(80)

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June 24, 1982

Mr. Homer Lowenberg
Office of Nuclear Materials
Safety and Safeguards
U. S. Nuclear Regulatory Commission
Washington D.C.

Dear Homer:

Enclosed is a set of back-up notes and references for the Fuel Cycle portion of the EIS Update. Also enclosed is a bibliography of material used by the Safeguards group. This should be added to that sent to you previously by Orv Hill. I expect that Bob McCallum will forward additional Safeguards material to you June 30, 1982 or before.

We received the updated EIS material on June 23, 1982.

Very truly yours,

Iral

Iral Nelson

ICN:bh

Enclosures

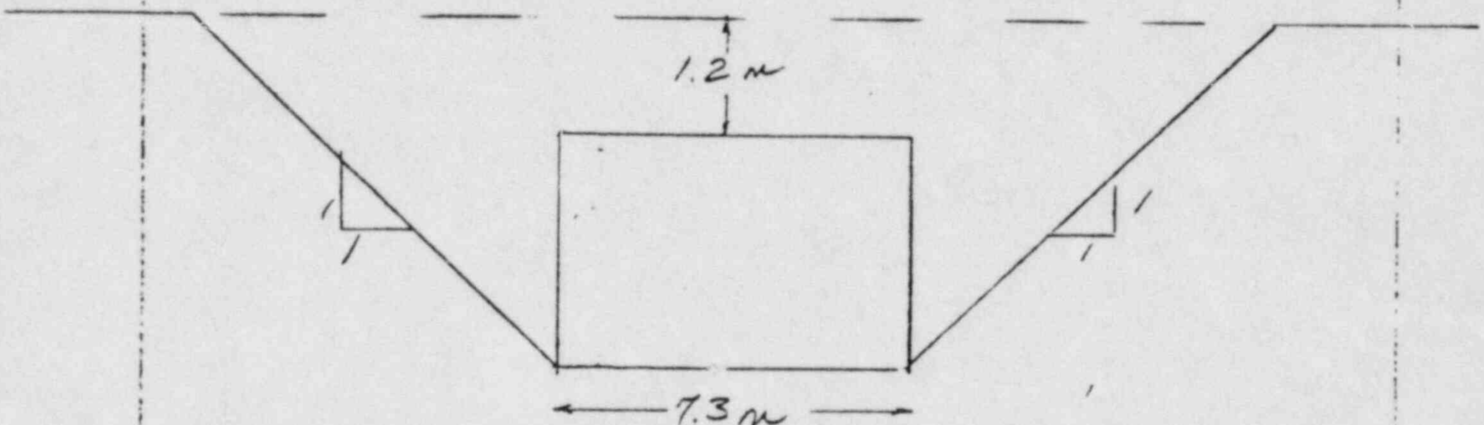
R.F. McCallum

TABLE OF CONTENTS

I. STORAGE IMPACTS

SAF generates 910 m^3 of TRU → 4350, 55 gal drums
IRP generates 300 m^3 of TRU → 1500, 55 gal drums
420 m^3 of metal scrap → 3060 - 10"D × 10'H containers

RHO-HS-ST-1 identifies configuration of TRU trench



Depth = 7.3 m

55 gallon drum ≈ 2'D × 3'H

Drums stacked 4 high

5850, 55 gallon drums

7.3 m → 24 ft → 12 drums across × 12 deep

(12)(12)(4) → 576 drums / level

5850 / 576 = 10.15 → 10 trenches

Solid radioactive waste buried in the ground is considered to be either in final disposal or interim storage. Waste buried after April 1970, which contains or is suspected of containing TRU waste in concentrations greater than 10 Ci/g, is considered to be in interim storage (20 yr). Large items of solid waste, such as failed equipment from locations where the presence of TRU waste can be safely ruled out, are packaged in concrete boxes and buried in industrial waste burial trenches. Small items of failed equipment and trash type contaminated waste, from locations where the presence of transuranium nuclides can be safely ruled out, are packaged in cardboard cartons, wood boxes, or steel or fiber drums and buried in the so-called "dry waste" trenches. A schematic drawing of a solid waste burial trench is shown in Figure 1-12.

