise test cannot be used. For the pressure rise formula, V′ = 0.06 in.^{3}. Reinstall the drain valve cover after the test.

17. Perform contamination survey and decontaminate cask to acceptable shipping levels, following 10 CFR Part 71.87(i).

18. Move the cask and transfer cart to the shipping area.

7.1.2.5 Cask Shipment

1. Engage the lifting yoke and the lifting trunnion sockets.

2. Verify that the trailer has "GA-4 Trailer" stenciled on the main beam. Lift the cask and move it to the trailer loading area. Set the cask down on the rear tiedowns of the trailer as indicated by the "bottom of cask" stenciled on the vertical support tube. Verify that "bottom of cask" is stenciled on the side of the cask that will rest on the trailer.

3. Lower the cask to a horizontal position on trailer. Keep the crane cables vertical over the lifting trunnions while setting the cask down on the front tiedowns. The trailer may have to be moved during lowering to keep the crane cable vertical. Disengage the lifting yoke.

4. Engage front and rear tiedowns.

5. Using a crane and lifting sling, install each impact limiter on the cask. Use the alignment marks on the cask and impact limiters to assist installation.

6. Tighten the impact limiter attachment bolts to a torque of 230 ± 15 ft-lb. Install tamper-indicating seals between tabs both on the impact limiters and on the cask body; apply appropriate labels.

7. Conduct a radiation dose survey to ensure compliance with 10 CFR Part 71.47. The survey shall measure all energies of both gamma and neutrons and shall be taken at enough points to ensure that any streaming doses are measured. Conduct a contamination survey of the trailer and accessible cask surfaces to

ensure compliance with 10 CFR Part 71.87(i). Calculate the transport index (10 CFR Part 71.4), which is the maximum dose rate at 1 meter from the package surface, expressed as mSv/hr x 100 (= mR/hr). Also verify that the dose rate meets the following formula from Section 5.4.8:

3.4 x (peak neutron dose rate at any point on the cask surface at its midlength)

+ 1.0 x (gamma dose rate at that location)

≤ 1000 mR/hr.

8. Complete shipping documents and apply the required placards.

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7.2 Procedure for Unloading the Packaging

This section describes the general procedure for unloading spent fuel from the casks. Any non-compliances as defined in 10 CFR Part 71.95 shall be reported within 30 days to the Director, Office of Nuclear Material Safety and Safeguards, US NRC, Washington, DC 20555.

7.2.1 Dry Cask Unloading

7.2.1.1 Receipt Inspection

1. Document the receipt of the cask.

2. Conduct a radiation dose survey to ensure compliance with 10 CFR Part 71.47. Conduct a contamination survey of the trailer to ensure compliance with 10 CFR Part 71.87(i).

3. Perform contamination survey of accessible cask surfaces; complete the survey as the remaining areas become accessible to ensure compliance with 10 CFR Part 71.87(i).

4. Inspect cask and trailer for damage and anti-tamper seals for tampering.

7.2.1.2 Remove Cask from Trailer

1. Drive trailer into facility. Set brakes and block wheels during uprighting of the cask if the facility crane can be moved toward the rear tiedowns. If the crane cannot move all the way above the rear tiedowns, the trailer will have to move during uprighting.

2. Install a lifting sling on the impact limiters. Loosen the impact limiter attachment bolts and remove bottom and top impact limiters; store them on the trailer. Use a load cell to ensure that only the weight of the impact limiter is being raised. Each impact limiter weighs about 2000 lb.

3. Remove the front and rear tiedowns by loosening the tiedown bolts and rotating the tiedown clamp out of the way.

4. Engage the cask lifting yoke and the cask lifting trunnion sockets near the top of the cask.

5. Raise the cask to a vertical position on the rear trailer supports. Keep the crane cables vertical over the lifting trunnions while hoisting. The trailer may have to be moved during hoisting to keep the crane cables vertical.

6. Remove the cask from the trailer and set it down on the facility transfer cart. Disengage the lifting yoke.

7.2.1.3 Preparation for Unloading the Cask

1. Move the cask and transfer cart to the cask preparation area.

2. Clean the cask of road dirt in preparation for unloading.

3. Remove the cover of the gas sample port. Back out the gas sample port until it hits the stop.

4. Connect to the gas sample port plug quick-disconnect a pressure gauge, a vacuum system and the facility off-gas process system. Check the cavity pressure. Depressurize the cavity, if required.

5. Untorque and remove the closure bolts.

6. Install a lifting sling and/or lifting fixture on the closure.

7. Move the cask to the unloading area under the hot cell.

7.2.1.4 Cask Unloading

1. Position the cask under the hot cell unloading port.

2. Mate the hot cell port collar to the cask.

3. Open the unloading port after the seal between the port collar and the cask surface is confirmed.

4. Remove the closure with the hot cell grapple.

5. Unload the fuel elements from the cask.

6. Install the closure on the cask, taking care not to damage the sealing surface.

7. Close the unloading port.

8. Disengage the hot cell port collar.

9. Perform a radiation dose survey to verify that all fuel elements have been removed.

10. Move the cask to the preparation area.

11. Remove the closure lifting sling or lifting fixture.

12. Lubricate the closure bolt threads. Install and tighten the closure bolts in a star pattern to a torque of 235 ± 15 ft-lb. Verify that the bolt heads are 1/4 in. below the closure surface to ensure proper bolt engagement.

13. Perform contamination survey and decontaminate cask to acceptable levels, following 10 CFR Part 71.87(i).

14. Move the cask and transfer cart to the shipping area.

7.2.1.5 Cask Shipment

1. Engage the lifting yoke in the lifting trunnion sockets.

2. Verify that the trailer has "GA-4 Trailer" stenciled on the main beam. Lift the cask and move it to the trailer loading area. Set the cask down on the rear tiedowns of the trailer, as indicated by the "bottom of cask" stenciled on the vertical support tube. Verify that "bottom of cask" is stenciled on the side of the cask that will rest on the trailer.

