AMENDMENT XII
January 1982

INSTRUCTIONS

AMENDMENT XII

The replacement pages in the enclosed packets are to be inserted in the CRBRP Environmental Report as follows:

VOLUME 1

Section	Pages to be Replaced
Table of Contents	Replace pages 13, 14, and 15, 15a Add page 14a
List of Tables	Replace pages 57 and 57a
List of Figures	Replace pages 73 and 73a

VOLUME 2

3.8	Replace 3.7-7, 3.8-1 through 3.8-5
5.3	Replace pages 5.3-5 thrugh 5.3-8, Add page 5.3-7a Replace pages 5.3-13 and 5.3-14 Add page 5.3-13a Replace pages 5.3-19 through 5.3-22
5.7	Replace pages 5.6-7, 5.7-1 through 5.7-1d Add pages 5.7-1e through 5.7-1k Replace pages 5.7-2 through 5.7-5 Replace pages 5.7-10, 5.7-11 and 5.8-1 Add pages 5.7-10a, 5.7-10b and 5.7-12

VOLUME 3

13.0	Replace pages 13.0-31, 13.0-32 and 13.0-32a Add page 13.0-31a

VOLUME 5

AMENDMENT XII	Insert AMENDMENT XII tab and pages AXII-1, AXII-2

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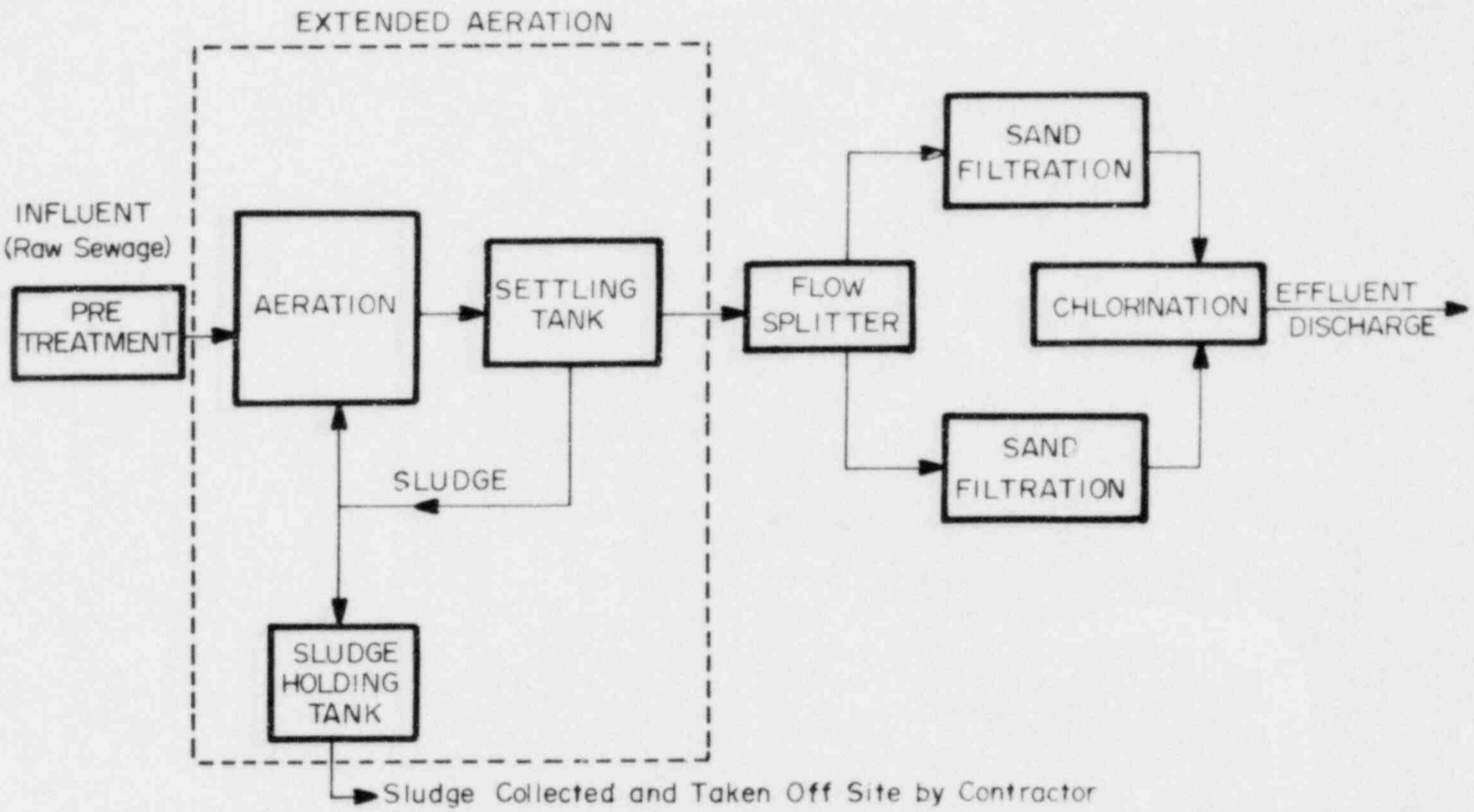

Figure 3.7-2 PERMANENT SANITARY WASTE SYSTEM SCHEMATIC

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3.8 RADIOACTIVE MATERIALS INVENTORY

3.8.1 NEW FUEL ELEMENTS

3.8.1.1 CORE ASSEMBLIES

A core fuel assembly is composed of 217 rods arranged in a
triangular pitch and supported in a hexagonal metal duct. Rods
are made of stainless steel and have an outer diameter of 0.230
inches. The dimension across the flats of the duct is
approximately 4.7 inches; the total weight of the assembly is
about 443 pounds. Longitudinally, each rod consists of a
36-inch active fuel region, 14-inch axial blankets on top and 9
bottom of the fuel and a fission gas plenum. Figure 3.8-1
represents a plan view of the core. Figure 3.8-2 presents a
schematic drawing of a single, core fuel rod. Fuel for the core
consists of oxides of plutonium and depleted uranium sintered 9
into pellets and encapsulated in the rods. The 36-inch core
length of 156 fuel assemblies contains 5.2 metric tons of heavy
metal (fertile and fissile plutonium plus uranium) with a 9
plutonium enrichment of 33.2 weight percent. In the 156 upper
and lower axial blanket sections of the fuel assemblies, the
total weignt of heavy metal is approximately 4.2 metric tons.

An annual shutdown for refueling is planned for all operating
cycles. The fuel management scheme calls for the replacement of
all fuel assemblies as a batch at two-year intervals. In
alternating years, under equilibrium conditions, six inner
blanket assemblies are removed and replaced by six fresh fuel 9
assemblies in order to add sufficient excess reactivity to the
system to complete the two-year burnup interval. A total of 162
fresh fuel assemblies are therefore required every two years.
New fuel assemblies will be packaged in special containers and
shipped to the site in the Safe Secure Trailer (SST) provided by
DOE's Division of Military Application. The shipping containers
will be DOT (Department of Transportation) and NRC approved. 6

12

Six fuel assemblies per shipment is expected. On this basis, average yearly shipments of fuel assemblies would be about 14.

3.8.1.2 INNER/RADIAL BLANKET ASSEMBLIES

A blanket assembly is composed of 61 rods arrayed in a triangular pitch and supported in a hexagonal metal duct similar to that of the fuel assembly. Rods are made of stainless steel and have an outer diameter of 0.506 inches. The dimension across the flats of the duct is the same as the fuel assembly, 4.7 inches; the total weight of the assembly is about 536 pounds. Longitudinally, each rod consists of a 64-inch blanket region and associated fission gas plenum.

