CALCULATION COVER PAGE

CALCULATION NUMBER: 1043-9 NO. OF PAGES 17

PROJECT: TN-40

TITLE: Evaluation of TN-40 Gask with BPRA & Thimble Plug Assemblies

Revision 0

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Revision 1

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PREPARED BY	DATE 12-31-1998	TITLE Evaluation of TN-40 Cask with BPRA & Thimble Plug Assemblies	SHEET 1 OF 17
CHECKED BY	DATE 5/28/99		CALC. NO 1043-9
			REV. 0

1.0 Purpose

To evaluate the TN-40 cask containing design basis fuel assemblies (40) with Thimble Plug Assemblies (TPAs) or Burnable Poison Rod Assemblies (BPRAs).

2.0 References

2.1 TN Calculation 1043-8, TN40 Source Terms- from BPRAs and TPAs.

2.2 QAD-CGGP (CCC-493) Computer Code, Radiation Shielding Information Center, Oak Ridge National Laboratory.

2.3 TN Calculation 1042-8, TN40 Primary Gamma Shielding.

2.4 SCALE 4.3, Modular Code System for Performing Standardized Computer Analyses for Licensing Evaluation for Workstations and Personal Computers, CCC-545, ORNL.

2.5 Computer Files : TN40qadf-1, TN40plen-1, TN40tfitt-1, tpaplen-1, tpatfitt-1

2.6 E-14797, "Test Plan for Qualifying the SCALE-4.3 Computer Program on the Transnuclear HP 9000/715 Workstation."

2.7 E-14798, "Test Report for Qualification of the SCALE-4.3 Computer Program on the Transnuclear HP 9000/715 Workstation."

2.8 TN Calculation 1042-30, "TN-40 Containment Analysis for Pressure & Leakage Rates."

2.9 TN Calculation 1042-07, "Source Terms for the TN-40 Cask."

2.10 Croff, et al, "Revised Uranium-Plutonium Cycle PWR and BWR Models for the ORIGEN Computer Code," ORNL/TM-6051, September 1978.

3.0 Methodology and Assumptions

3.1 Dose Rate

3.3 Cask Cavity Pressure

Reevaluate the cask cavity pressure due to additional gas (BPRAs) and/or reduced cavity volume from the inserted BPRAs and TPAs.

4.0 Calculation

4.3 Internal Pressure

Both the BPRAs and the TPAs have some effect on cask pressurization. First they both displace cavity free volume. Second, the BPRAs have a gas contained inside their rods which if ruptured can add to the cavity pressure. Since the BPRA has a larger displacement volume and could contribute additional gas to the cavity, it is the limiting case.

Volume of BPRAs (Ref 2.1 and 2.10):

top fitting – 2.468E3 (g SS034) / 8.02 (g/cc) = 308 cc/assembly
spring - 358 (g Inconel) / 8.19 (g/cc) = 44 cc/assembly
rods - 16 x $\pi(0.2155^2)$ x 152.37 = 355.7 in^3 = 5826 cc/assembly (Attachment B)

Total = 6178 cc/assembly x 40 = 2.471E5 cc/cask = 0.247 m^3/cask

From Ref 2.8, the free cavity volume of the TN-40 cask is 6.35 m^3. Therefore with 40 BPRA inserts installed into the fuel assemblies, the cavity free volume becomes 6.10 m^3.

Volume of gas in BPRAs:

The gas generated within the BPRA rods is from the reaction of B^{10} to produce He^4 through the reaction $B^{10}(n,\alpha)Li^7$. If we conservatively assume that all of the atoms are depleted and each atom produces an atom of He, we can calculate the amount of He gas produced by knowing the B^{10} loading of the BPRA rod. From Ref 2.1, Attachment B, the nominal B^{10} loading is given as 0.01928 g B^{10} per inch of rod height. The rod height is given in Attachment B as 142.68 inches, giving a value of 2.75 g B^{10}/rod. We therefore have:

2.75 (g B^{10}/rod) x 6.023E23 (atm/g-atm) / 10 (g B^{10}/g-atm) = 1.66E23 atm B^{10}/rod

If each atom of B^{10} produces an atom of He, the number of atoms of He produced in a 16 rod BPRA is:

1.66E23 x 16 = 2.66E24 atm He/assembly

For the cask, the amount of He gas that could be available for release is:

2.66E24 atm/assembly x 40 assembly / 6.023E23 atms/mole = 177 moles He/cask

or 177 moles x 22.4 L/mole = 3.96E3 L He = 3.96 m^3 He at STP.