3. Lower the cask to a horizontal position on trailer. Keep the crane cables vertical over the lifting trunnions while setting the cask down on the front tiedowns. The trailer may have to be moved during lowering to keep the crane cables vertical. Disengage the lifting yoke.

4. Engage front and rear tiedowns.

5. Using a crane and lifting sling, install each impact limiters on the cask. Use the alignment marks on the cask and impact limiter to assist installation.

6. Tighten the impact limiter attachment bolts to a torque of 230 ± 15 ft-lb. Apply appropriate labels.

7. Conduct a radiation dose survey to ensure compliance with 10 CFR Part 71.47. Conduct a contamination survey of the trailer and accessible cask surfaces to ensure compliance with 10 CFR Part 71.87(i).

8. Complete shipping documents and apply the required placards.

7.2.2 Wet Cask Unloading

7.2.2.1 Receipt Inspection

1. Document the receipt of the cask.

2. Conduct a radiation dose survey to ensure compliance with 10 CFR Part 71.47. Conduct a contamination survey of the trailer to ensure compliance with 10 CFR Part 71.87(i).

3. Perform contamination survey of accessible cask surfaces and complete survey as the remaining areas become accessible to ensure compliance with 10 CFR Part 71.87(i).

4. Inspect cask and trailer for damage and anti-tamper seals for tampering.

7.2.2.2 Remove Cask from Trailer

1. Drive trailer into facility. Set brakes and block wheels during uprighting of the cask if the facility crane can be moved toward the rear tiedowns. If the crane cannot move all the way above the rear tiedowns, the trailer will have to move during uprighting.

2. Install a lifting sling on the impact limiters. Loosen the impact limiter attachment bolts and remove bottom and top impact limiters, store on the trailer. Use a load cell to ensure that only the weight of the impact limiter is being raised. Each impact limiter weighs about 2000 lb.

3. Remove the front and rear tiedowns by loosening the tiedown bolts and rotating the tiedown clamp out of the way.

4. Engage the cask lifting yoke and the cask lifting trunnion sockets near the top of the cask.

5. Raise the cask to a vertical position on the rear trailer supports. Keep the crane cables vertical over the lifting trunnions while hoisting. The trailer may have to be moved during hoisting to keep the crane cables vertical.

6. Remove the cask from the trailer and set it down on the decontamination and service pad. For facilities that require redundant lifting when moving the cask, use the redundant lifting fixture which connects the sister hook to the redundant lift sockets. Disengage the lifting yoke.

7.2.2.3 Preparation for Transferring Cask to Pool

1. Clean the cask of road dirt in preparation for loading into the pool.

2. Remove the covers of the gas sample port and drain valve. Back out the gas sample port until it hits the stop. Remove the drain port plug and install a drain port valve in the closed position. Open the drain valve.

3. Connect a pressure gauge and the facility off-gas process system to the gas sample port plug quick-disconnect. Check the cavity pressure. Depressurize the cavity to atmospheric pressure, if required.

4.[e] Connect a water supply with a pressure gauge and relief valve to the drain port valve. Slowly fill the cask cavity with water, ensuring that the cavity pressure

[e] Alternatively, the cask cavity could be filled with water through the drain port valve as the cask is being lowered into the pool.

does not exceed MNOP, and vent the cavity gas to the facility off-gas process system.

5. Untorque the closure bolts and remove all but at least two.

7.2.2.4 Cask Unloading

1. Engage the lifting yoke to the cask lifting trunnion sockets. Attach the lifting yoke to the closure. For facilities that require redundant lifting when moving the cask, attach the redundant lifting fixture to the yoke and the sister hook. Engage the redundant lifting fixture and the redundant lift sockets.

2. Lift cask and slowly lower it into the pool until closure bolts are just above the water surface; remove the remaining two bolts.

3. Lower the cask to the bottom of the pool.

4. Disengage and remove the lifting yoke and closure (and redundant lifting fixture, if applicable) from the pool.

5. Inspect the closure seals and replace any of them that has nicks, cuts, scratches, or other deformations that will adversely affect seal performance.

6. Remove the fuel.

7. Attach the closure to the lifting yoke and engage the lifting yoke in the cask lifting trunnion sockets (and the redundant lifting fixture in the redundant lift sockets, if applicable). The yoke pins guide both the yoke and the closure onto the cask. Verify full yoke engagement by observation of the black indicator rod on each arm of the yoke. Visually confirm that the closure is seated in the cask body with the top of the closure approximately 1/8 in. above the top of the cask.

8. Raise the cask so that the closure is just above the pool surface. Verify that the closure is properly seated with the top surface of the closure just above the top of the cask.

9. Lubricate the threads, install and hand-tighten at least two of the closure bolts.

10. Connect an air supply (not to exceed 10 psig) to the gas sample port.

11. Raise the cask out of the pool. Rinse the yoke and the outside of the cask as it is being raised with clean water.

12.[f] Connect a drain line to the drain port valve. Drain the cask, using the air supply to ensure that all the water has drained.

13. Set down cask on the decontamination and service pad after the cask is drained. Remove the air supply connection from the gas sample port.

14. Disengage lifting yoke and closure lifting sling.

15. Remove the yoke guide pins. Lubricate the threads and install the remainder of the closure bolts. Tighten all bolts in a star pattern of three passes to a torque of 235 ± 15 ft-lb. Verify that the bolt head is 1/4 in. below the cask surface to ensure proper bolt engagement.