The fertile material in the blanket region is depleted uranium oxide sintered into pellets and encapsulated in stainless steel rods. The 64-inch blanket length of 214 blanket assemblies (82 inner blankets and 132 radial blankets) contains approximately 21.6 tons of heavy metal (99.8 w/o U-238 and 0.2 w/o U-235).

The inner blanket assemblies are replaced as a batch at two year intervals, with the exception of six assemblies which are replaced by fresh fuel assemblies at the mid-term refueling. Radial blanket assemblies in the first and second radial blanket rows are replaced as a batch at four and five year intervals, respectively. Therefore, on the average, during annual refueling, approximately 70 blanket assemblies will be shipped in a similar container as the unirradiated fuel assemblies. Based upon 6 assemblies per shipment there will be, on the average, 12 shipments arriving each year at the CRBRP carrying blanket assemblies.

3.8.2 IRRADIATED FUEL ELEMENTS

3.8.2.1 CORE ASSEMBLIES

Irradiated properties of the Clinch River core fuel assemblies were
developed based on annual refueling and a core full power capacity factor
of 75 percent (equivalent to 274 full power days of operation). An
average of 81 fuel assemblies will be discharged from the plant per year 9
at equilibrium core conditions. Total weight of these irradiated
assemblies is approximately 18 tons. The burnup averaged over all the 6 9
fuel assemblies discharged from the plant is approximately 80,000 MWD/Ton
of heavy metal in the core portion of the assembly. The peak pellet
burn-up design goal is 110,000 MWD/Ton of heavy metal. 9

9

Burnup averaged over all the axial blankets in the discharged assem-
blies is approximately 2,200 MWD/Ton of heavy metal in the blanket region 9
of the assembly. During irradiation, neutron capture in the fertile
material (U-238) of the axial blankets breeds, on the average, 0.3-0.4 kg 9
of fissile plutonium per discharged assembly. This gain in fissile
content partially compensates for the loss of fissile material in the
core region during operation. 9

The In-Vessel Transfer Machine (IVTM) mounted in the reactor head carries
out withdrawal of spent fuel assemblies from their positions in the
reactor core and deposits them into a sodium filled Core Component Pot 6
(CCP) in a transfer position outside the core but inside the reactor
vessel. Horizontal motion of the In-Vessel Transfer Machine is accom-
plished by means of triple rotating plugs mounted in the reactor head.

By rotating these plugs in sequence, the In-Vessel Transfer Machine, which is a simple straight pull device, can be indexed over any core or transfer position in the reactor.

After the spent fuel assembly has been placed in the transfer position, the Ex-Vessel Transfer Machine (EVTM) withdraws the CCP container with the assembly and transfers it to the sodium-filled Ex-Vessel Storage Tank (EVST) located in the Reactor Service Building.

Fuel assemblies will remain in the EVST for at least 100 days 9
prior to being loaded into a shipping cask for transportation.

Irradiated fuel assemblies will be transported and protected in 6
a cask approximately eight feet in diameter by 22 feet in
length. Irradiated fuel assemblies are inserted in removable
canisters. The approximate weight of the cask is 100 tons and 9
is designed for transportation on a standard high capacity 6
railroad flatcar. The cask and car combination is designed in
accordance with NRC and DOT regulations and is provided with
crash protection and passive cooling capability. The actual
number of fuel assemblies per cask shipped will be determined on
the basis of economic considerations and the heat load limit of 6 9
the cask.

It is estimated that during the spent fuel shipping phase there 9 12
will be 14 shipments per year.

3.8.2.2 INNER/RADIAL BLANKET ASSEMBLIES 9

Irradiated properties of the blanket assemblies were developed 9
based on the same reactor operation conditions as those used for

the core fuel assemblies. On the average, 70 blanket assemblies 6 9
will be discharged from the plant per year. The burnup averaged 9 9
over all the discharged blanket assemblies is approximately
8,000 MWD/Ton of heavy metal (depleted uranium). During
irradiation, neutron captures in the fertile material (U-238) of
the radial blanket breeds on the average 2.5-3.0 kg of fissile 9
plutonium per discharged blanket assembly.

The expected mode of protection for packaging of the discharged 9
blanket assemblies for shipment is the same as the core fuel
assemblies. One day after shutdown, the peak inner/radial
blanket assembly heat generation would be 19.7/12.0 kW. Thirty
days after shutdown, these heat generation values are 2.61/1.64 6 9
kW and 2.53/0.88 kW, respectively. It is estimated that the
number of inner/radial blanket assemblies removed from the 6
reactor will require about 12 shipments per year. 12

3.8.3 RADIOACTIVE WASTE MATERIAL

3.8.3.1 REPLACEMENT IN-VESSEL COMPONENTS

3.8.3.1.1 CONTROL ROD ASSEMBLIES AND DRIVE LINES

Control rod assembly consists of a bundle of stainless steel
clad, boron carbide pins. The 9 primary control rod assemblies
have bundles of 37 pins while the 6 secondary control rod 9
assemblies have bundles of 31 pins each. The bundles of pins
are arranged in hexagonal inner ducts within outer ducts having
the same external geometry as the fuel assembly ducts. The 20
percent cold worked Type 316 stainless steel tubing is

Since there is no usage of the Clinch River water for irrigation of crops, the only pathway for radiation exposure of the public through the aquatic food chain is the consumption of fish caught by sport fishermen in the general vicinity of the blowdown discharge. No other aquatic biota is considered edible in this area. The Corbicula clam, used for human consumption in some parts of the world, can be found in the Clinch River. However, it is used primarily as bait and is not generally part of the local diet.(10) No quantitative data is currently available on the amount of fish caught from this region by sport fishermen for human consumption.(11) Approximately 100 tons of non-game fish are taken annually from Watts Bar Reservoir by commercial fishermen.(12) However, a breakdown on the utilization of the catch is not available.

Doses are presented for relatively significant liquid exposure pathways 8
that exist. These include external doses received while swimming, boating and fishing and internal doses from ingestion of fish. However, it must be pointed out that these doses are not expected under normal circumstances due to the small radioactive plume associated with the CRBRP liquid discharge design. Concentrations of liquid effluents in the Clinch River beyond 60 feet from the point of discharge in most instances are at near 8
ambient levels. Therefore, drinking water taken from the Clinch River more than 60 feet downstream of the point of discharge will not contain measurable amounts of radioactivity and no significant internal doses can be expected. As discussed in Section 5.3.1.2, the doses calculated for exposure to liquid effluents are not expected under normal conditions. 8

5.3.1.3 DIRECT RADIATION FROM FACILITY

The shielding design criteria for the CRBRP specifies that, during normal operation, the dose rate at the surface of that part of the containment vessel which is above grade will be no more than 0.2 mr/hr. An estimated 90 percent of the containment building that is above grade is shielded from the Site boundary by buildings and is enclosed by the Reactor Confinement Structure consisting of four feet of concrete. 8

Radwaste tanks are housed in buildings protected with concrete walls. In addition, sodium storage tanks, the Radioactive Argon Processing System (RAPS) and the Cell Atmosphere Processing System (CAPS) are located below grade.

As described in Section 3.2, the probability of radioactive sodium leaking from the primary to the intermediate loop of the Heat Transport system is very small. Therefore, it is assumed that the only radioactive contaminant in the stream is tritium, a low energy beta-emitter (0.006 MeV) which presents no direct radiation hazard.