From Ref 2.8, the partial pressure from 100% fuel failure and He released from the BPRAs is:

$$P_{fg} = 1.0 \text{ atm} \times \frac{(9.04 \text{ m}^3 + 3.96 \text{ m}^3)}{6.10 \text{ m}^3} \times \frac{899 \ ^0\text{R}}{492 \ ^0\text{R}} = 3.89 \text{ atm}$$

and the total cavity pressure is $P_T = 2.16 + 3.89 = 6.05$ atm (88.9 psia)

5.0 Results

6.0 Conclusions

The bounding case of 40 BPRAs in the TN-40 cask has been evaluated and it has been shown that the internal pressure from the accident condition would increase the previously calculated internal pressure from 70.0 psia to 88.9 psia. However, this pressure is still below the design pressure of 100 pisg.

EXHIBIT B

PRAIRIE ISLAND INDEPENDENT SPENT FUEL STORAGE INSTALLATION

Response to October 20, 1999, Request for Additional Information on License Amendment Request dated August 31, 1999

ORIGEN2 Input File "TN40ORIGTPA" referenced in TransNuclear Calculation 1043-8, "TN-40 Source Terms - from BPRAs and TPAs"

Input Listing: 4 pages

```
SLIST TN40ORIGTPA.INP

  -1
  -1
  -1
  RDA   INPUT MODIFIED TO INCLUDE PLENUM SPRING  8/91
  BAS     ONE METRIC TON OF PWRU FUEL
  RDA     -1 = FRESH U FUEL WITH IMPURITIES (1 MT)
  RDA     -2 = FRESH ZIRCALOY COMPOSITION (1 KG)
  RDA     -3 = FRESH SS 304 COMPOSITION (1 KG)
  RDA     -4 = FRESH INCONEL COMPOSITION (1 KG)
  RDA   DETERMINE IRRADIATED TPA INSERTS SOURCE USING
  RDA   45,000 MWD/MTU BURNUP AND CORRECTION FACTORS FROM
  RDA   LUSEC - PNL REPORT 0.1 TOP AND 0.2 PLENUM
  RDA     WARNING:  VECTORS ARE OFTEN CHANGED WITH RESPECT TO THEIR CONTENT.
  RDA               THESE CHANGES WILL BE NOTED ON RDA CARDS.
  CUT     5 0.01 -1
  LIP     0 0 0
  LIB   0 1 2  3  219  220  221 39 33  0 1 9
  PHO     101  102   103  40
  TIT     INITIAL COMPOSITIONS OF UNIT AMOUNTS OF FUEL AND STRUCT MAT'LS
  RDA     READ  FUEL  COMPOSITION INCLUDING IMPURITIES (1000 KG)
  INP     -1  1  -1 -1 1 1
  RDA     READ  ZIRCALOY COMPOSITION (1.0 KG)
  INP     -2  1  -1 -1 1 1
  RDA     READ  SS304 COMPOSITION (1.0 KG)
  INP     -3  1  -1 -1 1 1
  RDA     READ INCONEL 718 COMPOSITION (1.0 KG)
  INP     -4  1  -1 -1 1 1
  TIT     IRRADIATION OF ONE METRIC TON OF PWRU FUEL,STRUCTURE & TPA -3.85% U-235
  MOV     -1 1 0 1.0
  ADD     -2 1 0 257.56      ZIRCALLOY
  ADD     -4 1 0 3.68       INCONEL
  HED     1                                                    CHARGE
  BUP
  IRP     40.0     37.5   1   2    4 2
  IRP     80.0     37.5   2   3    4 0
  IRP    120.0     37.5   3   4    4 0
  IRP    160.0     37.5   4   5    4 0
  IRP    200.0     37.5   5   6    4 0
  IRP    240.0     37.5   6   7    4 0
  IRP    280.0     37.5   7   8    4 0
  IRP    320.0     37.5   8   9    4 0
  IRP    360.0     37.5   9  10    4 0
  IRP    400.0     37.5  10   2    4 0   END OF THIS STEP=15,000 MWD/MTU