16. Close the drain valve handtight. Remove the drain port valve and install the drain port plug. Fully engage the gas sample port plug handtight. Install port covers.

17. Perform contamination survey and decontaminate cask to acceptable shipping levels, following 10 CFR Part 71.87(i).

7.2.2.5 Cask Shipment

1. Engage the lifting yoke in the lifting trunnion sockets. (If redundant lifting is required, attach the yoke to the lifting trunnion sockets and the redundant lifting fixture to the redundant lift sockets.)

2. Verify that the trailer has "GA-4 Trailer" stenciled on the main beam. Lift the cask and move it to the trailer loading area. (Remove the redundant lifting fixture, if applicable.) Set the cask down on the rear tiedowns of the trailer, as indicated by the "bottom of cask" stenciled on the vertical support tube. Verify that "bottom of cask" is stenciled on the side of the cask that will rest on the trailer.

3. Lower the cask to a horizontal position on trailer. Keep the crane cables vertical over the lifting trunnions while setting the cask down on the front tiedowns. The trailer may have to be moved during lowering to keep the crane cables vertical. Disengage the lifting yoke.

4. Engage front and rear tiedowns.

5. Using a crane and lifting sling, install each impact limiter on the cask. Use the alignment marks on the cask and impact limiters to assist installation.

6. Tighten the impact limiter attachment bolts in a star pattern to a torque of 230 ± 15 ft-lb. Apply appropriate labels.

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[f] Alternatively, the cask could be drained after the cask is set down on the decon/service pad.

7. Conduct a radiation dose survey to ensure compliance with 10 CFR Part 71.47. Conduct a contamination survey of the trailer and accessible cask surfaces to ensure compliance with 10 CFR Part 71.87(i).

8. Complete shipping documents and apply the required placards.

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7.3 Preparation of an Empty Package for Transport

The procedures for the shipment of an empty cask shall be in accordance with the following:

1. Verify that the cask cavity has been drained of water as directed in Section 7.2.2, Wet Cask Unloading.

2. Verify that the closure bolts are tightened to a torque of 235 ± 15 ft-lb. Ensure that port plugs are fully engaged and covers are installed.

3. Conduct a contamination and radiation dose survey. External radiation and removable contamination shall not exceed the limits of 49 CFR Part 173.427 (Ref. 7.3-1) or 10 CFR Part 71.87(i) and Part 71.47, as appropriate. Decontaminate if necessary.

4. Engage the lifting yoke and the lifting trunnion sockets. (If redundant lifting is required, attach the yoke to the lifting trunnion sockets and the redundant lifting fixture to the redundant lift sockets.)

5. Verify that the trailer has "GA-4 Trailer" stenciled on the main beam. Lift the cask and move it to the trailer loading area. (Remove the redundant lifting fixture, if applicable.) Set it down on the rear tiedowns of the trailer, as indicated by the "bottom of cask" stenciled on the vertical support tube.

6. Lower the cask to a horizontal position on trailer. Keep the crane cables vertical over the lifting trunnions while setting the cask down on the front tiedowns. The trailer may have to be moved during lowering to keep the crane cables vertical. Disengage the lifting yoke.

7. Engage front and rear tiedowns.

8. Using a crane and lifting sling, install each impact limiter on the cask.

9. Tighten the impact limiter attachment bolts in a star pattern to a torque of 230 ± 15 ft-lb.

10. Affix a label to the cask based on radiation readings and estimated residual contents according to 49 CFR Part 172.403.

11. Conduct a radiation dose survey to ensure compliance with 10 CFR Part 71.47. Conduct a contamination survey of the trailer and personnel barrier to ensure compliance with 10 CFR Part 71.87(i).

12. Prepare all necessary shipping papers.

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7.4 Appendix

7.4.1 References for Section 7.3

7.3-1 49 CFR Part 173, "Shippers — General Requirements for Shipments and Packagings," 1983.

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8. ACCEPTANCE TESTS AND MAINTENANCE PROGRAM

8.1 Acceptance Tests

This section describes all of the testing required on the GA-4 cask prior to its first use and is summarized in Table 8.1-1. In addition to the various tests, GA's quality assurance procedures require documented fabrication inspections to verify that component and assembled cask dimensions and gaps are within specified tolerances.

8.1.1 Visual Inspection

Both the inside and the outside of the cask shall be visually inspected before its first use. The purpose of this inspection is to check for obvious damage—such as deep dents or gouges, damaged lifting or tiedown trunnions, missing or loose bolts, and missing or damaged seals—and to ensure that the cask is properly cleaned and that it satisfies all requirements on the licensing drawings, including all non-destructive examinations.

The acceptance criteria are that (1) there are no deep dents or gouges; (2) there are no scratches on the sealing surface that could affect seal performance; (3) there is no dirt, grease, or debris in or on the cask; and (4) the cask is assembled according to the licensing drawings.

8.1.2 Structural and Pressure Tests

8.1.2.1 Trunnion and Redundant Lifting Socket Proof Loading. The purpose of this test is to show that the trunnions are adequately designed to lift the cask safely. Three tests will be performed: one to simulate lifting the cask by the upper trunnions when its axis is vertical, one to simulate lifting the cask by the redundant lifting sockets in a direction parallel to the cask axis, and one to simulate lifting the cask by all four trunnions when its axis is horizontal. For the first two tests, a load of 79,500 lb is applied to each of the two upper trunnions and redundant lifting sockets in a direction parallel to the cask axis. The load is equal to 300 percent of one-half of the combined weight of the cask (without impact limiters), contents, and water in the cavity (53,000 lb). This proof load is double the normal 150 percent since the lifting system is designed to double the normal factors of safety of a redundant lifting design. The lower two trunnions do not need to be proof-loaded in a direction parallel to the cask axis because they are not used for lifting in that direction. The load will be applied for a minimum of 10 minutes.