5.3.1.4 TRANSPORTATION OF RADIOACTIVE MATERIALS

5.3.1.4.1 NEW FUEL

Transfer of non-irradiated fuel between fuel-fabrication plants and the CRBRP Site will result in a small external dose to the general population along the routes and to the personnel involved in the shipping process (see Section 3.8 for details concerning transportation of core fuel). The core fuel will be 6
fabricated at DOE's Secure Automated Facility being built at the 12
DOE Hanford Site in the State of Washington. The blanket fuel will be fabricated at an existing commercial facility.

5.3.1.4.2 IRRADIATED FUEL

Transfer of irradiated fuel from the CRBRP to a fuel reprocessing plant will expose the general public along the route and the shippers to direct radiation. The irradiated fuel assemblies at the CRBRP will be loaded into shielded casks. 8
These casks are DOT-NRC approved shipping containers for transportation of spent fuel assemblies (see Section 3.8 for 6

details concerning transportation of irradiated fuel'. The spent fuel from the CRBRP will be transported to a yet to be determined facility for interim storage and reprocessing. Since 12
the actual Government facility has not yet been selected, the transportation impacts in Section 3.8 assume a distant facility.

5.3.1.4.3 RADIOACTIVE WASTES

Transportation of the radioactive wastes can also present a radiation hazard to the general public and shippers. Section
3.8 describes the type of radioactive waste package to be 8
shipped off-site for disposal. The CRBRP will use an NRC-licensed burial site for disposal of all packaged radioactive waste. As yet, the location of this site has not been determined.

5.3.2 DOSE RATE ESTIMATES

5.3.2.1 DOSES FROM AIRBORNE EXPOSURES

Doses received from exposure to gaseous effluents from the CRBRP were evaluated using equations 1 through 11 presented in the Appendix to Sections 5.2 and 5.3. Maximum external whole body and skin doses at the site boundary were calculated using the highest annual average χ/Q which occurs at the Site boundary.
Using a method similar to the method used in Section 5.2.2.1 to 8
obtain the maximum χ/Q at the exclusion boundary, the maximum site boundary χ/Q was found to occur in the northwest sector. Site boundary distance occurs in this sector at 2500 feet from

the plant and the annual average value for χ/Q of 5.10×10^{-5} sec/m^3 was obtained by interpolating the data in Table 2.6-39 for this radial distance. Values of 0.023 mrem/yr and 0.073 8
mrem/yr gamma whole body dose rate and beta plus gamma skin dose rates were obtained at this location assuming no protection from buildings or clothing.

As can be seen in Table 5.3A-1 of the Appendix to Sections 5.2 and 5.3, all of the radioisotopes present in the gaseous effluent contribute to an external gamma dose except Argon-39 and tritium which decays by beta emission only. On the basis of 8
the population distribution expected near

the end of plant life in 2010, presented in Table 2.2-12, and the annual
gamma dose distribution within 50 miles of the Site as determined by the
annual average values of χ/Q, presented in Table 2.6-39, the external popu-
lation dose (whole body) from CRBRP atmospheric releases is estimated to be
0.027 man-rem/yr. It should be noted that the dose to personnel exposed 8
to CRBRP atmospheric releases at the nearby Oak Ridge Gaseous Diffusion
Plant and Oak Ridge National Laboratory does not impact the total dose
to the population.

A comparison of the external dose resulting from the operation of the
CRBRP to the dose received from natural radioactivity assists in evalu-
ating the impact of the CRBRP. Near the plant site the average annual
dose from naturally occurring external sources of radiation is approxi-
mately 100 mrem, as discussed in Section 2.8. Therefore, on the basis
of projected population for 2010, the population dose within 50 miles
of the CRBRP from naturally occurring radioactivity is estimated to be
98,700 man-rem/yr. The calculated contribution from the CRBRP (which is
based on conservative assumptions) is 0.00004 percent of the population 8
dose from naturally occurring radioactivity.

Internal doses via the various exposure pathways to gaseous effluents
(inhalation and ingestion of milk, vegetables and meat) will be due almost
exclusively to the presence of tritium. The noble gases are relatively
inert and result in practically no internal exposure. These doses are
presented in Table 5.3-1.

The growing season for leafy vegetables in the Eastern Tennessee region
is assumed to be 90 days. All other variables used in the calculation
of dose from ingestion of leafy vegetables, such as total daily intake
and yield per unit area of cultivated land, are provided in Table 5.3A-13 8

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6.0 x 10^8 for bone, 5.0 x 10^7 for the GI Tract and 3.8 x 10^8 for 4
the kidney. Dose conversion factors for exposure via ingestion of Am-241 are not significantly higher than those dose conversion factors for the plutonium isotopes presented in Table 5.3A-5 of the Appendix to Sections 5.2 and 5.3. Therefore, doses from exposure to americium are not expected to be significant and will be less than the minimal dose from the plutonium isotopes.

5.3.2.3 DOSE FROM EXPOSURE TO DIRECT RADIATION FROM THE FACILITY

Because the containment building is 90 percent shielded by buildings constructed of concrete walls and because the four 8
feet of concrete from the confinement structure has not been accounted for in the analysis, the population dose from direct radiation presented in Table 5.3-4 is highly conservative. The dose is calculated with the assumption that the radiation field is caused by an isotropic point source at the center of containment having an energy of 3.0 MeV. The inverse square law was used to calculate the dose at several points beyond the Site. Build-up and attenuation in air was accounted for in the 8
calculations. Sky-shine was not considered since the closest point to the center of containment is not shielded by additional buildings.

The calculated dose rate to an individual (0.6 mrem/yr at the Site boundary) is 0.6 percent of the external dose received from 8
natural radiation in the Eastern Tennessee region.

5.3.2.4 DOSES VIA EXPOSURE TO RADIOACTIVE MATERIALS IN TRANSIT

5.3.2.4.1 NEW FUEL

Dose estimates have been made based upon transportation of fuel and blanket assemblies to the plant from the Hanford Site. These doses have been calculated based upon NUREG-0170[20]. 12

Assuming an average of 14 shipments of fresh fuel for the core 6 9
and axial blankets per year and 12 shipments of fresh fuel for the inner and radial blankets per year over a distance of 2500 miles per shipment, annual doses to the general public are estimated and presented in Table 5.3-5.

5.3.2.4.2 IRRADIATED FUEL

Population doses from transport of irradiated fuel to fuel reprocessing plants have also been estimated based upon NUREG 0170 with shipment by rail. Assuming 14 shipments per year for 6 9
spent fuel plus axial blanket assemblies and 12 shipments per year for inner and radial blankets assemblies and a transit 12
distance of 500 miles for each shipment, the population doses presented in Table 5.3-6 were calculated.

5.3.2.4.3 RADIOACTIVE WASTES

Approximately one-hundred thirty-five (135) 55-gallon drums of 9
solidified liquid wastes will be shipped from the Site to an 4 8
NRC-licensed burial ground each year. An estimated 112 drums of non-compactible solids and 28 drums of compactible will also be 9
shipped from the Site each year. An estimated four shipments per year will be made for irradiated control assemblies and radial shield assemblies. The estimated population doses to the general population would be 0.165 man-rem/yr, as shown in Table 5.3-6. These estimates assume a shipping distance of 500 miles per shipment.

5.3.3 SUMMARY OF DOSE RATE ESTIMATES AND EVALUATION OF RADIOLOGICAL IMPACT ON MAN

A summary of expected doses resulting from exposure to the CRBRP is presented in Table 5.3-7. Both individual and population doses are projected.

