rec'd 4/7/82 AM

OAK RIDGE NATIONAL LABORATORY
OPERATED BY
UNION CARBIDE CORPORATION
NUCLEAR DIVISION

POST OFFICE BOX X
OAK RIDGE, TENNESSEE 37830

April 5, 1982

Mr. H. Lowenberg
Office of Nuclear Materials
Safety and Safeguards
U.S. Nuclear Regulatory Commission
MS-396-SS
Washington, D.C. 20555

Dear Homer:

Enclosed with this letter is the summary ORIGEN2 output for the CRBR for use by yourself and PNL. I have also enclosed a memo summarizing the scope of the output, the assumptions employed in generating it, and other potentially relevant backup information.

I received your letter concerning the meeting in Silver Springs on April 14 and 15 and I will be there on April 14 to discuss the ORIGEN2 CRBR model and to meet with you beforehand. If questions arise in the interim, give me a call at FTS 624-6147.

Sincerely,

Allen

Allen G. Croff, Manager
Engineering Analysis and Planning
Chemical Technology Division

AGC:il
2 enclosures
cc: I. Nelson, PNL (w/att. and encl.)

Attachment to letter to H. Lowenberg
dated April 5, 1982

DESCRIPTION OF THE BASIS FOR ORIGEN2 CALCULATIONS CONCERNING CRBR

This memo is intended to supply sufficient information to the users of ORIGEN2 output concerning the CRBR until a draft NUREG/CR report becomes available.

General Background and Fuel Management

A summary of the most pertinent fuel management and burnup-related parameters is given in the attached Table 2. This table is based on the average rate at which fuel is charged to the reactor over a period of several cycles such that the refueling pattern repeats itself. A more detailed depiction of the refueling sequences is given in Table 3. A copy of the core map is also included to facilitate understanding of the refueling scheme. A summary description of the reactor characteristics is given in Table 5.

Material Compositions and Descriptions

The initial actinide composition of the unirradiated, undecayed $(U,Pu)O_2$ core fuel and the UO_2 blanket fuel is given in Table 4. The nonactinide composition of the fuel material was taken from Table 9 of ref. 1.

The description of the CRBR core and blanket fuel assemblies is given in Table 6, including dimensions and overall masses. The composition of the stainless steel 316 fuel assembly structural materials was taken from Table 7 of ref. 1.

ORIGEN2 Irradiation Parameters

The various fuel zones were irradiated separately using the specific powers and residence times given in Table 2. The irradiations were continuous with no allowance for decay during refueling intervals. The fuel assembly structural materials associated directly with each fuel zone were irradiated at the same flux level as the contained fuel. Fuel assembly structural materials outside of the fuel zones were irradiated at reduced fluxes based on neutron transport calculations. All irradiations were performed on a 1.0 MT initial heavy metal basis for each fuel zone.

ORIGEN2 Decay Calculation Parameters

The decay times employed in the calculations are self-evident by inspection of the column headings in the computer output and they will not be listed here. Major assumptions and parameters used are as follows:

a. the fresh, undecayed fuel was assumed to be decayed for 2 years before irradiation,

b. the spent fuel is assumed to be reprocessed 150 days after discharge from the reactor,

c. the parameters used during reprocessing are as follows:

   i. 0.5% of the uranium and plutonium goes to the HLW,

   ii. 0.05% of the nonvolatile fuel material is retained with the cladding,

   iii. 0.69% of the fuel assembly structural material is assumed to dissolve and go to the HLW,

   iv. 0.1% of the halogen elements and none of the noble gases, tritium, and ^{14}C is assumed to be in the HLW.

d. the compositions of the HLW, structural material waste, plutonium product, and uranium product are based on "blended" fuel which is generated by weighting each of the fuel zones in proportion to the rate at which it is charged to the reactor (see first column of Table 2).

charged

ORIGEN2 Output Description

The ORIGEN2 output is comprised of several segments for different materials and/or decay times. The first two segments summarize the composition of the charged and discharged fuel and structural material for each of the fuel zones on a 1.0 MTHM basis. Only masses (grams) are given and no decay times are provided.

The next four segments decay core + core axial blanket, radial blanket, core, and inner blanket fuel assemblies, respectively. For these segments and all succeeding segments, only summary tables (defined below) are given. The table types provided are mass (grams), radioactivity (curies), thermal power (watts), inhalation hazard (m^3 air to dilut to 10 CFR 20 values), ingestion hazard (m^3 wastes to dilute to 10 CFR 20 values), and alpha radioactivity for the actinides (curies) and neutron production. Decay times range from 60 days to 10 years. All of these segments are based on one fuel assembly (not 1.0 MTHM).

The next three segments summarize the results of the assumed reprocessing of the core + core axial blanket, inner and radial blankets (including their axial omponents), and of the blended fuel from all zones of the reactor weighted as described above. The output for each fuel composite consists of columns giving the composition of the as-produced HLW, structural material waste, uranium product, plutonium product, thorium product (small or zero), and the volatiles (halogens, noble gases, tritium, ^{14}C) from 1 MTHM. The volatiles are then decayed for times between 30 days and 180 days. The table types included here are the same as those above except that the thermal power and alpha radioactivity tables have been omitted.

The next two segments decay the HLW from 1 MT blended fuel for various times. The first segnet includes decay times ranging from 10 days to 2 years. The second segment has decay times ranging from 3 years to 1 million years. It should be noted that the as-produced HLW composition is given in the leftmost column of both of these segments. The types of tables produced are the same as those for the fuel assemblies described above.

The two segments following the HLW are for the fuel assembly structural material waste from 1 MT blended fuel. The decay times and other comments pertinent to the structural material waste are exactly the same as those given for the HLW above.

The final two segments decay the recovered uranium and plutonium from 1 MT blended fuel, respectively, for times ranging from 90 days to 100 years. The types of tables produced are the same as those for the fuel assemblies described above, but only the actinides are given.

Except for the first two of the above segments, all of the output consists of ORIGEN2 summary tables. A summary table is generated by first dividing the amount of each nuclide present at a particular time by the total amount present at that time (e.g., 10^4 Ci of ^{137}Cs divided by a total radioactivity of 10^6 curies). This fraction is then tested against a cutoff fraction specified by the user. If the nuclide being tested contributes more than the cutoff fraction, the entire line is printed for that nuclide. This test is performed for each decay time (column) for the reprocessing output, HLW, structural material waste, uranium, and plutonium segments. The test is performed for all columns except the leftmost in the case of the spent fuel assembly decay (to eliminate short-lived fission products). If the test is successful (true) for any of the columns tested, the entire line is printed. Otherwise, the nuclide is not printed. A similar procedure is followed for the chemical elements. This testing procedure is conducted separately for each table type (e.g., mass, radioactivity) since the principal contributors printed in the summary table can vary widely between table types. The cutoff fraction used in the case at hand was 0.001.