For the third test, a load of 20,625 lb is applied to each trunnion in a direction perpendicular to the cask axis and trunnion axis. This load is equal to 150 percent of one-quarter of the cask's design weight (55,000 lb). The load will be applied for a minimum of 10 minutes.

TABLE 8.1-1
ACCEPTANCE TESTS PRIOR TO FIRST USE

Test	Inspection and Test Criteria
Visual inspection	Inspect inside and outside of cask and components for damage
Trunnion and redundant lifting socket proof loading	Proof-load 2 upper trunnions and separately 2 redundant lifting sockets to 3 times (loaded cask weight + water in cavity – impact limiters) in cask axial direction
	Proof-load four trunnions to 1.5 times loaded cask weight in cask transverse direction
Containment boundary pressure test	Pressure test at 1.5 times MNOP
Neutron shield cavity pressure test	Pressure and leak test at 1.25 times relief valve setting
Containment system fabrication verification leakage tests	1×10^{-7} std-cm^3/s maximum allowable rate of leakage
DU cavity leakage test	1×10^{-7} std-cm^3/s maximum allowable rate of leakage
Shielding integrity	Gamma scan of DU shield liner Chemical analysis of neutron shield Detailed dose readings with fuel loaded
Thermal acceptance test	Temperatures lower than predicted by analysis
Component tests	Ensure functional acceptability of all cask components

Following the tests, all trunnions and redundant lifting sockets will be visually examined for any signs of cracking, yielding, or other damage, and all welds will be liquid-penetrant-examined, following ASME Code, Subsection NG 5233. The examination technique specified in ASME Code Section V, Article 6, and the acceptance criteria specified in NG 5350 shall be used.

8.1.2.2 Containment Boundary Pressure Test. The purpose of this pressure test is to show that the cask containment boundary is capable of sustaining a maximum normal operating pressure of 80 psig without mechanical damage. As required by 10 CFR Part 71 paragraph 71.85(b), the pressure test is performed at 1.5 times MNOP (80 psig), i.e., 120 psig. The test shall be conducted and accepted according to ASME Code Section III, Div. 1, Subsection NB-6000.

First, the closure plate will be placed in position and the 12 closure bolts torqued in a star pattern. The cask will then be pressurized to 120 psig. A pressure gauge installed in the pressurizing line will be used to observe the charge pressure and any subsequent pressure decay. The pressurizing line valve shall be monitored to ensure that there is no leakage through the valve. The cask will be maintained at the test pressure for a minimum of 10 min prior to the leakage and pressure decay examination. The pressure will then be held for sufficient time to permit all joints, connections, and regions of high stress, such as thickness transition sections, to be examined for leakage. A pressure reading will be made and recorded to note any pressure decay.

Proprietary Information

8.1.3 Leakage Tests

Leakage tests will be performed on the cask body, O-ring seals, and DU cavity. Leakage testing of the neutron shield cavity is included in the pressure test of Section 8.1.2.3.

The purpose of the leakage tests on the cask body and O-ring seals is to verify that the containment boundary leakage rate does not exceed the maximum allowable design leakage rate. The containment boundary includes the cask body (cask body wall, flange, and bottom plate), closure, gas sample port, drain valve, and primary O-rings. Leakage tests are required to show that all components of the containment boundary are leaktight. All cask body containment boundary welds will be leak tested during fabrication. The containment boundary seals—consisting of the inner of the two concentric closure O-ring seals and the

inner of the two gas sample port and drain valve O-ring seals—will both be tested, using the gas sample port plug and drain valve.

The DU cavity leakage test verifies that the cavity liner is leaktight and that helium will be retained in the DU cavity.

8.1.3.1 Cask Body. A leakage test, following the procedures given in ASME Code Section V, Article 10 (using the hood method helium mass spectrometer technique), will be used to verify that the cask body containment boundary is leaktight. The test will be performed before the final weld on the cavity liner is made. Either the closure or a temporary substitute can be installed on the cask body. The test equipment shall be operated to verify that there are no defects in the cask body that allow helium to reach the detector. The maximum allowable leakage is 1×10^{-7} std-cm^3/s, and test procedure sensitivity must be equal to or greater than 5×10^{-8} std-cm^3/s.

8.1.3.2 O-ring Seals. The O-ring seals at the interface between (1) the closure and the seal flange, (2) the gas sample port and closure, and (3) the drain valve and lower plate shall be tested for leakage through the gas sample port plug and drain valve. A helium mass spectrometer test shall be performed. The test procedure must have a minimum sensitivity of 5×10^{-8} std-cm^3/s, and the maximum measured leakage shall not exceed 1×10^{-7} std-cm^3/s. The following test procedures shall be used:

Closure and gas sample port seals

1. (See Fig. 8.1-1). With the gas sample port fully closed, connect the helium mass spectrometer leak detector (MSLD) line to the gas sample port quick-disconnect. Using the MSLD or auxiliary pump, evacuate the seal interspace to 0.01 atm or less. Continue pumping to achieve a detector background reading low enough so that a leakage of 5×10^{-8} std-cm^3/s could be clearly observed.

2. With the drain valve open, connect a vacuum pump and helium supply to an open drain port valve that is installed in the drain port. Note that the drain port valve is a piece of auxiliary equipment that is not used for transport. Evacuate the cask cavity to 0.01 atm or until the pressure stabilizes.

3. Calibrate the leak test system using the standard leak, following the ASME Code Section V, Article 10, Appendix V (Hood Technique). Insure that the background returns to a sufficiently low level (see step 1) after calibration.