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TABLE 5.3-4

ESTIMATED RADIATION DOSE TO THE PUBLIC VIA DIRECT RADIATION FROM THE CRBRP

Distance From Plant (miles)	Estimated Dose Rate (mrem/yr)
0.4	6.3×10^{-1}
0.6	9.0×10^{-2}
1.0	2.6×10^{-3}
2.0	7.6×10^{-7}
3.0	2.8×10^{-10}
4.0	1.6×10^{-13}
5.0	6.8×10^{-17}

Population Dose within 5 miles of Site = 0.02 man-rem/year

TABLE 5.3-5

ESTIMATED EXTERNAL TOTAL BODY DOSES TO THE GENERAL PUBLIC FROM SHIPPING UNIRRADIATED MATERIALS TO CRBRP SITE

Material*	Total Miles Per Year	Man-rems Received Per Year General Population
Fresh fuel Radial blanket	30,000	0.007
Fresh fuel Core and axial blanket	35,000	0.762
Total		0.769

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*These packages meet all DOT limits on external dose rates

TABLE 5.3-6

ESTIMATED EXTERNAL TOTAL BODY DOSES TO THE GENERAL PUBLIC FROM SHIPPING IRRADIATED MATERIALS FROM THE CRBRP SITE

Material	Total Miles Per Year	Man-rems Received Per Year General Population
Spent fuel		
Core and axial blanket	7,000	.105
Radial blanket	6,000	.090
Radwaste	10,000	.165
Total		.360

12

TABLE 5.3-7

SUMMARY OF INDIVIDUAL AND POPULATION DOSES

FROM EXPOSURE TO THE CRBRP

Exposure Pathway	Individual External Total Body (mrem/y)	Individual Internal Whole Body (mrem/y)	Population* External Total Body (man-rem/yr)	Population* Internal Whole Body (man-rem/yr)	
Gaseous Effluents	2.3×10^{-2}	5.6×10^{-1}	2.7×10^{-2}		8
Liquid Effluents	7.2×10^{-7}	1.9×10^{-2}	3.7×10^{-8}	3.9×10^{-3}	
Direct Radiation	6.3×10^{-1}	—	2.0×10^{-2}	—	
Transportation of Fuel and Radwaste	—	—	1.1×10^{0}	—	12
Total	6.5×10^{-1}	5.8×10^{-1}	1.1×10^{0}	3.9×10^{-3}	8
Percent of Natural Radiation**	6.5×10^{-1}	3.2×10^{0}	1.1×10^{-3}	2.2×10^{-5}	

*Population is 987,314 as projected for 2010 in Section 2.2.

**External natural background for Eastern Tennessee is 100 mrem/yr. Internal natural background is 18 mrem/yr.

+This value is very conservatively calculated since it does not include allowance for shielding provided by the four-foot thick concrete confinement structure. 8

cover changes from grassland to heavy brush, such species as the bob-white quail will decline in numbers. Clearing will return the area to shrubby habitat areas. This cycle will continue as long as the area is maintained by regular clearing operations.

The presence of 85-foot high transmission towers, approximately 15 feet taller than the bordering forest, is not expected to effect the Canada goose migration across the CRBRP Site.

5.6.2.3 ACCESS ROADS

Existing area roads will suffice for maintenance work; the majority of these roads are presently surfaced with gravel, regularly maintained and restricted to the public. Any rutting caused by maintenance vehicles on these roads will be repaired by grading and reseeding or graveling as necessary. Some routine maintenance work or emergency work will require vehicular traffic on the ROW. Rutting will be repaired by hand or machine, and any drainage disturbed will be restored.

5.6.2.4 AESTHETICS

Cleared rights-of-way can have a profound visual impact of the environment. Usually this impact is most noticeable when the lines pass through scenic, recreational or historical areas or where the public is afforded extensive views of the facilities. Only a short expanse of the proposed corridor is visible from White Wind Road and it is visible for only a few seconds to motorists, as discussed in Section 4.2. Although a newly cleared transmission line is not generally an aesthetically pleasing sight, public viewing of corridors in this condition will be insignificant in terms of time and amount of line observable. Natural buffers of vegetation will be maintained where public viewing of such maintenance conditions would be possible. The remainder of the proposed transmission facilities are out of sight of public view as access to the ROW is controlled by locked gates at all times.

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5.7 OTHER EFFECTS OF PLANT OPERATION

Operation of the CRBRP should institute no changes in land use not already abrogated during the construction phase. Comparison of the construction phase to the operational phase should, in fact, result in relief of some of the man-induced stresses due to significant reductions in the motion and noise of heavy equipment and vehicular traffic at the plant site. Stabilization of routing should result in greater tolerance of the installation by the terrestrial population. The effects of plant operation are discussed in Sections 5.1 through 5.6. Because of the plant design and the distance of the Site from other industrial or power plants in the area (ORGDP is three miles north-northwest) the CRBRP should not have either thermal or radioactive waste interaction with effluents released by other plants in the area. No wastes from the plant are anticipated to be disposed of by means other than those discussed in Sections 5.3 through 5.5.

5.7.1 FUEL CYCLE IMPACTS

The contribution of the plant fuel cycle to the environment has been estimated and is set forth in Table 5.7-1, CRBRP-Summary of Environmental Considerations for Fuel Cycle. Data presented in Table 5.7-2 show the minimal significance of the fuel cycle impact when compared to other effects. 12

5.7.1.1 CRBRP FUEL CYCLE

A simplified schematic diagram of the CRBRP fuel cycle employing plutonium recycle is shown in Figure 5.7-2. The mass flow parameters are characteristic of those for the CRBRP under psuedo-average equilibrium-cycle conditions (where the cycle-to-cycle variations in the batch CRBRP fuel management have been averaged out). At equilibrium, approximately 0.9 MT of plutonium and 11 MT of depleted uranium are fabricated into mixed-oxide fuel and blanket assemblies per year. One half of one percent heavy metal has been assumed to be lost in the fabrication process. In the reactor core, irradiation at 975 MW(th) for 274 equivalent full power days destroys approximately .28 MT of plutonium and 0.38 MT of uranium per year through fission and nuclear transmutation reactions. 0.27 MT of fission product isotopes are produced per year. Because of the breeding 12 characteristics of the CRBRP, plutonium is both produced and destroyed in the core and the discharge fuel and blankets contain approximately 0.97 MT of plutonium. This spent fuel is chemically reprocessed, where once again 1/2% of heavy metal isotopes are assumed to be lost or unrecoverable. Fission products, irradiated structural material and other wastes are shipped to a waste storage facility. The recovered plutonium (0.96 MT/year), and perhaps the uranium as well, is recycled as fresh fuel input to the fuel fabrication facilities. The net gain of approximately 0.07 MT of plutonium per year can be stored for later use.

Adequate supplies of plutonium are projected to be available from DOE-produced material to startup and operate CRBRP for several years. No impacts are included in the estimate for production of this material. This material must be converted to an oxide form at a yet to be determined facility prior to fuel fabrication. Oxide conversion is normally performed at reprocessing plants. The impacts of conversion are bounded by the impacts of operating the reprocessing plant given in Table 5.7-1. 12

Fabrication of the mixed oxide core fuel is planned to be performed at the Secure Automated Fabrication (SAF) line, to be installed in the Fuels and Materials Examination Facility at DOE's Hanford reservation. CRBRP fuel fabrication will require about 65 percent of the SAF line capabity on an annual average basis. The data presented in Table 5.7-1 for mixed oxide fuel fabrication are based on the impacts in DOE/EA-0116 "Environmental Assessment for the Fuels and Materials Examination Facility," July 1980, and supplements.

Blanket fuel fabrication for the CRBRP will be carried out at a yet to be selected commercial facility. An average of 75 blanket fuel assemblies will be required per year (based on 224 assemblies required initially, 142 more assemblies required 2 years later, and 82 more assemblies required 2 years after that). There will be about 100 kg of uranium per assembly, with an isotopic composition at 0.2 percent U-235 and 99.8 percent U-238. Thus, a throughput of about 7.5 MT/yr of uranium will be needed. For the purpose of assessing environmental impacts, the impact of the model UO_2 blanket fabrication facility in WASH 1248, were apportioned to the 7.5 metric ton/year throughput required for CRBRP.