References

1. A. G. Croff, J. W. McAdoo, and M. A. Bjerke, LMFBR Models for the ORIGEN2 Computer Code, ORNL/TM-7176 (October 1981).

Table 2. Details of CRBR average irradiation characteristics

Material type	Average[a] charge rate kg/cycle	Parameter: Average inventory kg heavy metal	Average power MW(t)	Average specific power MW(t)/MTIHM	Residence time full-power days	Average discharge burnup MWd/MTIHM
Core						
Fuel[b]	2645.0	5290.0	748.9	141.6	550	77,880
AB[c]	2152.9	4305.8	17.1	3.97	550	2,184
Fuel + AB	4797.9	9595.8	766.0	79.83	550	43,907
Inner blanket						
"Fuel"[d]	2240.8	4481.5	113.1	25.24	550	13,882
AB	1742.8	3485.6	13.3	3.82	550	2,101
"Fuel" + AB	3983.6	7967.1	126.4	15.87	550	8,729
Radial blankets						
Radial blanket 1						
"Fuel"	850.9	3403.6	46.6	13.7	1100	15,070
AB	661.8	2647.3	5.1	1.93	1100	2,123
"Fuel" + AB	1512.7	6050.9	51.7	8.54	1100	9,394
Radial blanket 2						
"Fuel"	748.8	3744.0	27.7	7.40	1375	10,175
AB	582.4	2912.0	3.1	1.06	1375	1,458
"Fuel" + AB	1331.2	6656.0	30.8	4.63	1375	6,366
Radial blanket 1 + 2						
"Fuel"	1599.7	7147.6	74.3	10.4	1229	12,779
AB	1244.2	5559.3	8.2	1.48	1229	1,819
"Fuel" + AB	2843.9	12,706.9	82.5	6.49	1229	7,977
Total	11,625.4	30,269.8	975	32.21		23,063

[a] Averaged over cycles 5–10.

[b] 36 in. $(Pu,U)O_2$ region.

[c] Composite of upper (14 in.) and lower (14 in.) UO_2 axial blankets.

[d] 36 in. UO_2 region at the same axial elevation as the core fuel.

Table 3. Details of the CRBR fuel cycle management for cycles 5-10

Cycle[a]	Parameter	Fuel management schedule, kg heavy metal (fuel assemblies)											
		Core			Inner blanket			Radial blanket 1			Radial blanket 2		
		Fuel[b]	AB[c]	Fuel + AB	"Fuel"[d]	AB	"Fuel" + AB	"Fuel"	AB	"Fuel" + AB	"Fuel"	AB	"Fuel" + AB
EOC4	Inventory	0	0	0 (0)	0	0	0 (0)	0	0	0 (0)	3744.0	2912.0	6656.0 (66)
BOC5	+ Charge	5190.2	4224.6	9414.8 (156)	4651.7	3618.0	8269.7 (82)	3403.6	2647.3	6050.9 (60)	0	0	0 (0)
	- Inventory	5190.2	4224.6	9414.8 (156)	4651.7	3618.0	8269.7 (82)	3403.6	2647.3	6050.9 (60)	3744.0	2912.0	6656.0 (66)
EOC5	- Discharge	0	0	0 (0)	340.4	264.7	605.1 (6)	0	0	0 (0)	3744.0	2912.0	6656.0 (66)
	- Inventory	5190.2	4224.6	9414.8 (156)	4311.3	3353.3	7664.6 (76)	3403.6	2647.3	6050.9 (60)	0	0	0 (0)
BOC6	+ Charge	199.6	162.5	362.1 (6)	0	0	0 (0)	0	0	0 (0)	3744.0	2912.0	6656.0 (66)
	- Inventory	5389.8	4387.1	9766.9 (162)	4311.3	3353.3	7664.6 (76)	3403.6	2647.3	6050.9 (60)	3744.0	2912.0	6656.0 (66)
EOC6	- Discharge	5389.8	4387.1	9766.9 (162)	4311.3	3353.3	7664.6 (76)	0	0	0 (0)	0	0	0 (0)
	- Inventory	0	0	0 (0)	0	0	0 (0)	3403.6	2647.3	6050.9 (60)	3744.0	2912.0	6656.0 (66)
BOC7	+ Charge	5190.2	4224.6	9414.8 (156)	4651.7	3618.0	8269.7 (82)	0	0	0 (0)	0	0	0 (0)
	- Inventory	5190.2	4224.6	9414.8 (156)	4651.7	3618.0	8269.7 (82)	3403.6	2647.3	6050.9 (60)	3744.0	2912.0	6656.0 (66)
EOC7	- Discharge	0	0	0 (0)	340.4	264.7	605.1 (6)	0	0	0 (0)	0	0	0 (0)
	- Inventory	5190.2	4224.6	9414.8 (156)	4311.3	3353.3	7664.6 (76)	3403.6	2647.3	6050.9 (60)	3744.0	2912.0	6656.0 (66)
BOC8	+ Charge	199.6	162.5	362.1 (6)	0	0	0 (0)	0	0	0 (0)	0	0	0 (0)
	- Inventory	5389.8	4387.1	9776.9 (162)	4311.3	3353.3	7664.6 (76)	3403.6	2647.3	6050.9 (60)	3744.0	2912.0	6656.0 (66)
EOC8	- Discharge	5389.8	4387.1	9776.9 (162)	4311.3	3353.3	7664.6 (76)	3403.6	2647.3	6050.9 (60)	0	0	0 (0)
	- Inventory	0	0	0 (0)	0	0	0 (0)	0	0	0 (0)	3744.0	2912.0	6656.0 (66)
BOC9	+ Charge	5190.2	4224.6	9414.8 (156)	4651.7	3618.0	8269.7 (82)	3403.6	2647.3	6050.9 (60)	0	0	0 (0)
	- Inventory	5190.2	4224.6	9414.8 (156)	4651.7	3618.0	8269.7 (82)	3403.6	2647.3	6050.9 (60)	3744.0	2912.0	6656.0 (66)
EOC9	- Discharge	0	0	0 (0)	340.4	264.7	605.1 (6)	0	0	0 (0)	0	0	0 (0)
	- Inventory	5190.2	4224.6	9414.8 (156)	4311.3	3353.3	7664.6 (76)	3403.6	2647.3	6050.9 (60)	3744.0	2912.0	6656.0 (66)
BOC10	+ Charge	199.6	162.5	362.1 (6)	0	0	0 (0)	0	0	0 (0)			
	- Inventory	5389.8	4387.1	9776.9 (162)	4311.3	3353.3	7664.6 (76)	3403.6	2647.3	6050.9 (60)	3744.0	2912.0	6656.0 (66)
EOC10	- Discharge	5389.8	4387.1	9776.9 (162)	4311.3	3353.3	7664.6 (76)	0	0	0 (0)	3744.0	2912.0	6656.0 (66)
	- Inventory	0	0	0 (0)	0	0	0 (0)	3403.6	2647.3	6050.9 (60)	0	0	0 (0)

[a] EOCx = end of cycle x; BOCy = beginning of cycle y.