4. Close off the pump evacuating the cask cavity through the drain port valve. Note the cask pressure. Open the helium supply to backfill the cask to 1 atm absolute (0 psig).

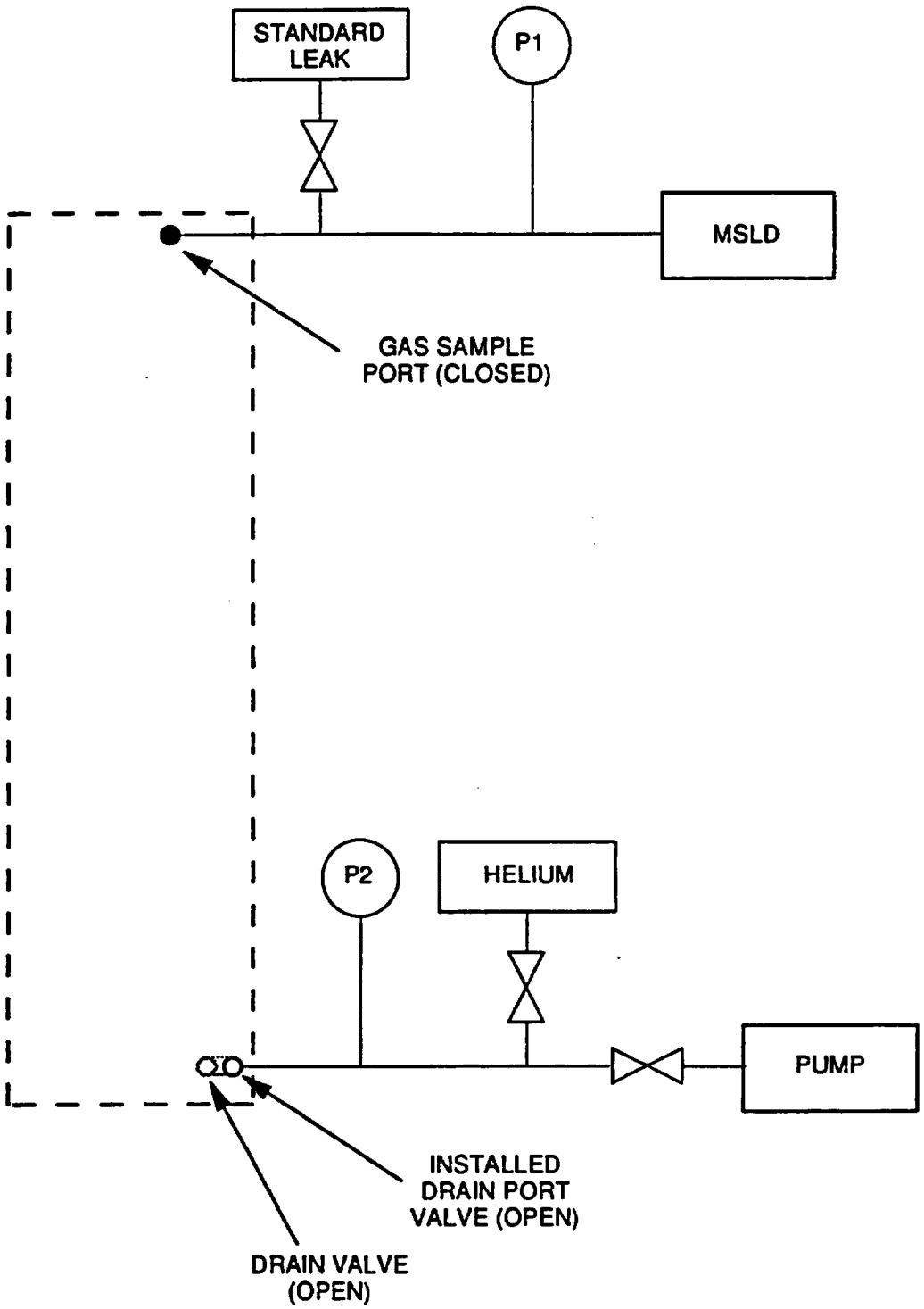

Fig. 8.1-1. Testing of closure and gas sample port seals

5. Immediately after achieving 1 atm in the cavity, monitor the MSLD output for at least 30 seconds. The leakage rate (increase above background) must be $< 1 \times 10^{-7}$ std-cm^3/s. (Note: if the cask cavity contains less than 100% helium, as determined from the cavity pressure before backfilling, the leakage measured by the MSLD must be divided by the fraction of helium.)

Drain valve seals

1. Using the previous setup (Fig. 8.1-1), evacuate the helium from the cask cavity through the drain port valve. Remove the drain valve and replace the seals. Reinsert and fully torque the drain valve into the closed position.

2. (See Fig. 8.1-2). Connect the MSLD to the drain valve quick-disconnect. Using the MSLD or auxiliary pump, evacuate the seal interspace to 0.01 atm or less. Continue pumping to achieve a detector background reading low enough so that a leakage of 5×10^{-8} std-cm^3/s could be clearly observed.

3. With the gas sample port in the open position, connect a vacuum pump and helium supply to the quick-disconnect on the port. Evacuate the cask cavity to 0.01 atm or until the pressure stabilizes.

4. Calibrate the leak test system using the standard leak, following the ASME Code Section V, Article 10, Appendix V (Hood Technique). Insure that the background returns to a sufficiently low level (see step 2) after calibration.

5. Close off the pump evacuating the cask cavity through the gas sample port. Note the cask pressure. Open the helium supply to backfill the cask to 1 atm absolute (0 psig).