President Reagan's nuclear policy statement of October 8, 1981, endorsed nuclear fuel reprocessing by private industry. The Department of Energy has requested private industry to consider the possibility of making a future commitement to build and operate a reprocessing plant to meet near-term industry requirements. Should the industry not make such a commitment in a time frame compatible with CRBRP needs, other alternatives are available, such as the modification and use of existing reprocessing facilities at Savannah River, Hanford or Barnwell, construction of new facilities, or possible multi-national ventures. For the purpose of assessing environmental impacts as identified in Table 5.7-1, gaseous radioactive effluents were calculated by applying the confinement factors of the model reprocessing plant in WASH 1535 to the average annual CRBRP fuel source term. Other effluents from the reprocessing plant were estimated by apportioning the effluents of the model plant in WASH 1535 to the 7.5 metric ton/year mixed oxide throughput required for CRBRP. 12

Conservative estimates of the solid radioactive wastes resulting from the CRBRP fuel cycle are included in Table 5.7-5.

Also shown are similar wastes from the fuel cycle for a typical 1000 MWe LWR. The low-level wastes will be transported to an existing DOE or commercial burial facility for disposal. Transuranic contaminated wastes from fuel fabrication at the SAF line are planned to be disposed of in an existing burial area at DOE's Hanford reservation. Transuranic and high-level wastes resulting from reprocessing the CRBRP fuel will be disposed of at a yet to be built Federal repository.

5.7.1.2 FUEL CYCLE IMPACTS

CRBRP fuel fabrication (core fuel) requires about 65% of the SAF line capacity on an annual average basis. Thus, the environmental impact of CRBRP fuel fabrication is a portion of the SAF line impact, which is a portion of the FMEF impact. The FMEF annual 50-year dose commitments to maximum individuals and the general population within 50 miles of the FMEF are as follows: 12

Organ	Maximum Individual Dose (millirem)	Population Dose (Man-rem)
Whole Body	1.5×10^{-3}	4.6×10^{-3}
Thyroid	2.2×10^{-4}	9.0×10^{-4}
Lung	2.9×10^{-3}	1.1×10^{-2}
Bone	9.5×10^{-3}	4.0×10^{-2}
Liver	5.3×10^{-3}	2.1×10^{-2}

Natural background and medical exposures would give an annual average exposure to individuals of about 150 millirem. The annual whole body population doses due to natural radioactivity would be about 25,000 man-rem for the year 2000 population within 50 miles of the FMEF.

Annual 50-year dose commitments to maximum individuals and the general population within 50 miles of the model LMFBR fuel reprocessing plant for atmospheric releases would be as follows:

Organ	Maximum Individual Dose (millirem)	Population Dose (Man-rem)
Whole Body	0.055	0.94
Thyroid	0.141	1.10
Lung	0.053	0.96
Bone	0.121	1.93
Liver	0.072	0.88

Natural background exposures would give an annual average exposure to individuals in the vicinity of the model plant site of about 102 millirem.[1] The annual whole body population dose due to natural radioactivity for the population within a 50 mile radius of the model plant is estimated to be 1.02×10^5 man-rem.[1] 12

It should be noted that there would be no liquid releases of radioactivity from the model plant. The C-14 released would produce a world-wide population dose commitment, over all time, of 37 man-rem, based on a constant world population of 6×10^9 people.[2]

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[1]WASH 1535, Volume II, "Proposed Final Environmental Statement, Liquid Metal Fast Breeder Reactor Program," December 1974.

[2]ERDA-1535, Volume I, Section III D, "Final Environmental Statement, Liquid Metal Fast Breeder Reactor Program" December 1975.

Impacts from high level waste product solidification are specifically assessed as contributing to the total impact from operation of the reprocessing facility.

Impacts from transportation of new fuel to CRBRP, from operation of CRBRP and from transportation of spent fuel from CRBRP are identified in Section 5.3.

The impact of transportation of wastes from reprocessing were estimated assuming a 2500 mile trip for each shipment, and are given below:

	Volume/yr	Trips/yr	Dose (Person-rem)	
Low Level	4000 ft^3	11	0.601	
Transuranic	4070 ft^3	40	2.16	12
High Level	22 ft^3	3	0.117	

The low level and transuranic wastes from fuel fabrication are to be disposed of at the DOE's Hanford Reservation. Transportation from the fuel fabrication plant to the waste management site occurs over a route completely within the Hanford Reservation, with no public exposure. Thus there will be no impact from this transportation phase.

Table 5.7-6 compares the constituents of the annual generation of high-level wastes from reprocessing CRBRP fuel with those for a typical LWR. As the CRBRP high-level wastes are similar to those from an LWR, impacts from disposal of these wastes will be no different than those from the LWR fuel cycle.

The radioactive wastes resulting from the CRBRP supporting fuel cycle are comparable to those from a typical LWR and will be a small portion of the annual U.S. generation rate. Therefore, no significant impacts are expected from their transport and disposal.

5.7.1.3 SAFEGUARDS AND SECURITY

The presence of Special Nuclear Material (SNM) in the CRBRP fuel cycle requires that safeguards and security be applied to the accounting and protection of the SNM. The safeguards and security system at the CRBRP plant site is described in PSAR Section 13.7. The non self-protected SNM is transported by the DOE in the Safe Secure Trailer (SST) described in classified DOE documentation. Accountability during fuel fabrication is described in HEDL-TC-1542, Description of the Accountability Computer Functions in the Rescoped FMEF, October 1979. Other information with regards to the safeguards and security of SAF is in classified DOE documentation. The safeguards and security system for reprocessing is plant specific and will meet all applicable regulations. 12

The safeguards and security systems used throughout the CRBRP fuel cycle are expected to be effective in accounting for and protecting the SNM. No environmental impacts are expected from these safeguards and security systems.

5.7.2 POWER PLANT OPERATIONAL NOISE AND IMPACT

The CRBRP will contain a large number of sound sources, most of which will be well enclosed in thick concrete structures and will, thus, pose no noise problems. There are, however, several external sources of noise whose effect on the surrounding area is described in this section. Estimated ambient noise level, predicted CRBRP noise levels and impact assessment are discussed in subsequent subsections.

5.7.2.1 ESTIMATED AMBIENT NOISE LEVEL

The area on and around the plant site has an ambient noise level characteristic of a sparsely populated rural area. The only consistent source of non-natural noise is traffic on Interstate 40 which is about 1-1/4 miles from the center of the CRBRP Site at its closest approach. At the nearest dwelling to the CRBRP Site center, trucks passing on the interstate highway can be heard, but not cars. Based on measurements made in other similar rural areas, the average A-weighted ambient noise level is estimated to be 6
40-45 dBA. Traffic on the interstate is believed to be a major contributor to the ambient noise level.

5.7.2.2 PREDICTED NOISE LEVELS

The major sources of noise from the plant site will be the mechanical draft cooling towers, the turbine generator building and the main power output transformer. Arrangement of main plant structures is shown in Figure 2.1-4, and the location of these structures on the Site is shown in Figure 2.1-3. Cooling tower sound levels were determined from published references (also see Section 5.1.8.4). The transformer sound level estimates were based on the National Electrical Manufacturers Association (NEMA) transformer ratings. The sound levels from the turbine-generator building were based on estimates of the internal machinery noise level corrected for the transmission loss of the metal panel walls.