[b] 36 in. $(Pu,U)O_2$ region.

[c] Composite of upper (14 in.) and lower (14 in.) UO_2 axial blankets.

[d] 36 in. UO_2 region at the same axial elevation as the core fuel.

Table 4. Initial compositions of 1000 kg of CRBR heavy metal

Nuclide	Material type	
	Fuel[a]	Blankets
U-235, g	1,340	2,000
U-238, g	668,660	998,000
Total uranium, g	670,000	1,000,000
Pu-236, g	0.005	
Pu-238, g	198	
Pu-239, g	283,932	
Pu-240, g	38,610	
Pu-241, g	6,600	
Pu-242, g	660	
Total plutonium, g	330,000	
Total heavy metal, g	1,000,000	1,000,000

[a]Assumes no preirradiation decay.

Table 5. Summary characteristics for the CRBR

Parameter	Fuel region(s)[a]					
	Fuel	AB	Fuel + AB	IB	RB[b]	Fuel + AB + IB + RB
Electric power, MW(e) net						
Thermal power, MW(t)	749.0	17.1	766.1	126.4	82.5	975.0
Average specific power,[c] MW(t)/MTIHM	141.6	3.97	79.8	15.9	6.49	32.21
Average fuel burnup, MWd/MTIHM	77,880	3871	43,907	8729	7977	23,063
Irradiation duration, full-power days	550	550	550	550	1229	
Refueling cycle length, full-power days	275	275	275	275	275	275
Average charge, kg/refueling cycle[d]						
^{235}U	3.5	4.3	7.8	8.0	5.7	21.5
Total uranium	1772.1	2152.9	3925.0	3983.6	2843.9	10,752
Fissile plutonium[e]	768.5	0	768.5	0	0	768.5
Total plutonium	872.9	0	872.9	0	0	872.9
Total (U + Pu)	2645.0	2152.9	4797.9	3983.6	2843.9	11,625
Average discharge, kg/refueling cycle[d]						
^{235}U	2.5	3.7	6.2	6.1	4.2	16.5
Total uranium	1669.8	2095.0	3764.8	3801.1	2690.5	10,256
Fissile plutonium[e]	624.2	51.6	675.8	141.4	123.8	941.0
Total plutonium	762.3	52.7	815.0	146.4	130.3	1091.7
Total (U + Pu)	2432.1	2147.7	4579.8	3947.5	2820.8	11,348

[a] Fuel = 36 in. $(Pu,U)O_2$ region, AB = UO_2 axial blankets associated with fuel, IB = entire inner blanket, RB = entire radial blanket.

[b] Weighted average of inner radial blanket (4 cycle residence) and outer radial blanket (5 cycle residence).

[c] Based on rated power level.

[d] Averaged over 4 cycles.

[e] $^{239}Pu + ^{241}Pu + ^{239}Np$.

Table 6. Physical characteristics of CRBR fuel assemblies

	Core and axial blanket	Inner and radial blankets
Assembly component lengths, cm		
Upper end hardware	30.4	29.2
Gas plenum	124.5	124.5
Upper axial blanket	35.6	
Core or radial blanket	91.4	162.6
Lower axial blanket	35.6	
Lower end hardware	109.2	109.2
Overall total	426.7	426.7
Fuel element total	290.6	290.6
Assembly shape	hexagonal	hexagonal
Assembly flats, cm	11.62	11.62
Fuel element arrangement	triangular	triangular
Fuel elements per assembly	217	61
Fuel element OD, cm	0.584	1.285
Fuel pellet OD, cm		
Core	0.491	
Axial blanket	0.483	
Inner and radial blanket		1.194
Fuel pellet density, % of theoretical		
Core	91.3	
Axial blanket	96.0	
Inner and radial blanket		95.6
Fuel element pitch, cm	0.731	1.378
Cladding thickness, cm	0.038	0.038
Channel thickness, cm	0.305	0.305
Channel height, cm	314	314
Circumscribed volume/assembly, m^3	0.0607	0.0607
Heavy metal/assembly, kg	60.35	100.85
MO_2 assembly, kg[b]	68.45	114.39
Stainless steel/assembly, kg	135.5	122.6
Assembly total weight, kg	204	237

[a] Based on data in ref. 10.

[b] $(Pu,U)O_2$ in the core and UO_2 axial blanket and UO_2 in the inner and radial blankets.