  DEC    430.0           2   3    4 0   END OF FIRST CYCLE
  IRP    470.0     37.5   3   4    4 0
  IRP    510.0     37.5   4   5    4 0
  IRP    550.0     37.5   5   6    4 0
  IRP    590.0     37.5   6   7    4 0
  IRP    630.0     37.5   7   8    4 0
  IRP    670.0     37.5   8   9    4 0
  IRP    710.0     37.5   9  10    4 0
  IRP    750.0     37.5  10  11    4 0
  IRP    790.0     37.5  11  12    4 0
  IRP    830.0     37.5  12   4    4 0   END OF THIS STEP=30,000 MWD/MTU
  DEC    860.0           4   5    4 0   END OF SECOND CYCLE
```

```
IRP     900.0      37.5    5    7     4 0
IRP     940.0      37.5    7    6     4 0
IRP     980.0      37.5    6    8     4 0
IRP    1020.0      37.5    8    7     4 0
IRP    1060.0      37.5    7    9     4 0
IRP    1100.0      37.5    9    8     4 0
IRP    1140.0      37.5    8   10     4 0
IRP    1180.0      37.5   10    9     4 0
IRP    1220.0      37.5    9   11     4 0
IRP    1260.0      37.5   11   10     4 0   END OF THIS STEP=45,000 MWD/MTU
BUP
OPTL     8 8 8 8 7 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8
OPTA     8 8 8 8 7 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8
OPTF     8 8 8 8 7 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8
OUT      10  1  -1  0
RDA      -10 = IRRADIATED FUEL ZONE AT DISCHARGE
MOV      10 -10 0 1.0
RDA         IRRADIATION OF TPA TOP
MOV      -3  1 0 2.468        SS304
ADD      -4  1 0 0.358      INCONEL
HED  1          CHARGE
IRF      40.0     -0.100    1    2     4 2
IRF      80.0     -0.100    2    3     4 0
IRF     120.0     -0.100    3    4     4 0
IRF     160.0     -0.100    4    5     4 0
IRF     200.0     -0.100    5    6     4 0
IRF     240.0     -0.100    6    7     4 0
IRF     280.0     -0.100    7    8     4 0
IRF     320.0     -0.100    8    9     4 0
IRF     360.0     -0.100    9   10     4 0
IRF     400.0     -0.100   10    2     4 0   END OF THIS STEP=15,000 MWD/MTU
DEC     430.0               2    3     4 0   END OF FIRST CYCLE
IRF     470.0     -0.100    3    4     4 0
IRF     510.0     -0.100    4    5     4 0
IRF     550.0     -0.100    5    6     4 0
IRF     590.0     -0.100    6    7     4 0
IRF     630.0     -0.100    7    8     4 0
IRF     670.0     -0.100    8    9     4 0
IRF     710.0     -0.100    9   10     4 0
IRF     750.0     -0.100   10   11     4 0
IRF     790.0     -0.100   11   12     4 0
IRF     830.0     -0.100   12    4     4 0   END OF THIS STEP=30,000 MWD/MTU
DEC     860.0               4    5     4 0   END OF SECOND CYCLE
IRF     900.0     -0.100    5    7     4 0
IRF     940.0     -0.100    7    6     4 0
IRF     980.0     -0.100    6    8     4 0
IRF    1020.0     -0.100    8    7     4 0
IRF    1060.0     -0.100    7    9     4 0
IRF    1100.0     -0.100    9    8     4 0