6. Immediately after achieving 1 atm in the cavity, monitor the MSLD output for at least 30 seconds. The leakage rate (increase above background) must be $< 1 \times 10^{-7}$ std-cm^3/s. (Note: if the cask cavity contains less than 100% helium, as determined from the cavity pressure before backfilling, the leakage measured by the MSLD must be divided by the fraction of helium.)

8.1.3.3 DU Cavity. The DU cavity shall be tested for leakage through the cask cavity liner. For this test a leakage rate of less than 1×10^{-7} std-cm^3/s is sufficient to show that the cavity liner is leaktight. Therefore the test sensitivity is 5×10^{-8} std-cm^3/s.

1. Connect the MSLD to the port quick-disconnect. Using the MSLD or auxiliary pump, evacuate the DU cavity to 0.01 atm or less. Continue pumping to achieve a detector background reading low enough so that a leakage of 5×10^{-8} std-cm^3/s could be clearly observed.

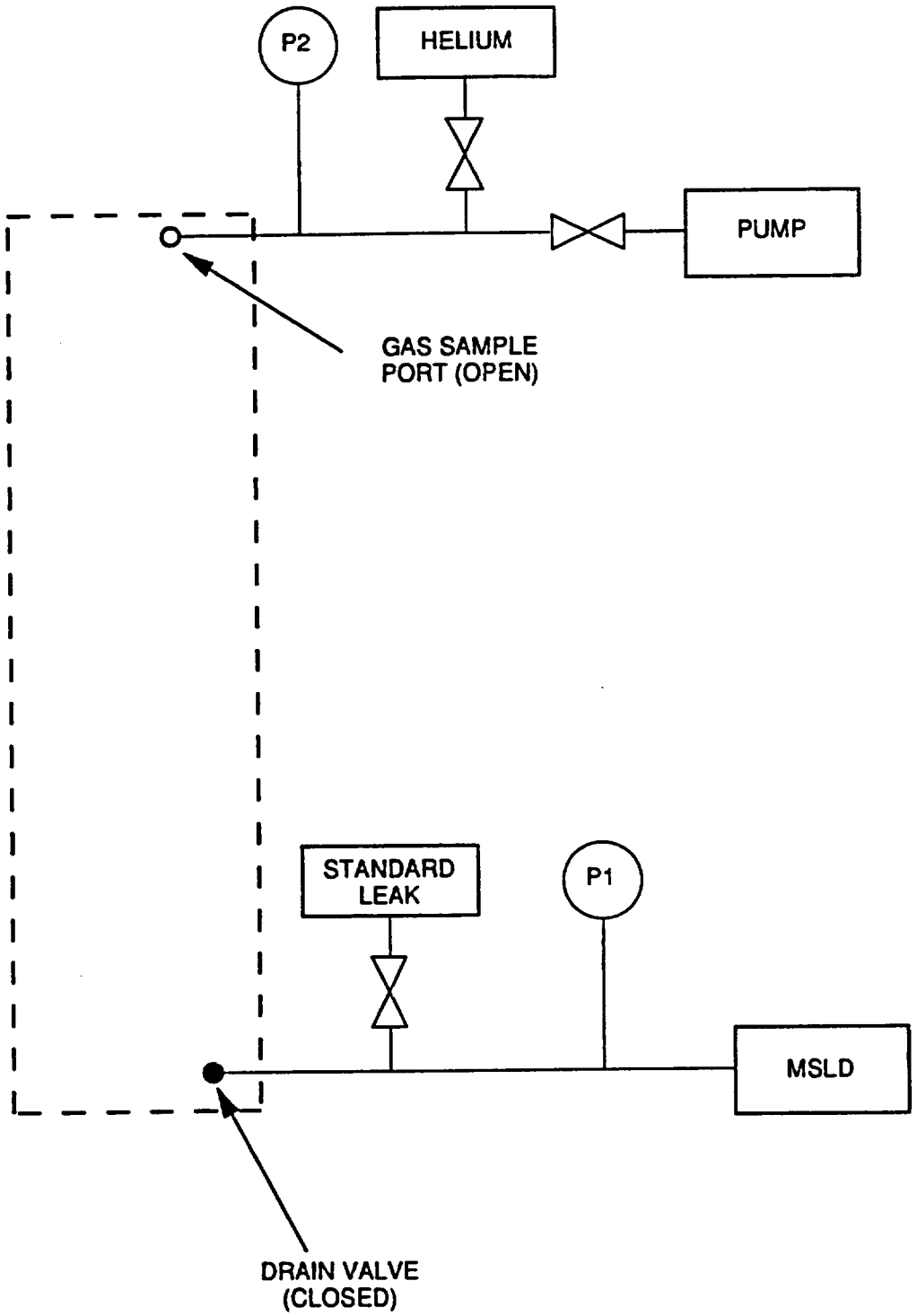

Fig. 8.1-2. Testing of drain valve seals

2. Form an envelope for helium in the cask cavity by taping plastic or other suitable material to the cavity liner. Tape the plastic at a point above the liner/flange weld but below the DU cavity test port. A helium supply line will penetrate the plastic.

3. Calibrate the leak test system using the standard leak, following the ASME Code Section V, Article 10, Appendix V (Hood Technique). Insure that the background returns to a sufficiently low level (see step 1) after calibration.

4. Flow helium into the enclosed space until the plastic is taut.

5. Monitor the MSLD output for at least 30 seconds. The leakage rate (increase above background) must be $< 1 \times 10^{-7}$ std-cm^3/s. (Note: the leakage measured by the MSLD must be divided by the fraction of helium in the envelope, which is estimated as 0.25.)