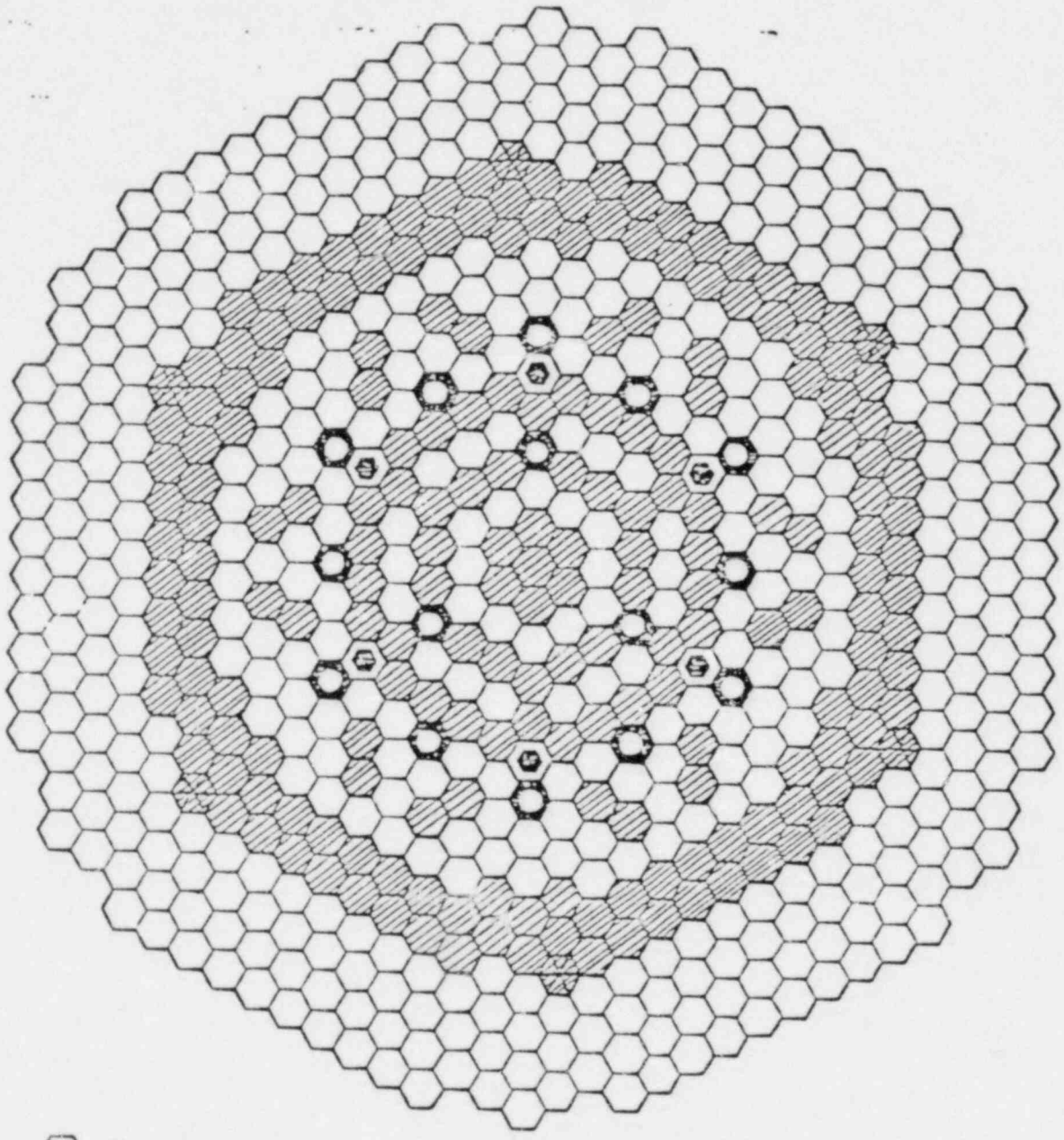

Figure 4.3-1 Clinch River Breeder Reactor Core Layout

1544-1

~~Amend. 31~~ Amend. 64
~~Sept. 1979.~~ Jan. 1982
as marked

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PAGE                    TABLE OF CONTENTS ON UNIT = 13 FOR OUTPUT UNIT = 11

  1   OUTPUT TABLES--TITLE=SUMMARY OF FUEL AND STRUCT MAT'L CHG AND DISCHG                    RECYCLE # =  0
  1           REACTIVITY AND BURNUP DATA - Core Fuel, Core Ax. Blan; Inner Blan-Fuel.
              *ACTIVATION PRODUCTS*****ACTIVATION PRODUCTS*****ACTIVATION PRODUCTS*****ACTIVATION PRODUCTS****
  2           CONCENTRATIONS, GRAMS          NUCLIDE TABLE:
 16           CONCENTRATIONS, GRAMS          ELEMENT TABLE:
 16           CONCENTRATIONS, GRAMS          SUMMARY TABLE:
              *ACTINIDES + DAUGHTERS***ACTINIDES + DAUGHTERS***ACTINIDES + DAUGHTERS***ACTINIDES + DAUGHTERS**
 20           CONCENTRATIONS, GRAMS          NUCLIDE TABLE:
 23           CONCENTRATIONS, GRAMS          ELEMENT TABLE:
 24           CONCENTRATIONS, GRAMS          SUMMARY TABLE:
              *FISSION PRODUCTS********FISSION PRODUCTS********FISSION PRODUCTS********FISSION PRODUCTS*******
 26           CONCENTRATIONS, GRAMS          NUCLIDE TABLE:
 43           CONCENTRATIONS, GRAMS          ELEMENT TABLE:
 44           CONCENTRATIONS, GRAMS          SUMMARY TABLE:
 47           (ALPHA,N) NEUTRON SOURCE
 48           SPONTANEOUS FISSION NEUTRON SOURCE

 49   OUTPUT TABLES--TITLE=SUMMARY OF FUEL AND STRUCT MAT'L CHG AND DISCHG
 49           REACTIVITY AND BURNUP DATA - Inner Blanket-Axial Blanket; Radial Blnt-Fuel, -Radial Blanket-Axial Blanket RECYCLE # =  0
              *ACTIVATION PRODUCTS*****ACTIVATION PRODUCTS*****ACTIVATION PRODUCTS*****ACTIVATION PRODUCTS*****
 50           CONCENTRATIONS, GRAMS          NUCLIDE TABLE:
 64           CONCENTRATIONS, GRAMS          ELEMENT TABLE:
 66           CONCENTRATIONS, GRAMS          SUMMARY TABLE:
              *ACTINIDES + DAUGHTERS***ACTINIDES + DAUGHTERS***ACTINIDES + DAUGHTERS***ACTINIDES + DAUGHTERS**
 68           CONCENTRATIONS, GRAMS          NUCLIDE TABLE:
 71           CONCENTRATIONS, GRAMS          ELEMENT TABLE:
 72           CONCENTRATIONS, GRAMS          SUMMARY TABLE:
              *FISSION PRODUCTS********FISSION PRODUCTS********FISSION PRODUCTS********FISSION PRODUCTS*******
 74           CONCENTRATIONS, GRAMS          NUCLIDE TABLE:
 91           CONCENTRATIONS, GRAMS          ELEMENT TABLE:
 92           CONCENTRATIONS, GRAMS          SUMMARY TABLE:
 95           (ALPHA,N) NEUTRON SOURCE
 96           SPONTANEOUS FISSION NEUTRON SOURCE