IRF    1140.0     -0.100    8   10     4 0
IRF    1180.0     -0.100   10    9     4 0
IRF    1220.0     -0.100    9   11     4 0
IRF    1260.0     -0.100   11   10     4 0   END OF THIS STEP=45,000 MWD/MTU
RDA         -9 = IRRADIATED TPA TOP AT DISCHARGE
MOV      10  -9  0 1.0
```

```
RDA    IRRADIATION OF THE TPA PLENUM
MOV      -3  1  0 2.177      SS304
HED  1      CHARGE
IRF     40.0    -2.00      1   2     4 2   FLUX CORRECTION FACTOR  0.2/0.1
IRF     80.0    -2.00      2   3     4 0
IRF    120.0    -2.00      3   4     4 0
IRF    160.0    -2.00      4   5     4 0
IRF    200.0    -2.00      5   6     4 0
IRF    240.0    -2.00      6   7     4 0
IRF    280.0    -2.00      7   8     4 0
IRF    320.0    -2.00      8   9     4 0
IRF    360.0    -2.00      9  10     4 0
IRF    400.0    -2.00     10   2     4 0   END OF THIS STEP=15,000 MWD/MTU
DEC    430.0               2   3     4 0   END OF FIRST CYCLE
IRF    470.0    -2.00      3   4     4 0
IRF    510.0    -2.00      4   5     4 0
IRF    550.0    -2.00      5   6     4 0
IRF    590.0    -2.00      6   7     4 0
IRF    630.0    -2.00      7   8     4 0
IRF    670.0    -2.00      8   9     4 0
IRF    710.0    -2.00      9  10     4 0
IRF    750.0    -2.00     10  11     4 0
IRF    790.0    -2.00     11  12     4 0
IRF    830.0    -2.00     12   4     4 0   END OF THIS STEP=30,000 MWD/MTU
DEC    860.0               4   5     4 0   END OF SECOND CYCLE
IRF    900.0    -2.00      5   7     4 0
IRF    940.0    -2.00      7   6     4 0
IRF    980.0    -2.00      6   8     4 0
IRF   1020.0    -2.00      8   7     4 0
IRF   1060.0    -2.00      7   9     4 0
IRF   1100.0    -2.00      9   8     4 0
IRF   1140.0    -2.00      8  10     4 0
IRF   1180.0    -2.00     10   9     4 0
IRF   1220.0    -2.00      9  11     4 0
IRF   1260.0    -2.00     11  12     4 0   END OF THIS STEP=45,000 MWD/MTU
RDA     DECAY  MODULE
TIT    DECAY OF IRRADIATED FUEL ZONE    BURNUP = 45,000  MWD/MTU
MOV  -10  1  0  1.0      IRRADIATED FUEL ZONE
MOV  12  -10  0  1.0     STORE IRRATIATED TPA PLENUM AT DISCHARGE
HED  1      DISCHARGE
DEC      9.0       1   2    5  4
DEC     10.0       2   3    5  0
DEC     11.0       3   4    5  0
DEC     12.0       4   5    5  0
DEC     13.0       5   6    5  0
DEC     14.0       6   7    5  0
DEC     16.0       7   8    5  0
DEC     18.0       8   9    5  0
DEC     20.0       9  10    5  0
DEC     22.0      10  11    5  0
DEC     24.0      11  12    5  0
OPTL   8 8 8 8 7 8 7 8 7 8 8 8 8 8 8 8 8 8 8 8 8 8 8
OPTA   8 8 8 8 7 8 7 8 7 8 8 8 8 8 8 8 8 8 8 8 8 8 8
OPTF   8 8 8 8 7 8 7 8 7 8 8 8 8 8 8 8 8 8 8 8 8 8 8
OUT      -12   1  -1  0
```

```
TIT         DECAY OF IRRADIATED TPA TOP FITTINGS
MOV  -9   1  0  1.0   IRRADIATED TPA TOP FITTINGS AT DISCHARGE
HED    1        DISCHARGE