6. Following the test, backfill the DU cavity with helium to 1 atm absolute.

7. Weld the cap over the DU cavity port. Perform a liquid penetrant examination of the weld.

8.1.4 Component Tests

All components that require testing will be tested to show that they operate according to their design requirements. Any component that does not perform according to its design requirements will be rejected and replaced.

8.1.4.1 Valves, Rupture Discs, and Fluid Transport Devices. This cask does not require rupture discs. The gas sample port and drain valve perform a safety function when they are fully engaged in that they form a part of the containment boundary. However, a test is not required since the thermal and structural loading on them is insignificant and their design adequacy can be shown by analysis. The quick-disconnects attached to the gas sample port plug and drain valve are not part of the containment boundary and are used only for seal leakage testing, venting, vacuum drying, or inerting. The drain plug is not part of the containment boundary and is used only for shielding; therefore, it also does not need to be tested.

8.1.4.2 Gaskets. An acceptance test of the seals is not required other than the Containment System Fabrication Verification Leakage Test. Section 4.5.1 describes the successful design verification test that was performed on the ethylene propylene O-ring seals specified in the drawings in Section 1.3. The seals were tested in a test article with the same configuration as shown in the drawings in Section 1.3 and under conditions simulating the most severe service conditions under which the O-rings are to perform.

8.1.4.3 Aluminum Honeycomb. The impact limiters contain aluminum honeycomb with nominal crush strengths of 220 psi, 725 psi, and 1400 psi. Tests are required to verify that the nominal crush strength is within a range of plus or minus 12½% of the nominal value over a temperature range of −20°F to 200°F. The tests required are as follows:

- Qualification tests for each honeycomb type shall be performed at –20°F, room temperature (70°F), and 200°F, to establish the temperature effect on the crush strength of each honeycomb type.

- Verification tests of each production lot of honeycomb used shall be performed at room temperature (70°F). These tests together with the temperature effects established previously shall be used to verify the crush strength requirements.

8.1.4.4 Boron Carbide. The B_4C criticality poison is inserted into drilled holes in the fuel support structure (FSS). GA specifies that the boron in the pellets be 96% enriched and the minimum density be 96% of theoretical, or .088 lb/in.^{3} The supplier of the pellets will perform testing per ASTM C791 ("Standard Methods for Chemical, Mass Spectrometric, and Spectrochemical Analysis of Nuclear-Grade Boron Carbide") or a similar procedure approved by GA to verify that the specifications are met. The minimum diameter and length of an assembled pellet stack are specified on the drawings and are consistent with the criticality analysis (Section 6). Dimensional checks on the pellets are performed by qualified inspectors. Following installation of the pellets, the FSS is radiographed to assure that all pellets have been included.

8.1.5 Tests for Shielding Integrity

The integrity of the cask's shielding will be determined during cask fabrication. The depleted uranium (DU) shield procurement specification requires that the fabricator perform a gamma scan to ensure that there are no shielding discontinuities. A continuous gamma scan will be performed at a scanning rate and grid spacing that will provide 100 percent inspection coverage. The source strength shall be sufficient to provide readings through the shielding that have a standard deviation of less than 5% 2σ. The minimum detector reading through the shielding shall be five times background. The shielding effectiveness shall be shown to be equivalent to 100 percent of the minimum DU wall thickness.

The shielding effectiveness of the steel portion of the cask wall is verified by requiring, through inspection during fabrication, that the shell thicknesses meet the drawing dimensions.

GA will require the neutron shield supplier to certify that the material meets the minimum requirements for hydrogen and boron content. In addition, we will perform an independent chemical analysis of the neutron shield as an overcheck. The minimum requirements are the values used in the shielding analysis (Section 5) and are as follows:

Hydrogen	6.28×10^{22} atoms/cm^3 @ 180°F,
Boron	1% by weight.

The bulk neutron shield temperature at maximum normal conditions is 172°F. For conservatism, GA specifies that the minimum density must be met at 180°F.

After assembly of the cask, detailed gamma and neutron dose readings will be obtained from a first-use test with loaded fuel. The dose readings shall be below the limits given in 10 CFR Part 71.47 when the source term is scaled up to the design basis fuel source.

8.1.6 Thermal Acceptance Test

After fabrication of the first unit, GA will perform a thermal acceptance test to verify the heat rejection capability of the packaging. The test will be conducted with the cask in a horizontal (transport) condition. Four electrical heaters, each producing 600–620 Watts, will be inserted into the cavity chambers. The heater dimensions will approximate those of a fuel assembly. Thermocouples will measure the surface temperatures of the fuel support structure (FSS) and cavity liner at a minimum of six points. One thermocouple will measure the temperature at the cavity top, on the bottom surface of the test lid. The cask will be backfilled with air rather than helium, and an insulated test lid will be used instead of the closure to allow penetrations for instrumentation. The DU cavity will be backfilled with helium as in the normal configuration. Temperatures on the outer skin will be determined at the same axial locations as the internal points, using 2 thermocouples per axial location. The ambient temperature will also be measured.

After initiating power to the heaters, the thermocouple output and heater power will be recorded every 30 minutes, at a minimum. The test will continue until a steady-state condition has been reached, as evidenced by the response of the internal thermocouples. Based on the thermal analysis, this is expected to require approximately 100 hr (4 days).

In order to correlate test results with analytical predictions, the transient thermal analysis documented in Section 3.4 will be repeated using actual test conditions:

1) Electrical heaters instead of fuel assemblies,
2) Air as cavity gas instead of helium,
3) Test lid instead of closure, and
4) Measured ambient temperature as boundary condition.

The packaging will be considered thermally acceptable if no measured temperature exceeds its predicted value. If this criterion is not met, the thermal evaluation of Section 3.4 shall be modified to account for the test results. If the revised thermal evaluation shows all temperatures are still within acceptable limits, the packaging will be considered thermally acceptable.