 97   OUTPUT TABLES--TITLE=DECAY OF CORE FUEL+CORE AXIAL BLANKET AND STRUCTURAL MATERIAL 60 days - 10 yr. RECYCLE # =  0
 97           REACTIVITY AND BURNUP DATA
              *ACTIVATION PRODUCTS*****ACTIVATION PRODUCTS*****ACTIVATION PRODUCTS*****ACTIVATION PRODUCTS*****
 98           CONCENTRATIONS, GRAMS          SUMMARY TABLE:
100           RADIOACTIVITY, CURIES          SUMMARY TABLE:
102           THERMAL POWER, WATTS           SUMMARY TABLE:
104           RADIOACTIVE INHALATION HAZARD, M**3 AIR AT RCG      SUMMARY TABLE:
106           RADIOACTIVE INGESTION HAZARD,  M**3 WATER AT RCG    SUMMARY TABLE:
              *ACTINIDES + DAUGHTERS***ACTINIDES + DAUGHTERS***ACTINIDES + DAUGHTERS***ACTINIDES + DAUGHTERS**
108           CONCENTRATIONS, GRAMS          SUMMARY TABLE:
110           RADIOACTIVITY, CURIES          SUMMARY TABLE:
112           THERMAL POWER, WATTS           SUMMARY TABLE:
114           RADIOACTIVE INHALATION HAZARD, M**3 AIR AT RCG      SUMMARY TABLE:
116           RADIOACTIVE INGESTION HAZARD,  M**3 WATER AT RCG    SUMMARY TABLE:
118           ALPHA RADIOACTIVITY CURIES     SUMMARY TABLE:
              *FISSION PRODUCTS********FISSION PRODUCTS********FISSION PRODUCTS********FISSION PRODUCTS*******
120           CONCENTRATIONS, GRAMS          SUMMARY TABLE:
123           RADIOACTIVITY, CURIES          SUMMARY TABLE:
125           THERMAL POWER, WATTS           SUMMARY TABLE:
127           RADIOACTIVE INHALATION HAZARD, M**3 AIR AT RCG      SUMMARY TABLE:
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PAGE                    TABLE OF CONTENTS ON UNIT = 13 FOR OUTPUT UNIT = 11
  129               RADIOACTIVE INGESTION HAZARD,   M**3 WATER AT RCG        SUMMARY TABLE:
  131               (ALPHA,N) NEUTRON SOURCE
  132               SPONTANEOUS FISSION NEUTRON SOURCE

  133   OUTPUT TABLES--TITLE=DECAY OF RADIAL BLANKET FUEL AND STRUCTURAL MATERIAL - 60 days-10 yrs.        RECYCLE # =  0
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  136               CONCENTRATIONS, GRAMS           SUMMARY TABLE:
  138               RADIOACTIVITY,  CURIES          SUMMARY TABLE:
  140               THERMAL POWER,  WATTS           SUMMARY TABLE:
  142               RADIOACTIVE INHALATION HAZARD,  M**3 AIR AT RCG      SUMMARY TABLE:
                    RADIOACTIVE INGESTION HAZARD,   M**3 WATER AT RCG        SUMMARY TABLE:
                    *ACTINIDS + DAUGHTERS***ACTINIDES + DAUGHTERS***ACTINIDES + DAUGHTERS***ACTINIDES + DAUGHTERS**
  144               CONCENTRATIONS, GRAMS           SUMMARY TABLE:
  146               RADIOACTIVITY,  CURIES          SUMMARY TABLE:
  148               THERMAL POWER,  WATTS           SUMMARY TABLE:
  150               RADIOACTIVE INHALATION HAZARD,  M**3 AIR AT RCG      SUMMARY TABLE:
  152               RADIOACTIVE INGESTION HAZARD,   M**3 WATER AT RCG        SUMMARY TABLE:
  154               ALPHA RADIOACTIVITY CURIES      SUMMARY TABLE:
                    *FISSION PRODUCTS********FISSION PRODUCTS********FISSION PRODUCTS********FISSION PRODUCTS********
  156               CONCENTRATIONS, GRAMS           SUMMARY TABLE:
  159               RADIOACTIVITY,  CURIES          SUMMARY TABLE:
  161               THERMAL POWER,  WATTS           SUMMARY TABLE:
  163               RADIOACTIVE INHALATION HAZARD,  M**3 AIR AT RCG      SUMMARY TABLE:
  165               RADIOACTIVE INGESTION HAZARD,   M**3 WATER AT RCG        SUMMARY TABLE:
  167               (ALPHA,N) NEUTRON SOURCE
  168               SPONTANEOUS FISSION NEUTRON SOURCE

  169   OUTPUT TABLES--TITLE=DECAY OF CORE FUEL AND STRUCTURAL MATERIAL - 60 days- 10 yrs.        RECYCLE # =  0
  169               REACTIVITY AND BURNUP DATA
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  172               CONCENTRATIONS, GRAMS           SUMMARY TABLE:
  174               RADIOACTIVITY,  CURIES          SUMMARY TABLE:
  176               THERMAL POWER,  WATTS           SUMMARY TABLE:
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  170               RADIOACTIVE INGESTION HAZARD,   M**3 WATER AT RCG        SUMMARY TABLE:
                    *ACTINIDES + DAUGHTERS***ACTINIDES + DAUGHTERS***ACTINIDES + DAUGHTERS***ACTINIDES + DAUGHTERS**
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  182               RADIOACTIVITY,  CURIES          SUMMARY TABLE:
  184               THERMAL POWER,  WATTS           SUMMARY TABLE:
  186               RADIOACTIVE INHALATION HAZARD,  M**3 AIR AT RCG      SUMMARY TABLE:
  188               RADIOACTIVE INGESTION HAZARD,   M**3 WATER AT RCG        SUMMARY TABLE:
  190               ALPHA RADIOACTIVITY CURIES      SUMMARY TABLE:
                    *FISSION PRODUCTS********FISSION PRODUCTS********FISSION PRODUCTS********FISSION PRODUCTS********
  192               CONCENTRATIONS, GRAMS           SUMMARY TABLE:
  195               RADIOACTIVITY,  CURIES          SUMMARY TABLE:
  197               THERMAL POWER,  WATTS           SUMMARY TABLE:
  199               RADIOACTIVE INHALATION HAZARD,  M**3 AIR AT RCG      SUMMARY TABLE:
  201               RADIOACTIVE INGESTION HAZARD,   M**3 WATER AT RCG        SUMMARY TABLE:
  203               (ALPHA,N) NEUTRON SOURCE
  204               SPONTANEOUS FISSION NEUTRON SOURCE