DEC       9.0       1   2   5  4
DEC      10.0       2   3   5  0
DEC      11.0       3   4   5  0
DEC      12.0       4   5   5  0
DEC      13.0       5   6   5  0
DEC      14.0       6   7   5  0
DEC      16.0       7   8   5  0
DEC      18.0       8   9   5  0
DEC      20.0       9  10   5  0
DEC      22.0      10  11   5  0
DEC      24.0      11  12   5  0
OPTL   8 8 8 8 7 8 7 8 7 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8
OUT       -12   1  -1  0
TIT         DECAY OF IRRATIATED TPA PLENUM
MOV      -10   1  0  1.0   IRRADIATED TPA PLENUM AT DISCHARGE
HED   1   DISCHARGE
DEC       9.0       1   2   5  4
DEC      10.0       2   3   5  0
DEC      11.0       3   4   5  0
DEC      12.0       4   5   5  0
DEC      13.0       5   6   5  0
DEC      14.0       6   7   5  0
DEC      16.0       7   8   5  0
DEC      18.0       8   9   5  0
DEC      20.0       9  10   5  0
DEC      22.0      10  11   5  0
DEC      24.0      11  12   5  0
OPTL   8 8 8 8 7 8 7 8 7 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8
OUT       -12   1  -1  0
END
2   922340  290.0  922350 38500.0  922380  961210.0  0 0.0     FUEL ACTINIDES
4   030000  1.0    050000 1.0       060000  89.4      070000 25.0    FUEL IMPUR
4   080000 134454.0 090000 10.7     110000  15.0      120000  2.0    FUEL IMPUR
4   130000 16.7    140000 12.1      150000  35.0      170000  5.3    FUEL IMPUR
4   200000 2.0     220000 1.0       230000  3.0       240000  4.0    FUEL IMPUR
4   250000 1.7     260000 18.0      270000  1.0       280000  24.0   FUEL IMPUR
4   290000 1.0     300000 40.3      420000  10.0      470000  0.1    FUEL IMPUR
4   480000 25.0    490000 2.0       500000  4.0       640000  2.5    FUEL IMPUR
4   740000 2.0     820000 1.0       830000  0.4       0       0.0    FUEL IMPUR
0
4   400000 979.11  500000 16.0      260000  2.25      240000  1.25     ZIRC-4
4   280000 0.02    130000 0.024     050000  0.00033   480000  0.00025  ZIRC-4
4   060000 0.120   270000 0.010     290000  0.020     720000  0.078    ZIRC-4
4   010000 0.013   250000 0.020     070000  0.080     080000  0.950    ZIRC-4
4   160000 0.035   220000 0.020     740000  0.020     230000  0.020    ZIRC-4
5   920000 0.0002  0      0.0                                        ZIRC-4
0
4   260000 688.44  240000 190.0     280000 89.2       250000 20.0      SS-304
4   060000 0.8     150000 0.45      160000 0.3        140000 10.0      SS-304
4   070000 1.3     270000 0.8       0      0.0                       SS-304
0
4   260000 179.8   240000 189.8     280000 519.6      130000 6.0       INC-718
4   060000 0.4     270000 4.69      290000 1.0        250000 2.0       INC-718
4   420000 29.96   070000 1.3       410000 55.46      160000 0.07      INC-718
4   140000 2.0     220000 8.0       0      0.0                       INC-718
0
```