The radiated noise levels were determined by assuming that the total sound power emitted by the plant, suitably corrected for directivity (geometry, location and orientation), is radiated hemispherically from the center of the plant site. The sound levels in the surrounding area were calculated by summing the contribution from each of the sources at each point of interest. Corrections were made for the shielding effect of the plant on the cooling tower noise and of the turbine-generator building on the transformer noise.

A correction for the molecular absorption of sound in air also has been included.(1) The magnitude of this correction was determined by assuming a sound spectrum for the cooling tower noise.(2) Because most of the area surrounding the plant site is and will remain heavily wooded, a correction for the ground attenuation was estimated and included in the calculated sound levels.(3) A significant change in the ground attenuation is anticipated with a seasonal change from summer to winter because of the loss of foliage from the woods.

The nearest dwellings to the CRBRP Site are located approximately 3,100 feet south-southwest of the plant site and approximately 3,200 feet west-southwest of the plant site. Both dwellings are at an elevation of about 800 feet MSL, one on each side of Poplar Springs Creek. The predicted sound level, due to normal plant operation alone, at both of these locations is 42 dBA in the summer and 45 dBA in the winter. 6

At radial distances greater than several thousand feet, contours of equal sound level are almost circular. At a radial contour one mile from the plant site center the predicted summer noise level from the plant is 37 dBA; the corresponding predicted winter level from the plant is 41 dBA. Ambient levels may be higher than these values particularly for locations nearer Interstate 40. The one-mile contour and the two nearest dwellings are shown in Figure 5.7-1.

5.7.2.3 IMPACT OF OPERATIONAL NOISE

The U.S. Department of Housing and Urban Development[4] has provided outdoor noise exposure guidelines for non-aircraft noise. Four categories of external noise exposure are defined. The categories and their respective noise limits are listed in Table 5.7-3.

Since the noise from the power plant is essentially constant, the "acceptable" category corresponds to sound levels below 45 dBA, the "normally acceptable" category to levels between 45 and 65 dBA, the "normally unacceptable" category levels between 65 and 75 dBA and the "unacceptable" category corresponds to levels above 75 dBA.

Based on the predicted levels and contours described in Section 5.7.2.2, the population distribution from Table 2.7-3 and the peak transient population from Table 2.2-14 and Figure 2.2-7, there will be no exposure of the permanent population or of the transient population at nearby recreation areas to noise levels above 45 dBA. 6

At many locations, particularly a recreation area at Caney Creek, the ambient noise from the interstate highway will exceed the noise produced by the plant.

The State of Tennessee and Roane County do not have any regulations or zoning restrictions related to noise that are applicable to the CRBRP Site. The City of Oak Ridge has a zoning ordinance[5] which specifies that sound shall not exceed the decibel levels given in Table 5.7-4 when adjacent to the uses listed. The ordinance does not indicate whether the sound level limits are linear or A-weighted sound levels. The specified levels are assumed to be A-weighted values since the A-weighting simulates the response of the human ear and is thus used in most such ordinances.

To the north, the CRBRP Site property line adjoins the Clinch River Consolidated Industrial Park. The sound level contour shown in Figure 5.7-1 shows that the sound level at this property line will be significantly less than the specified limit in Table 5.7-4. The remainder of the area adjoining the Site is rural in character and separated from the Site by the Clinch River. The Oak Ridge ordinance does not specifically address this type of area. However, based on the predicted noise levels, the impact of the noise produced by the plant on the surrounding area will be negligible. 6

TABLE 5.7-1

CRBRP - SUMMARY OF ENVIRONMENTAL CONSIDERATIONS FOR FUEL CYCLE

Natural Resource Use	Fuel Fabrication Mixed Oxide (Core Fuel)	Fuel Fabrication Uranium Dioxide (Blanket)	Reprocessing	Waste Management	Transportation	Total
Land (acres)						
Temporarily Committed	--	3.4	5.1	--	--	8.5
Undisturbed Area	--	2.9	4.8	--	--	7.7
Disturbed Area	--	0.5	0.3	--	--	0.8
Permanently Committed	--	--	0.2	1.0	--	1.2
Water (gallons/day)						
Discharged to air	--	5.3×10^3	5.82×10^3	--	--	1.11×10^4
Discharged to water bodies	--	6.4×10^3	--	--	--	6.4×10^3
Discharged to ground	7.5×10^2	--	--	--	--	7.5×10^2
Total Wa[illegible]	7.5×10^2	1.17×10^4	5.82×10^3	--	--	1.83×10^4
Fossil Fuel						
Electrical Ene[illegible]-/yr)	9.0×10^3**	8.15×10^3	3.0×10^3	--	--	2.02×10^4
Equivalent Co[illegible]	3.6×10^3	3.60×10^2	1.3×10^3	--	--	5.26×10^3
Effluents						
Chemicals						
Gases* (MT/yr)						
SO_x	133	13.3	48.0	--	--	194
NO_x	35.2	3.5	12.7	--	--	51.4
Hydrocarbons	0.36	3.5×10^{-2}	0.13	--	--	0.525
CO	0.86	8.7×10^{-2}	0.31	--	--	1.26
Particulates	35.2	3.5	12.7	--	--	51.4
HF	--	2.36×10^{-3}	--	--	--	2.36×10^{-3}
NH_3	--	7.08×10^{-3}	--	--	--	7.08×10^{-3}

12

(Continued)

Natural Resource Use	Fuel Fabrication: Mixed Oxide (Core Fuel)	Fuel Fabrication: Uranium Dioxide (Blanket)	Reprocessing	Waste Management	Transportation	Total
Liquids (grams/yr)						
H_2SO_4	1.0×10^5	--	--	--	--	1.0×10^5
HNO_3	1.0×10^5	--	--	--	--	1.0×10^5
NH_4OH	--	8.1×10^7	--	--	--	8.1×10^7
$Ca(OH)_2$	--	4.8×10^6	--	--	--	4.8×10^6
CaF_2	--	2.1×10^3	--	--	--	2.1×10^3
PO_4^{-3}	1.0×10^4	4.3×10^4	--	--	--	5.3×10^4
PO_4^{3-} (after degrading)	1.0×10^3	4.3×10^3	--	--	--	5.3×10^3
Total solids	--	1.6×10^5	--	--	--	1.6×10^5
PO_4^{3-} (in cooling tower drift)	--	2.4×10^3	--	--	--	2.4×10^3
Radiological (Curies/yr)						
Gases						
Pu-236	2.0×10^{-9}	--	1.34×10^{-9}	--	--	3.34×10^{-9}
Pu-238	3.4×10^{-6}	--	9.0×10^{-5}	--	--	9.3×10^{-5}
Pu-239	2.2×10^{-6}	--	2.18×10^{-5}	--	--	2.4×10^{-5}
Pu-240	2.2×10^{-6}	--	2.21×10^{-5}	--	--	2.4×10^{-5}
Pu-241	3.0×10^{-4}	--	2.48×10^{-3}	--	--	2.8×10^{-3}
Pu-242	3.0×10^{-9}	--	4.71×10^{-8}	--	--	5.0×10^{-8}
U-232	--	--	1.04×10^{-10}	--	--	1.04×10^{-10}
U-234	5.8×10^{-11}	--	2.36×10^{-9}	--	--	2.4×10^{-9}
U-235	2.5×10^{-12}	3.2×10^{-9}	8.48×10^{-11}	--	--	3.3×10^{-9}

(Continued)

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TABLE 5.7-1 (Continued)