  205   OUTPUT TABLES--TITLE=DECAY OF INNER BLANKET FUEL AND STRUCTURAL MATERIAL - 60days- 10 yrs.        RECYCLE # =  0
```

Included in MP. 97-132 output that was used for CRBR FC ER

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PAGE                    TABLE OF CONTENTS ON UNIT = 13 FOR OUTPUT UNIT = 11
  205           REACTIVITY AND BURNUP DATA
                *ACTIVATION PRODUCTS*****ACTIVATION PRODUCTS*****ACTIVATION PRODUCTS*****ACTIVATION PRODUCTS****
  206           CONCENTRATIONS, GRAMS          SUMMARY TABLE:
  208           RADIOACTIVITY, CURIES          SUMMARY TABLE:
  210           THERMAL POWER, WATTS           SUMMARY TABLE:
  212           RADIOACTIVE INHALATION HAZARD, M**3 AIR AT RCG      SUMMARY TABLE:
  214           RADIOACTIVE INGESTION HAZARD,  M**3 WATER AT RCG        SUMMARY TABLE:
                *ACTINIDES + DAUGHTERS***ACTINIDES + DAUGHTERS***ACTINIDES + DAUGHTERS***ACTINIDES + DAUGHTERS**
  216           CONCENTRATIONS, GRAMS          SUMMARY TABLE:
  218           RADIOACTIVITY, CURIES          SUMMARY TABLE:
  220           THERMAL POWER, WATTS           SUMMARY TABLE:
  222           RADIOACTIVE INHALATION HAZARD, M**3 AIR AT RCG      SUMMARY TABLE:
  224           RADIOACTIVE INGESTION HAZARD,  M**3 WATER AT RCG        SUMMARY TABLE:
  226           ALPHA RADIOACTIVITY CURIES     SUMMARY TABLE:
                *FISSION PRODUCTS********FISSION PRODUCTS********FISSION PRODUCTS********FISSION PRODUCTS*******
  228           CONCENTRATIONS, GRAMS          SUMMARY TABLE:
  231           RADIOACTIVITY, CURIES          SUMMARY TABLE:
  233           THERMAL POWER, WATTS           SUMMARY TABLE:
  235           RADIOACTIVE INHALATION HAZARD, M**3 AIR AT RCG      SUMMARY TABLE:
  237           RADIOACTIVE INGESTION HAZARD,  M**3 WATER AT RCG        SUMMARY TABLE:
  239           (ALPHA,N) NEUTRON SOURCE
  240           SPONTANEOUS FISSION NEUTRON SOURCE

  241   OUTPUT TABLES--TITLE=REPROCESSING OUTPUT AND VOLATILES DECAY                          RECYCLE # = 0
  241           REACTIVITY AND BURNUP DATA Core Ass. (Incl AB)
                *ACTIVATION PRODUCTS*****ACTIVATION PRODUCTS*****ACTIVATION PRODUCTS*****ACTIVATION PRODUCTS****
  242           CONCENTRATIONS, GRAMS          SUMMARY TABLE:
  244           RADIOACTIVITY, CURIES          SUMMARY TABLE:
  246           RADIOACTIVE INHALATION HAZARD, M**3 AIR AT RCG      SUMMARY TABLE:
  248           RADIOACTIVE INGESTION HAZARD,  M**3 WATER AT RCG        SUMMARY TABLE:
                *ACTINIDES + DAUGHTERS***ACTINIDES + DAUGHTERS***ACTINIDES + DAUGHTERS***ACTINIDES + DAUGHTERS**
  250           CONCENTRATIONS, GRAMS          SUMMARY TABLE:
  252           RADIOACTIVITY, CURIES          SUMMARY TABLE:
  254           RADIOACTIVE INHALATION HAZARD, M**3 AIR AT RCG      SUMMARY TABLE:
  256           RADIOACTIVE INGESTION HAZARD,  M**3 WATER AT RCG        SUMMARY TABLE:
                *FISSION PRODUCTS********FISSION PRODUCTS********FISSION PRODUCTS********FISSION PRODUCTS*******
  258           CONCENTRATIONS, GRAMS          SUMMARY TABLE:
  261           RADIOACTIVITY, CURIES          SUMMARY TABLE:
  263           RADIOACTIVE INHALATION HAZARD, M**3 AIR AT RCG      SUMMARY TABLE:
  265           RADIOACTIVE INGESTION HAZARD,  M**3 WATER AT RCG        SUMMARY TABLE:
  267           (ALPHA,N) NEUTRON SOURCE
  268           SPONTANEOUS FISSION NEUTRON SOURCE

  269   OUTPUT TABLES--TITLE=REPROCESSING OUTPUT AND VOLATILES DECAY                          RECYCLE # = 0
  269           REACTIVITY AND BURNUP DATA Radial and Inner Blanket Ass. (Incl AB)
                *ACTIVATION PRODUCTS*****ACTIVATION PRODUCTS*****ACTIVATION PRODUCTS*****ACTIVATION PRODUCTS****
  270           CONCENTRATIONS, GRAMS          SUMMARY TABLE:
  272           RADIOACTIVITY, CURIES          SUMMARY TABLE:
  274           RADIOACTIVE INHALATION HAZARD, M**3 AIR AT RCG      SUMMARY TABLE:
  276           RADIOACTIVE INGESTION HAZARD,  M**3 WATER AT RCG        SUMMARY TABLE:
                *ACTINIDES + DAUGHTERS***ACTINIDES + DAUGHTERS***ACTINIDES + DAUGHTERS***ACTINIDES + DAUGHTERS**
  278           CONCENTRATIONS, GRAMS          SUMMARY TABLE:
  280           RADIOACTIVITY, CURIES          SUMMARY TABLE:
  282           RADIOACTIVE INHALATION HAZARD, M**3 AIR AT RCG      SUMMARY TABLE:
  284           RADIOACTIVE INGESTION HAZARD,  M**3 WATER AT RCG        SUMMARY TABLE:
                *FISSION PRODUCTS********FISSION PRODUCTS********FISSION PRODUCTS********FISSION PRODUCTS*******
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Included in pp 297-304 42 that output for blanket fuel

(continued)

Use pp 297-324 (see note prev. page)

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PAGE                    TABLE OF CONTENTS ON UNIT = 13 FOR OUTPUT UNIT = 11
 286          CONCENTRATIONS, GRAMS          SUMMARY TABLE:
 289          RADIOACTIVITY, CURIES          SUMMARY TABLE:
 291          RADIOACTIVE INHALATION HAZARD, M**3 AIR AT RCG      SUMMARY TABLE:
 293          RADIOACTIVE INGESTION HAZARD,  M**3 WATER AT RCG    SUMMARY TABLE:
 295          (ALPHA,N) NEUTRON SOURCE
 296          SPONTANEOUS FISSION NEUTRON SOURCE

 297  OUTPUT TABLES--TITLE=REPROCESSING OUTPUT AND VOLATILES DECAY - 30 days - 180 days                RECYCLE # = 0