EXHIBIT C

PRAIRIE ISLAND INDEPENDENT SPENT FUEL STORAGE INSTALLATION

Response to October 20, 1999, Request for Additional Information on License Amendment Request dated August 31, 1999

ORIGEN2 Input File "TN40ORIGBPRA" referenced in TransNuclear Calculation 1043-8, "TN-40 Source Terms - from BPRAs and TPAs"

Input Listing: 4 pages

```
SLIST TN40ORIGBPRA.INP

  -1
  -1
  -1
  RDA   INPUT MODIFIED TO INCLUDE PLENUM SPRING  8/91
  BAS     ONE METRIC TON OF PWRU FUEL
  RDA     -1 = FRESH U FUEL WITH IMPURITIES (1 MT)
  RDA     -2 = FRESH ZIRCALOY COMPOSITION (1 KG)
  RDA     -3 = FRESH SS 304 COMPOSITION (1 KG)
  RDA     -4 = FRESH INCONEL COMPOSITION (1 KG)
  RDA  DETERMINE IRRADIATED BPRA INSERTS SOURCE USING
  RDA  30,000 MWD/MTU BURNUP AND CORRECTION FACTORS FROM
  RDA   LUSEC - PNL REPORT 0.1 TOP AND 0.2 PLENUM
  RDA     WARNING:  VECTORS ARE OFTEN CHANGED WITH RESPECT TO THEIR CONTENT.
  RDA               THESE CHANGES WILL BE NOTED ON RDA CARDS.
  CUT     5 0.01 -1
  LIP     0 0 0
  LIB   0 1 2  3  204  205  206 39 33  0 1 1
  PHO     101  102   103  40
  TIT     INITIAL COMPOSITIONS OF UNIT AMOUNTS OF FUEL AND STRUCT MAT'LS
  RDA     READ  FUEL  COMPOSITION INCLUDING IMPURITIES (1000 KG)
  INP     -1  1  -1 -1 1 1
  RDA     READ  ZIRCALOY COMPOSITION (1.0 KG)
  INP     -2  1  -1 -1 1 1
  RDA     READ  SS304 COMPOSITION (1.0 KG)
  INP     -3  1  -1 -1 1 1
  RDA     READ INCONEL 718 COMPOSITION (1.0 KG)
  INP     -4  1  -1 -1 1 1
  TIT     IRRADIATION OF ONE METRIC TON OF PWRU FUEL,STRUCTURE & BPRA -3.85% U-235
  MOV     -1 1 0 1.0
  ADD     -2 1 0 257.56      ZIRCALLOY
  ADD     -4 1 0 3.68       INCONEL
  ADD     -3 1 0 7.96       SS304 (BPRA RODS)
  HED     1                                                    CHARGE
  BUP
  IRP     40.0     37.5   1   2    4 2
  IRP     80.0     37.5   2   3    4 0
  IRP    120.0     37.5   3   4    4 0
  IRP    160.0     37.5   4   5    4 0
  IRP    200.0     37.5   5   6    4 0
  IRP    240.0     37.5   6   7    4 0
  IRP    280.0     37.5   7   8    4 0
  IRP    320.0     37.5   8   9    4 0
  IRP    360.0     37.5   9  10    4 0
  IRP    400.0     37.5  10   2    4 0   END OF THIS STEP=15,000 MWD/MTU
  DEC    430.0           2   3    4 0   END OF FIRST CYCLE
  IRP    470.0     37.5   3   4    4 0
  IRP    510.0     37.5   4   5    4 0
  IRP    550.0     37.5   5   6    4 0
  IRP    590.0     37.5   6   7    4 0
  IRP    630.0     37.5   7   8    4 0
  IRP    670.0     37.5   8   9    4 0
  IRP    710.0     37.5   9  10    4 0
  IRP    750.0     37.5  10  11    4 0
  IRP    790.0     37.5  11  12    4 0
  IRP    830.0     37.5  12  10    4 0   END OF THIS STEP=30,000 MWD/MTU
  BUP
```

```
OPTL    8 8 8 8 7 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8
OPTA    8 8 8 8 7 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8
OPTF    8 8 8 8 7 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8
OUT     10  1  -1  0