Natural Resource Use	Fuel Fabrication: Mixed Oxide (Core Fuel)	Fuel Fabrication: Uranium Dioxide (Blanket)	Reprocessing	Waste Management	Transportation	Total
Radiological (Curies/yr)						
Gases						
U-236	--	--	1.7×10^{-10}	--	--	1.7×10^{-10}
U-238	5.4×10^{-11}	2.5×10^{-9}	7.9×10^{-9}	--	--	1.0×10^{-8}
Th-228	--	--	3.0×10^{-12}	--	--	3.0×10^{-12}
Th-231	2.5×10^{-12}	3.2×10^{-9}	8.48×10^{-12}	--	--	3.2×10^{-9}
Th-234	5.4×10^{-11}	2.5×10^{-9}	7.9×10^{-10}	--	--	3.3×10^{-9}
Am-241	--	--	1.37×10^{-5}	--	--	1.37×10^{-5}
Np-237	--	--	2.22×10^{-10}	--	--	2.22×10^{-10}
Pa-234	5.4×10^{-11}	2.5×10^{-9}	7.9×10^{-10}	--	--	3.3×10^{-9}
H-3	--	--	5.34×10^{3}	--	--	5.34×10^{3}
Kr-85	--	--	4.67×10^{2}	--	--	4.67×10^{2}
C-14	--	--	1.44×10^{-4}	--	--	1.44×10^{-1}
I-129	--	--	3.32×10^{-5}	--	--	3.32×10^{-5}
I-131	--	--	4.96×10^{-10}	--	--	4.96×10^{-10}
Ru-103	--	--	7.43×10^{-5}	--	--	7.43×10^{-5}
Ru-106	--	--	5.07×10^{-3}	--	--	5.07×10^{-3}
Ce-134	--	--	4.74×10^{-5}	--	--	4.74×10^{-5}
Ce-137	--	--	1.60×10^{-4}	--	--	1.60×10^{-4}
Particulate Fission Products	--	--	4.88×10^{-3}	--	--	4.88×10^{-3}

12

(Continued)

TABLE 5.7-1 (Continued)

Natural Resource Use	Fuel Fabrication Mixed Oxide (Core Fuel)	Fuel Fabrication Uranium Dioxide (Blanket)	Reprocessing	Waste Management	Transportation	Total
Radiological (Curies/yr)						
Liquids						
U-Total	--	5.0×10^{-3}	--	--	--	5.0×10^{-3}
Th-234	--	2.0×10^{-3}	--	--	--	2.0×10^{-3}
Pa-234	--	2.0×10^{-3}	--	--	--	2.0×10^{-3}
Solids (Ci/yr)						
Other than high level						
Alpha	1.0×10^{5}	--	7.0×10^{5}	--	--	8.0×10^{5}
Beta-Gamma	34.	--	40	--	--	74
High Level	--	--	3.8×10^{6}	--	--	3.8×10^{6}
Thermal Generation (Btu/yr)	Not Available	1.25×10^{10}	7.2×10^{8}	--	1.7×10^{7}	1.25×10^{10}

* Based upon combustion of equivalent coal for power generation
**Total for FMEF operation

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TABLE 5.7-4

CITY OF OAK RIDGE NOISE LIMITS(5)

Sound Level, dB	Adjacent Uses	Where Measured
50	All Residential Districts	Common Lot Line
55	Neighborhood Business District	Common Lot Line
60	General Business District	Common Lot Line
65	Industrial District	Common Lot Line
75	Major Street	Lot Line at Street
60	Secondary Residential Street	At Street Lot Line

6

TABLE 5.7-5

Comparison of Annual Waste Volumes

Facility	CRBRP Fuel Cycle	1000 Mwe LWR Fuel Cycle (Pu Recycle)
Low-Level		
Mill	-	254,000 MT (1)
Conversion	-	1,200 ft^3 (1)
Enrichment	-	50 ft^3 (1)
Fuel Fabrication	6,000 - 11,000 ft^3 (2 & 3)	10,000-30,000 ft^3 (3)
Fuel Reprocessing	2,000 - 4,000 ft^3 (3)	600- 4,000 ft^3 (3)
Transuranic		
Fuel Fabrication	3,600 ft^3 (2)	10,000-30,000 ft^3 (3)
Fuel Reprocessing	2,070-4,070 ft^3 (3)	660-4060 ft^3 (3)
High-Level		
Fuel Reprocessing	22 ft^3 (3)	55 ft^3 (3)

(1) "Report to the President by the Interagency Review Group on Nuclear Waste Management," TID-29442, Appendix D (March 1979).

(2) "FMEF Environmental Assessment, Supplement for Secure Automatic Fabrication (SAF)," DOE/FA-0016 (July 1980).

(3) "Proposed Final Environmental Statement, Liquid Metal Fast Breeder Reactor Program," WASH-1535, Table 4.6-3 (December 1974).

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TABLE 5.7-6

Comparison of Annual High-Level Waste Constituents (Ci)

Nuclide	CRBRP	1000 Mwe LWR[(1)]
H-3	4.5×10^{2}	1.28×10^{3}
Sr-90	3.16×10^{3}	2.3×10^{6}
Ru-106	5.07×10^{6}	7.2×10^{6}
I-129	1.66×10^{-3}	6.5×10^{-3}
Cs-134	2.37×10^{5}	4.6×10^{6}
Cs-137	8.01×10^{5}	3.5×10^{6}
Ce-144	4.3×10^{6}	9.1×10^{6}
Pu-238	9×10^{2}	1.15×10^{3}
Pu-239	2.16×10^{2}	7×10^{1}
Pu-240	2.21×10^{2}	1.4×10^{2}
Pu-241	2.48×10^{2}	3.4×10^{4}
Am-241	6.86×10^{4}	2.7×10^{4}
Cm-242	1.09×10^{6}	3.8×10^{5}
Cm-244	3.51×10^{3}	2.7×10^{5}

12

(1) "Final Environmental Impact Statement, Management of Commercially Generated Radioactive Wastes," DOE/EIS-0046F, Table 4.2.3 (October 1980).