 297          REACTIVITY AND BURNUP DATA - All materials blended
              *ACTIVATION PRODUCTS*****ACTIVATION PRODUCTS*****ACTIVATION PRODUCTS*****ACTIVATION PRODUCTS*****
 298          CONCENTRATIONS, GRAMS          SUMMARY TABLE:
 300          RADIOACTIVITY, CURIES          SUMMARY TABLE:
 302          RADIOACTIVE INHALATION HAZARD, M**3 AIR AT RCG      SUMMARY TABLE:
 304          RADIOACTIVE INGESTION HAZARD,  M**3 WATER AT RCG    SUMMARY TABLE:
              *ACTINIDES + DAUGHTERS***ACTINIDES + DAUGHTERS***ACTINIDES + DAUGHTERS***ACTINIDES + DAUGHTERS**
 306          CONCENTRATIONS, GRAMS          SUMMARY TABLE:
 308          RADIOACTIVITY, CURIES          SUMMARY TABLE:
 310          RADIOACTIVE INHALATION HAZARD, M**3 AIR AT RCG      SUMMARY TABLE:
 312          RADIOACTIVE INGESTION HAZARD,  M**3 WATER AT RCG    SUMMARY TABLE:
              *FISSION PRODUCTS********FISSION PRODUCTS********FISSION PRODUCTS********FISSION PRODUCTS********
 314          CONCENTRATIONS, GRAMS          SUMMARY TABLE:
 317          RADIOACTIVITY, CURIES          SUMMARY TABLE:
 319          RADIOACTIVE INHALATION HAZARD, M**3 AIR AT RCG      SUMMARY TABLE:
 321          RADIOACTIVE INGESTION HAZARD,  M**3 WATER AT RCG    SUMMARY TABLE:
 323          (ALPHA,N) NEUTRON SOURCE
 324          SPONTANEOUS FISSION NEUTRON SOURCE

 325  OUTPUT TABLES--TITLE=DECAY OF HIGH-LEVEL WASTE FROM BLENDED FUEL - 10 days - 2 years            RECYCLE # = 0
 325          REACTIVITY AND BURNUP DATA
              *ACTIVATION PRODUCTS*****ACTIVATION PRODUCTS*****ACTIVATION PRODUCTS*****ACTIVATION PRODUCTS*****
 326          CONCENTRATIONS, GRAMS          SUMMARY TABLE:
 328          RADIOACTIVITY, CURIES          SUMMARY TABLE:
 330          THERMAL POWER, WATTS           SUMMARY TABLE:
 332          RADIOACTIVE INHALATION HAZARD, M**3 AIR AT RCG      SUMMARY TABLE:
 334          RADIOACTIVE INGESTION HAZARD,  M**3 WATER AT RCG    SUMMARY TABLE:
              *ACTINIDES + DAUGHTERS***ACTINIDES + DAUGHTERS***ACTINIDES + DAUGHTERS***ACTINIDES + DAUGHTERS**
 336          CONCENTRATIONS, GRAMS          SUMMARY TABLE:
 338          RADIOACTIVITY, CURIES          SUMMARY TABLE:
 340          THERMAL POWER, WATTS           SUMMARY TABLE:
 342          RADIOACTIVE INHALATION HAZARD, M**3 AIR AT RCG      SUMMARY TABLE:
 344          RADIOACTIVE INGESTION HAZARD,  M**3 WATER AT RCG    SUMMARY TABLE:
 346          ALPHA RADIOACTIVITY CURIES     SUMMARY TABLE:
              *FISSION PRODUCTS********FISSION PRODUCTS********FISSION PRODUCTS********FISSION PRODUCTS********
 348          CONCENTRATIONS, GRAMS          SUMMARY TABLE:
 351          RADIOACTIVITY, CURIES          SUMMARY TABLE:
 353          THERMAL POWER, WATTS           SUMMARY TABLE:
 355          RADIOACTIVE INHALATION HAZARD, M**3 AIR AT RCG      SUMMARY TABLE:
 357          RADIOACTIVE INGESTION HAZARD,  M**3 WATER AT RCG    SUMMARY TABLE:
 359          (ALPHA,N) NEUTRON SOURCE
 360          SPONTANEOUS FISSION NEUTRON SOURCE

 361  OUTPUT TABLES--TITLE=DECAY OF HIGH-LEVEL WASTE FROM BLENDED FUEL - 3 yr - 10^6 yr.              RECYCLE # = 0
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PAGE                    TABLE OF CONTENTS ON UNIT = 13 FOR OUTPUT UNIT = 11
 361            REACTIVITY AND BURNUP DATA
                *ACTIVATION PRODUCTS*****ACTIVATION PRODUCTS*****ACTIVATION PRODUCTS*****ACTIVATION PRODUCTS****
 362            CONCENTRATIONS, GRAMS          SUMMARY TABLE:
 364            RADIOACTIVITY, CURIES          SUMMARY TABLE:
 366            THERMAL POWER, WATTS           SUMMARY TABLE:
 368            RADIOACTIVE INHALATION HAZARD, M**3 AIR AT RCG       SUMMARY TABLE:
 370            RADIOACTIVE INGESTION HAZARD,  M**3 WATER AT RCG         SUMMARY TABLE:
                *ACTINIDES + DAUGHTERS***ACTINIDES + DAUGHTERS***ACTINIDES + DAUGHTERS***ACTINIDES + DAUGHTERS**
 372            CONCENTRATIONS, GRAMS          SUMMARY TABLE:
 374            RADIOACTIVITY, CURIES          SUMMARY TABLE:
 376            THERMAL POWER, WATTS           SUMMARY TABLE:
 378            RADIOACTIVE INHALATION HAZARD, M**3 AIR AT RCG       SUMMARY TABLE:
 380            RADIOACTIVE INGESTION HAZARD,  M**3 WATER AT RCG         SUMMARY TABLE:
 382            ALPHA RADIOACTIVITY CURIES     SUMMARY TABLE:
                *FISSION PRODUCTS********FISSION PRODUCTS********FISSION PRODUCTS********FISSION PRODUCTS*******
 384            CONCENTRATIONS, GRAMS          SUMMARY TABLE:
 387            RADIOACTIVITY, CURIES          SUMMARY TABLE:
 389            THERMAL POWER, WATTS           SUMMARY TABLE:
 391            RADIOACTIVE INHALATION HAZARD, M**3 AIR AT RCG       SUMMARY TABLE:
 393            RADIOACTIVE INGESTION HAZARD,  M**3 WATER AT RCG         SUMMARY TABLE:
 395            (ALPHA,N) NEUTRON SOURCE
 396            SPONTANEOUS FISSION NEUTRON SOURCE

 397  OUTPUT TABLES--TITLE=DECAY OF STRUCTURAL MATERIAL WASTES - 10 days - 2 years                RECYCLE # = 0
 397            REACTIVITY AND BURNUP DATA
                *ACTIVATION PRODUCTS*****ACTIVATION PRODUCTS*****ACTIVATION PRODUCTS*****ACTIVATION PRODUCTS****
 398            CONCENTRATIONS, GRAMS          SUMMARY TABLE:
 400            RADIOACTIVITY, CURIES          SUMMARY TABLE:
 402            THERMAL POWER, WATTS           SUMMARY TABLE:
 404            RADIOACTIVE INHALATION HAZARD, M**3 AIR AT RCG       SUMMARY TABLE:
 406            RADIOACTIVE INGESTION HAZARD,  M**3 WATER AT RCG         SUMMARY TABLE:
                *ACTINIDES + DAUGHTERS***ACTINIDES + DAUGHTERS***ACTINIDES + DAUGHTERS***ACTINIDES + DAUGHTERS**
 408            CONCENTRATIONS, GRAMS          SUMMARY TABLE:
 410            RADIOACTIVITY, CURIES          SUMMARY TABLE:
 412            THERMAL POWER, WATTS           SUMMARY TABLE:
 414            RADIOACTIVE INHALATION HAZARD, M**3 AIR AT RCG       SUMMARY TABLE:
 416            RADIOACTIVE INGESTION HAZARD,  M**3 WATER AT RCG         SUMMARY TABLE:
 418            ALPHA RADIOACTIVITY CURIES     SUMMARY TABLE:
                *FISSION PRODUCTS********FISSION PRODUCTS********FISSION PRODUCTS********FISSION PRODUCTS*******
 420            CONCENTRATIONS, GRAMS          SUMMARY TABLE:
 423            RADIOACTIVITY, CURIES          SUMMARY TABLE:
 425            THERMAL POWER, WATTS           SUMMARY TABLE:
 427            RADIOACTIVE INHALATION HAZARD, M**3 AIR AT RCG       SUMMARY TABLE:
 429            RADIOACTIVE INGESTION HAZARD,  M**3 WATER AT RCG         SUMMARY TABLE:
 431            (ALPHA,N) NEUTRON SOURCE
 432            SPONTANEOUS FISSION NEUTRON SOURCE

 433  OUTPUT TABLES--TITLE=DECAY OF STRUCTURAL MATERIAL WASTES - 3 years - 10^6 years             RECYCLE # = 0
 433            REACTIVITY AND BURNUP DATA
                *ACTIVATION PRODUCTS*****ACTIVATION PRODUCTS*****ACTIVATION PRODUCTS*****ACTIVATION PRODUCTS****
 434            CONCENTRATIONS, GRAMS          SUMMARY TABLE:
 436            RADIOACTIVITY, CURIES          SUMMARY TABLE:
 438            THERMAL POWER, WATTS           SUMMARY TABLE:
 440            RADIOACTIVE INHALATION HAZARD, M**3 AIR AT RCG       SUMMARY TABLE:
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PAGE                    TABLE OF CONTENTS ON UNIT = 13 FOR OUTPUT UNIT = 11
442             RADIOACTIVE INGESTION HAZARD,   M**3 WATER AT RCG       SUMMARY TABLE:
                *ACTINIDES + DAUGHTERS***ACTINIDES + DAUGHTERS***ACTINIDES + DAUGHTERS***ACTINIDES + DAUGHTERS**
444             CONCENTRATIONS, GRAMS           SUMMARY TABLE:
446             RADIOACTIVITY,  CURIES          SUMMARY TABLE:
448             THERMAL POWER,  WATTS           SUMMARY TABLE:
450             RADIOACTIVE INHALATION HAZARD,  M**3 AIR AT RCG     SUMMARY TABLE:
452             RADIOACTIVE INGESTION HAZARD,   M**3 WATER AT RCG       SUMMARY TABLE:
454             ALPHA RADIOACTIVITY CURIES      SUMMARY TABLE:
                *FISSION PRODUCTS********FISSION PRODUCTS********FISSION PRODUCTS********FISSION PRODUCTS*******
456             CONCENTRATIONS, GRAMS           SUMMARY TABLE:
459             RADIOACTIVITY,  CURIES          SUMMARY TABLE:
461             THERMAL POWER,  WATTS           SUMMARY TABLE:
463             RADIOACTIVE INHALATION HAZARD,  M**3 AIR AT RCG     SUMMARY TABLE:
465             RADIOACTIVE INGESTION HAZARD,   M**3 WATER AT RCG       SUMMARY TABLE:
467             (ALPHA,N) NEUTRON SOURCE
468             SPONTANEOUS FISSION NEUTRON SOURCE

469     OUTPUT TABLES--TITLE=DECAY OF RECOVERED URANIUM - 90 days - 100 years
469             REACTIVITY AND BURNUP DATA                                  RECYCLE # = 0
                *ACTIVATION PRODUCTS*****ACTIVATION PRODUCTS*****ACTIVATION PRODUCTS*****ACTIVATION PRODUCTS****
                *ACTINIDES + DAUGHTERS***ACTINIDES + DAUGHTERS***ACTINIDES + DAUGHTERS***ACTINIDES + DAUGHTERS**
470             CONCENTRATIONS, GRAMS           SUMMARY TABLE:
472             RADIOACTIVITY,  CURIES          SUMMARY TABLE:
474             THERMAL POWER,  WATTS           SUMMARY TABLE:
476             RADIOACTIVE INHALATION HAZARD,  M**3 AIR AT RCG     SUMMARY TABLE:
478             RADIOACTIVE INGESTION HAZARD,   M**3 WATER AT RCG       SUMMARY TABLE:
480             ALPHA RADIOACTIVITY CURIES      SUMMARY TABLE:
                *FISSION PRODUCTS*******FISSION PRODUCTS********FISSION PRODUCTS********FISSION PRODUCTS*******
482             (ALPHA,N) NEUTRON SOURCE
483             SPONTANEOUS FISSION NEUTRON SOURCE

484     OUTPUT TABLES--TITLE=DECAY OF RECOVERED PLUTONIUM - 90 days - 100 years,  RECYCLE # = 0
484             REACTIVITY AND BURNUP DATA
                *ACTIVATION PRODUCTS*****ACTIVATION PRODUCTS*****ACTIVATION PRODUCTS*****ACTIVATION PRODUCTS****
                *ACTINIDES + DAUGHTERS***ACTINIDES + DAUGHTERS***ACTINIDES + DAUGHTERS***ACTINIDES + DAUGHTERS**
485             CONCENTRATIONS, GRAMS           SUMMARY TABLE:
487             RADIOACTIVITY,  CURIES          SUMMARY TABLE:
489             THERMAL POWER,  WATTS           SUMMARY TABLE:
491             RADIOACTIVE INHALATION HAZARD,  M**3 AIR AT RCG     SUMMARY TABLE:
493             RADIOACTIVE INGESTION HAZARD,   M**3 WATER AT RCG       SUMMARY TABLE:
495             ALPHA RADIOACTIVITY CURIES      SUMMARY TABLE:
                *FISSION PRODUCTS********FISSION PRODUCTS********FISSION PRODUCTS********FISSION PRODUCTS*******
497             (ALPHA,N) NEUTRON SOURCE
498             SPONTANEOUS FISSION NEUTRON SOURCE
```