RDA     -10 = IRRADIATED FUEL ZONE AT DISCHARGE
MOV     10 -10 0 1.0
RDA        IRRADIATION OF BPRA TOP
MOV     -3  1 0 2.468       SS304
ADD     -4  1 0 0.358     INCONEL
HED  1        CHARGE
IRF     40.0     -0.100   1   2    4 2
IRF     80.0     -0.100   2   3    4 0
IRF    120.0     -0.100   3   4    4 0
IRF    160.0     -0.100   4   5    4 0
IRF    200.0     -0.100   5   6    4 0
IRF    240.0     -0.100   6   7    4 0
IRF    280.0     -0.100   7   8    4 0
IRF    320.0     -0.100   8   9    4 0
IRF    360.0     -0.100   9  10    4 0
IRF    400.0     -0.100  10   2    4 0   END OF THIS STEP=15,000 MWD/MTU
DEC    430.0              2   3    4 0   END OF FIRST CYCLE
IRF    470.0     -0.100   3   4    4 0
IRF    510.0     -0.100   4   5    4 0
IRF    550.0     -0.100   5   6    4 0
IRF    590.0     -0.100   6   7    4 0
IRF    630.0     -0.100   7   8    4 0
IRF    670.0     -0.100   8   9    4 0
IRF    710.0     -0.100   9  10    4 0
IRF    750.0     -0.100  10  11    4 0
IRF    790.0     -0.100  11  12    4 0
IRF    830.0     -0.100  12  10    4 0   END OF THIS STEP=30,000 MWD/MTU
RDA        -9 = IRRADIATED END FITTINGS AT DISCHARGE
MOV      10  -9  0 1.0
RDA    IRRADIATION OF THE BPRA PLENUM
MOV      -3  1  0  0.421     SS304
HED  1      CHARGE
IRF     40.0    -2.00   1   2    4 2   FLUX CORRECTION FACTOR  0.2/0.1
IRF     80.0    -2.00   2   3    4 0
IRF    120.0    -2.00   3   4    4 0
IRF    160.0    -2.00   4   5    4 0
IRF    200.0    -2.00   5   6    4 0
IRF    240.0    -2.00   6   7    4 0
IRF    280.0    -2.00   7   8    4 0
IRF    320.0    -2.00   8   9    4 0
IRF    360.0    -2.00   9  10    4 0
IRF    400.0    -2.00  10   2    4 0   END OF THIS STEP=15,000 MWD/MTU
DEC    430.0             2   3    4 0   END OF FIRST CYCLE
IRF    470.0    -2.00   3   4    4 0
IRF    510.0    -2.00   4   5    4 0
IRF    550.0    -2.00   5   6    4 0
IRF    590.0    -2.00   6   7    4 0
IRF    630.0    -2.00   7   8    4 0
IRF    670.0    -2.00   8   9    4 0
IRF    710.0    -2.00   9  10    4 0
IRF    750.0    -2.00  10  11    4 0
IRF    790.0    -2.00  11  12    4 0
IRF    830.0    -2.00  12   4    4 0   END OF THIS STEP=30,000 MWD/MTU
```

```
RDA     DECAY  MODULE
TIT    DECAY OF IRRADIATED FUEL ZONE    BURNUP = 30,000  MWD/MTU
MOV  -10  1  0  1.0     IRRADIATED FUEL ZONE
MOV   4  -10  0  1.0    STORE IRRATIATED PLENUM AT DISCHARGE
HED  1     DISCHARGE
DEC     16.0       1   2   5  4
DEC     18.0       2   3   5  0
DEC     19.0       3   4   5  0
DEC     20.0       4   5   5  0
DEC     21.0       5   6   5  0
DEC     22.0       6   7   5  0
DEC     23.0       7   8   5  0
DEC     24.0       8   9   5  0
DEC     26.0       9  10   5  0
DEC     28.0      10  11   5  0
DEC     30.0      11  12   5  0
OPTL   8 8 8 8 7 8 7 8 7 8 8 8 8 8 8 8 8 8 8 8 8 8 8
OPTA   8 8 8 8 3 8 7 8 7 8 8 8 8 8 8 8 8 8 8 8 8 8 8
OPTF   8 8 8 8 7 8 7 8 7 8 8 8 8 8 8 8 8 8 8 8 8 8 8
OUT      -12   1  -1  0
TIT        DECAY OF IRRADIATED BPRA TOP