Prior to 1970, the waste was packaged in iron drums and iron or concrete boxes and buried in special trenches. Subsequent evaluation of iron drums directly buried in Hanford soils indicated that failures could occur in less than 20 yr and retrieval, as contamination-free packages, might not be possible. Two alternatives to direct burial were implemented on a test basis, either of which will protect the containers from direct contact with the soil and will permit retrieval.

The first alternative, a prototype concrete V Trench, was built and filled with TRU-bearing waste drums, as shown in Figure 1-13. A metal cover and several feet of earth cover isolate the drums from the environment. This alternative provides protection of the drums from the soil and allows sampling of the storage trench atmosphere for radioactive materials and combustible gases, either of which would indicate drum failure.

Currently, a simpler alternative, pad storage, is being utilized. The TRU-bearing solid waste is segregated as combustible and noncombustible at the point of origin and placed in labeled drums. The segregated waste drums are placed on the storage pad in a stack four or five drums high; each layer of drums is separated by plywood treated with fire retardant. When drums are stacked to cover an area 7.3 by 7.3 m (24 by 24 ft), the stack is covered with plywood and plastic-reinforced nylon sheeting prior to covering with 1.2 m (4 ft) of earth. Capability for sampling the storage atmosphere is also provided. (A schematic of this storage alternative is shown in Figure 1-14).

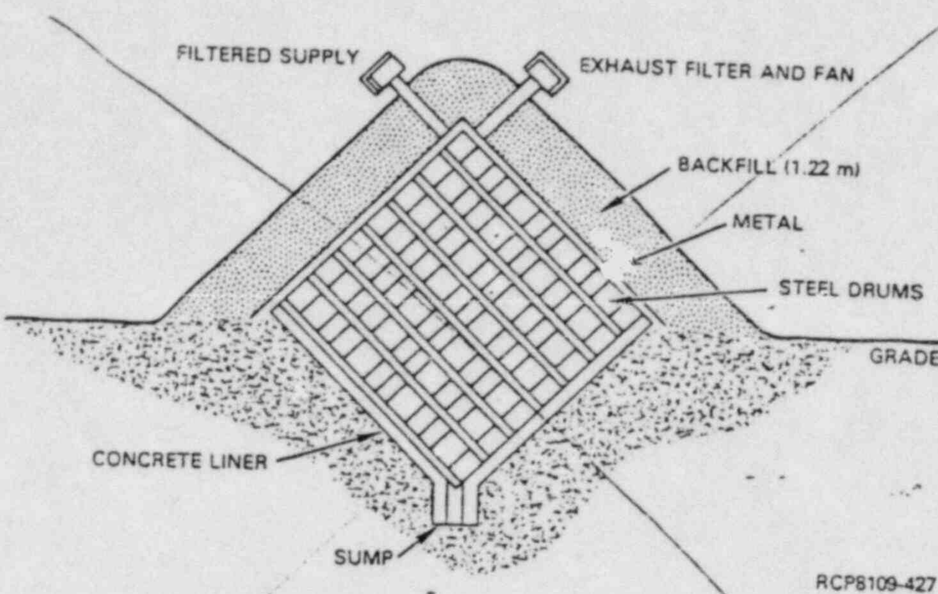


FIGURE 1-13. Vee Trench TRU Storage.