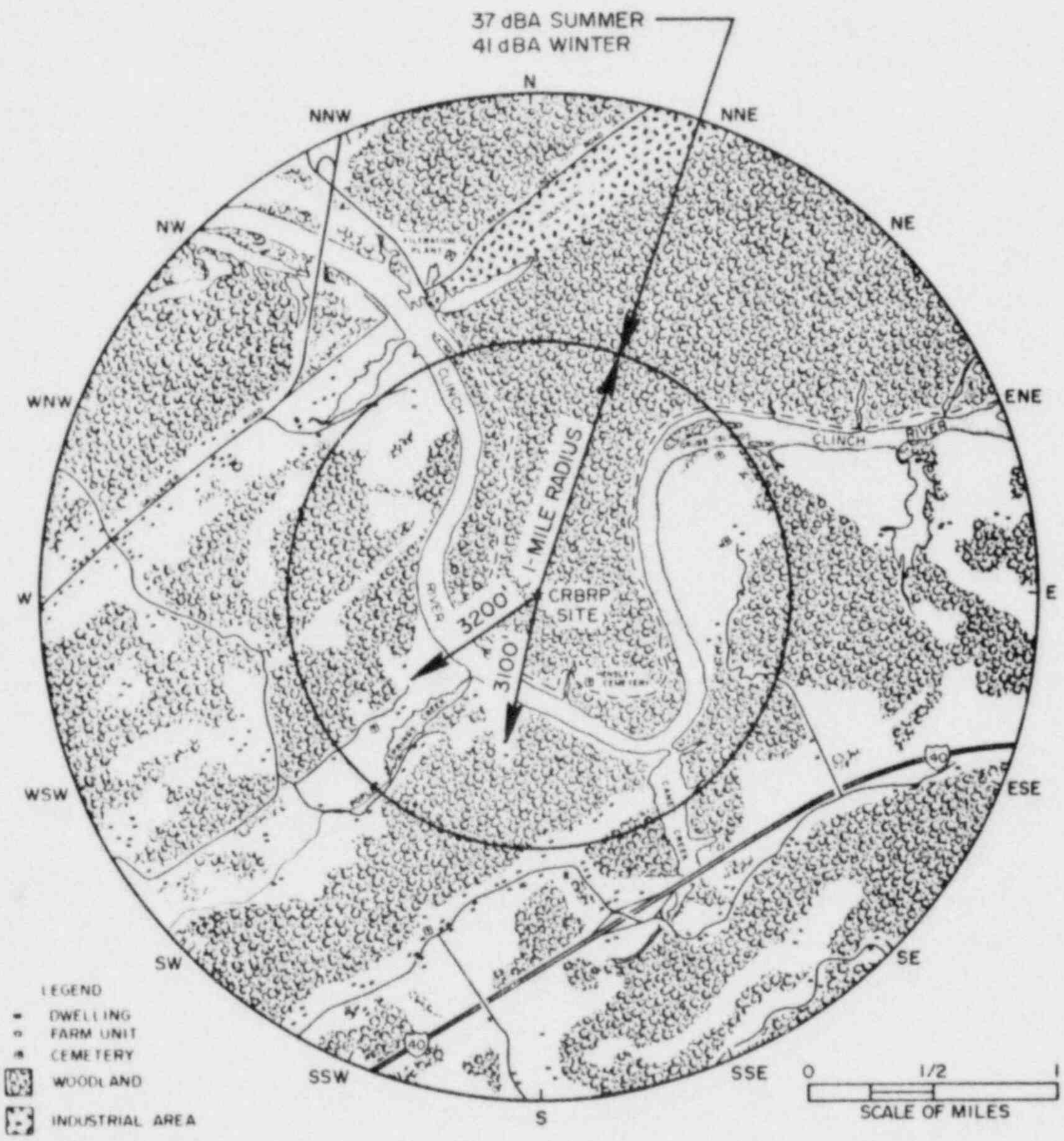


Figure 5.7-1. One-Mile CRBRP Sound Level Contour and Nearest Dwellings

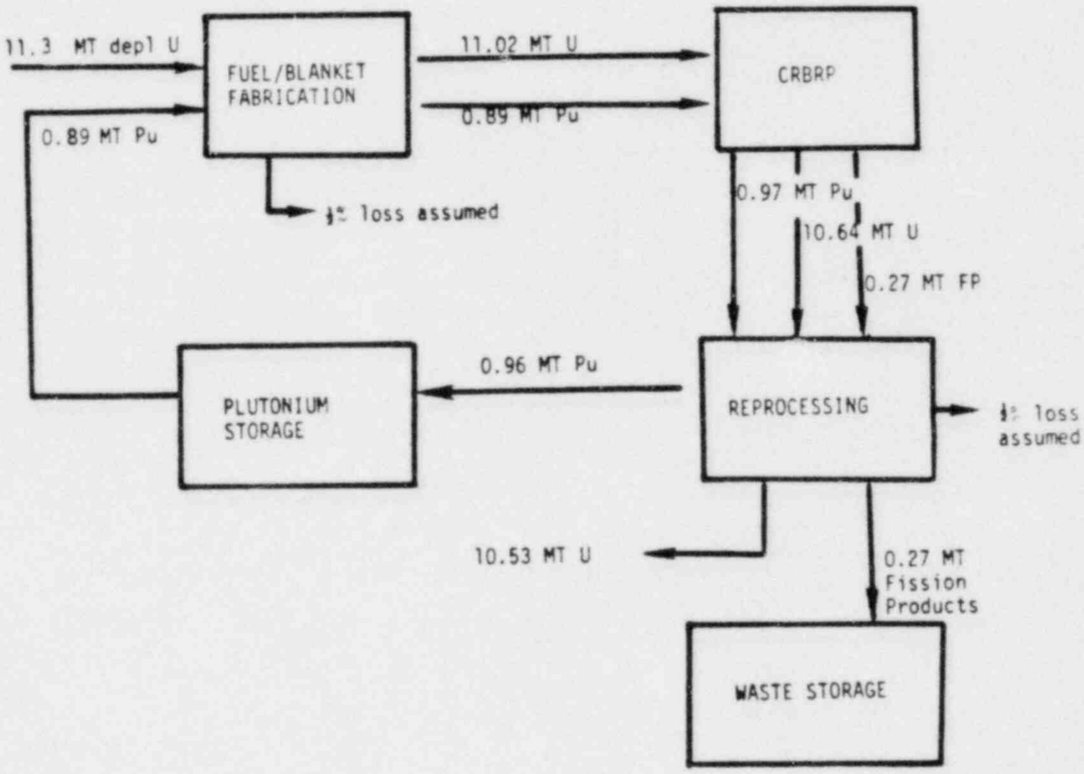
FIGURE 5.7-2

CRBRP EQUILIBRIUM FUEL CYCLE

PLUTONIUM AND URANIUM MASS FLOW

(MT/year, average)

12



5.8 RESOURCES COMMITTED

The commitment of resources ascribed to the construction of the CRBRP was discussed in Section 4.3. This section is concerned with the commitment of resources during the expected life of the plant. Commitments of the various types of resources are not all of equal consequence. During operation of the plant, resources are utilized in amounts that, relative to their general availability, will not constitute an irreversible or irretrievable commitment.

5.8.1 COMMITMENT OF LAND RESOURCES

Approximately 135 acres of primarily forested land area (on-site plus off-site) have been committed for the CRBRP and its related facilities. This commitment, however, does not represent a measurable fraction of the productive forest resources of the region. The commitment of 135 acres is only 0.27 percent of the total acreage within a five-mile radius of the plant.

The Site has little agricultural potential due to the poor suitability of the soil and has been designated as an area for industrial development as discussed in Section 2.7. Should it be desirable at the end of the facility's expected life, the land can be returned to a condition suitable for future industrial development. Decommissioning and dismantling of the facility are discussed in Section 5.9.

No further alteration or destruction of wildlife habitats should occur during plant operation.

5.8.2 COMMITMENT OF WATER RESOURCES

One of the major resources committed during plant operation will be water from the Clinch River. Flow rate of the river varies from an

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AMENDMENT XII

Additional Information for Detailed
Environmental Assessment of the Clinch
River Breeder Reactor Plant (CRBRP) Site

Amendment XII

Revisions Resulting from Additional
or Updated Information and Minor Corrections

Section		Major Reason for Revision
3.8	-	Update fuel shipping information
5.3	-	Update fuel shipping information and revise dose estimates due to material in transit.
5.7	-	Revised to expand and update the discussion of the fuel cycle.
13.0	-	Revised to incorporate a reference to Section 5.3.

QUESTION 750.1R

Since there are no known commercial plans for participating in the CRBR fuel cycle on a licensed basis, it appears that the fuel cycle related to CRBR will have to be carried out by DOE in its own unlicensed facilities. Accordingly, it will be necessary for DOE to project its plans for carrying out the fuel cycle functions related to processing, safeguarding and transportation of fuels and for managing the handling and disposal of wastes.

In this regard, please provide an amendment to the environmental report that describes DOE's planned program and facilities for such functions related to CRBR, including estimates of the resources used and effluents and assessments of the potential effects, including radiological, resulting from such activities. This report will serve as the basis for NRC to perform its independent evaluations of these functions for CRBR licensing purposes.

RESPONSE:

The information requested in question 750.1R is provided in the ER Amendment XII.