8.2 Maintenance Program

This section describes the scheduled maintenance operations required for the safe and efficient use of the GA-4 cask. The annual program, summarized in Table 8.2-1, shall have been performed within the preceding 12-month period before the cask is used. When the cask is not used for more than a year, the annual maintenance is not required until its next use.

8.2.1 Structural and Pressure Tests

The neutron shield cavity will be tested annually for pressure and leakage using the procedure outlined in Section 8.1.2.3. The relief valve will be tested annually to verify a cracking pressure of 150 psig ± 10%.

8.2.2 Leakage Tests

8.2.2.1 Containment System Periodic Verification Leakage Test. The two O-ring seals at the closure/seal/flange interface, the two O-ring seals on the gas sample port, and all primary and secondary drain valve and drain plug O-rings shall be replaced after the third use of the cask and before the containment system's periodic verification leakage test which is performed annually. To meet the containment criteria defined in Chapter 4, the cask shall have been tested within the preceding 12-month period before the cask is used. The test procedure must have a minimum sensitivity of 5×10^{-8} std-cm^3/s, and the maximum measured leakage of any primary seal shall not exceed 1.0×10^{-7} std-cm^3/s. Section 8.1.3.2 gives the procedures that may be followed.

8.2.2.2 Containment System Assembly Verification Leakage Test. Before each shipment, a leakage test is required of the primary O-ring seals at the closure/seal/flange interface, the drain valve, and the gas sample port. This test is performed after final installation of the cask lid and final closure of the gas sample port and drain valve. A gas pressure rise test that shows there is no leakage, measured to a sensitivity of 1×10^{-3} std-cm^3/s, shall be performed. Section 7.1.1.4, Steps 16 and 17 give the procedures that may be followed. If a seal has been replaced, a periodic verification leakage test is required.

8.2.2.3 Neutron Shield Cavity Periodic Verification Leakage Test. Annual leakage testing of the neutron shield cavity is included with the pressure test required in Section 8.2.1 and described in Section 8.1.2.3.

TABLE 8.2-1
ANNUAL MAINTENANCE PROGRAM

Requirement	Inspection and Test
Visual inspection	Inspect cask and components to ensure that they are in unimpaired physical condition. Verify that the liner has no bulges, cracks or other indications that it has been damaged.
Subsystem maintenance	Inspect fasteners; impact limiters; neutron shield outer skin; gas sample port plug and drain valve and their quick-disconnects; and lifting and tiedown trunnions for damage. Replace wear surfaces if function is impaired. Replace closure bolts and impact limiter bolts every 20 years.
Neutron shield cavity pressure test	Pressure and leak test at 1.25 times relief valve setting. [Proprietary Information]
Containment system periodic verification leakage test	Closure, drain valve, and gas sample port primary O-ring seals: 1.00 x 10^{-7} std-cm^3/s allowable leakage rate; replace O-rings before test.
Neutron shielding test	Boron content 1% minimum; freezing point below –40°F.

8.2.3 Subsystem Maintenance

This section describes the inspection and replacement of package components. All replaced or repaired parts shall meet the same requirements as the original part, as specified in the fabrication drawing.

8.2.3.1 Fasteners. All fasteners shall be given a careful visual examination before each shipment. During the annual maintenance fasteners and threaded inserts shall be given a careful examination. Any fasteners with damaged heads or threads which affect the fastener performance such as broken threads or the torque wrench slips off the head, shall be replaced. The closure bolts and impact limiter bolts shall be replaced every 20 years.

8.2.3.2 Impact Limiters. The exterior of the impact limiters shall be visually inspected before each shipment and during the annual inspection to ensure that they are in unimpaired physical condition, with the exception of superficial defects such as marks or dents.

8.2.3.3 Lifting and Tiedown Trunnions. The lifting and tiedown trunnions will be visually examined for damage upon the arrival of the cask at each destination. If a trunnion wear surface is found to have significant damage or excessive wear, the wear surfaces shall be replaced.

8.2.4 Valves and O-ring Seals on the Containment Vessel

8.2.4.1 Gas Sample Port. The gas sample port assembly and the associated plug shall be disassembled and given a careful visual examination as part of the annual inspection and maintenance program.

O-ring seals shall be replaced and any damaged parts shall be repaired or replaced if their performance has been affected. Repaired or replaced parts shall meet the same requirements as the original part, as specified in the fabrication drawing.

8.2.4.2 Drain Valve and Drain Plug. The drain valve and drain plug shall be disassembled and given a careful visual examination as part of the annual inspection and maintenance program. O-rings shall be replaced, and damaged parts shall be repaired or replaced if their performance has been affected. Repaired or replaced parts shall meet the same requirements as the original part, as specified in the fabrication drawing.

8.2.4.3 Closure O-ring Seals. The closure O-ring seals shall be replaced before the containment system periodic verification leakage test. Replacement of O-ring seals shall be in accordance with the specifications in the fabrication drawing.

8.2.5 Shielding

The depleted-uranium gamma shield does not require any planned maintenance.

Proprietary Information

8.2.6 Thermal

The GA-4 cask design and maintenance prevent deterioration of the heat transfer mechanisms over time. Since the helium in the DU cavity is relied on for heat transfer, this cavity is welded closed following its leakage test (Section 8.1.3.3). The helium is thus sealed in the cavity and will not permeate steel. [Proprietary Information] A complete thermal test of the cask is therefore not required as part of the planned maintenance.

8.2.7 Miscellaneous

The exterior of the package shall be inspected before each shipment and during the annual inspection to ensure that the package is in an unimpaired physical condition, with the exception of superficial defects such as marks or dents.

No other planned inspection or maintenance is required.