MOV  -9   1  0  1.0   IRRADIATED END FITTINGS AT DISCHARGE
HED    1       DISCHARGE
DEC     16.0       1   2   5  4
DEC     18.0       2   3   5  0
DEC     19.0       3   4   5  0
DEC     20.0       4   5   5  0
DEC     21.0       5   6   5  0
DEC     22.0       6   7   5  0
DEC     23.0       7   8   5  0
DEC     24.0       8   9   5  0
DEC     26.0       9  10   5  0
DEC     28.0      10  11   5  0
DEC     30.0      11  12   5  0
OPTL   8 8 8 8 7 8 7 8 7 8 8 8 8 8 8 8 8 8 8 8 8 8 8
OUT      -12   1  -1  0
TIT        DECAY OF IRRATIATED BPRA PLENUM
MOV     -10   1  0  1.0   IRRADIATED PLENUM AT DISCHARGE
HED   1   DISCHARGE
DEC     16.0       1   2   5  4
DEC     18.0       2   3   5  0
DEC     19.0       3   4   5  0
DEC     20.0       4   5   5  0
DEC     21.0       5   6   5  0
DEC     22.0       6   7   5  0
DEC     23.0       7   8   5  0
DEC     24.0       8   9   5  0
DEC     26.0       9  10   5  0
DEC     28.0      10  11   5  0
DEC     30.0      11  12   5  0
OPTL   8 8 8 8 7 8 7 8 7 8 8 8 8 8 8 8 8 8 8 8 8 8 8
OPTA   8 8 8 8 7 8 7 8 7 8 8 8 8 8 8 8 8 8 8 8 8 8 8
OPTF   8 8 8 8 7 8 7 8 7 8 8 8 8 8 8 8 8 8 8 8 8 8 8
OUT      -12   1  -1  0
END
```

```
2   922340  290.0   922350 38500.0  922380  961210.0  0 0.0     FUEL ACTINIDES
4   030000  1.0     050000 1.0      060000  89.4      070000 25.0    FUEL IMPUR
4   080000 134454.0 090000 10.7     110000  15.0      120000  2.0    FUEL IMPUR
4   130000 16.7     140000 12.1     150000  35.0      170000  5.3    FUEL IMPUR
4   200000 2.0      220000 1.0      230000  3.0       240000  4.0    FUEL IMPUR
4   250000 1.7      260000 18.0     270000  1.0       280000  24.0   FUEL IMPUR
4   290000 1.0      300000 40.3     420000  10.0      470000  0.1    FUEL IMPUR
4   480000 25.0     490000 2.0      500000  4.0       640000  2.5    FUEL IMPUR
4   740000 2.0      820000 1.0      830000  0.4       0       0.0    FUEL IMPUR
0
4   400000 979.11   500000 16.0     260000  2.25      240000  1.25     ZIRC-4
4   280000 0.02     130000 0.024    050000  0.00033   480000  0.00025  ZIRC-4
4   060000 0.120    270000 0.010    290000  0.020     720000  0.078    ZIRC-4
4   010000 0.013    250000 0.020    070000  0.080     080000  0.950    ZIRC-4
4   160000 0.035    220000 0.020    740000  0.020     230000  0.020    ZIRC-4
5   920000 0.0002   0      0.0                                       ZIRC-4
0
4   260000 688.44   240000 190.0    280000  89.2      250000 20.0      SS-304
4   060000 0.8      150000 0.45     160000  0.3       140000 10.0      SS-304
4   070000 1.3      270000 0.8      0       0.0                        SS-304
0
4   260000 180.8    240000 190.8    280000  520.6     130000 6.0       INC-718
4   060000 0.4      270000 1.00     290000  1.0       250000 2.0       INC-718
4   420000 29.96    070000 1.3      410000  55.46     160000 0.07      INC-718
4   140000 2.0      220000 8.0      0       0.0                        INC-718
0
```