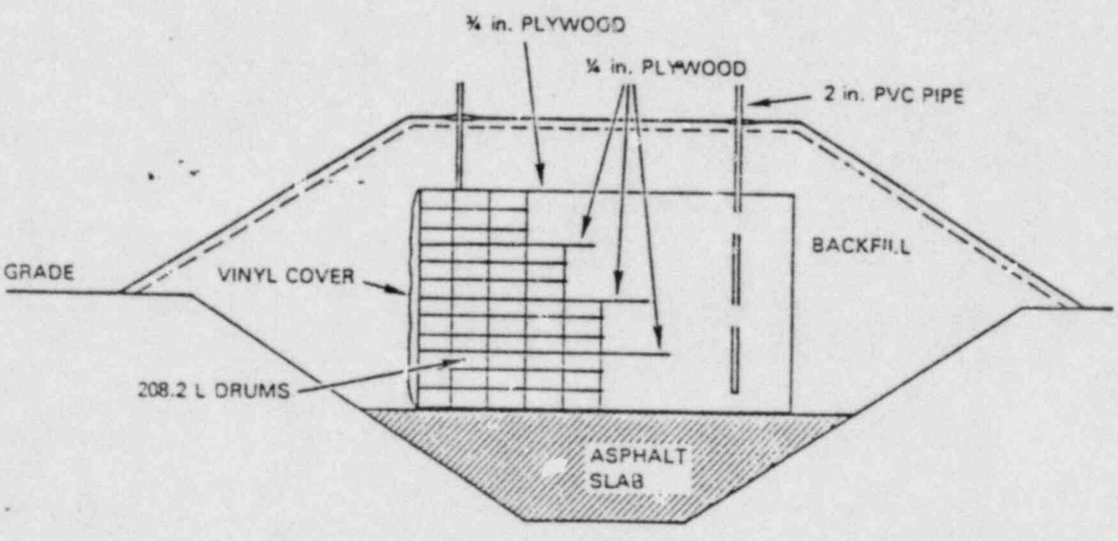
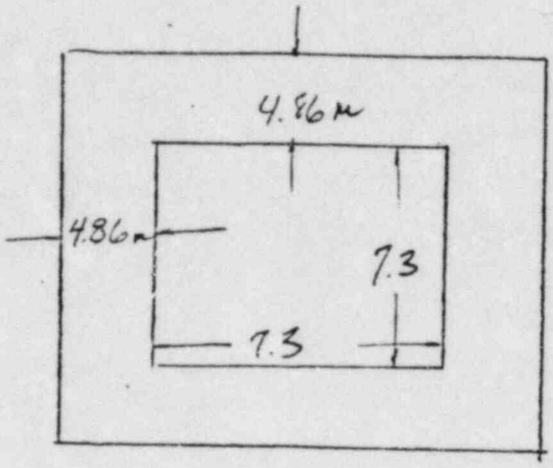


FIGURE 1-14. The Asphalt Storage Pad (Currently Used Method).

Area of each trench



Height = (4 rows)(3'/drum) $\cdot \frac{1\,m}{3.28\,ft}$ = 3.66 m

3.66 m + 1.2 m (cover) → 4.86 m

7.3 + 2(4.86) = 17.0 m

(17.0 m)(17.0 m)(10 trenches) → 2890 m^2

0.71 acres = 0.29 ha

Cylinders

$10'' D \times 10' H \rightarrow \frac{\pi (10)^2 (10)}{4(144)} \rightarrow 5.5 ft^3$

55 gallon drum

$2' D \times 3' H \rightarrow 9.4 ft^3$

If used same trench configuration for metal scrap cylinders as for 55 gallon drums need plywood frames and would lay cylinders on side.

In an 7.3m × 7.3m × 4.0m zone can store ≈ 2 deep × 24 across × 13 high when cylinders laying flat

2 × 24 × 13 = 624

Need ≈ 4-5 more trenches

As metal cylinder configuration not certain
might put less in each trench

∴ Assumed might need ≈ 1-2 more trenches

6 trenches (17.0)(17.0) ⇒ 1734 m^2

1734 m^2 = 0.43 acres = 0.17 ha

TOTAL: 0.71 / 0.43 } 1.14 acres = 0.46 ha

∴

ANNUALIZED: 0.038 acres or 0.015 ha

II. BURIAL GROUND IMPACTS

A. LAND

CRBRP - LLW = 2000 m^3, 9570 - 55 gallon drum

- Sodium bearing solids = 630 m^3, 2940 - 55 gallon drum

- Metallic sodium = 12 m^3, 60 - 55 gallon drums

FRP - LLW = 750 m^3, 3600 - 55 gallon drum

10CFR 61 (NUREG-0782), p E-30

$1 \times 10^6 m^3$ of LLW → 58 trenches

$\approx \frac{3400 m^3}{1 \times 10^6 m^3}$ (58 trenches) → 0.197 of 1 trench

Trench = 30m × 8m × 170m, 3m between trenches

Cross Section = (30 + 1.5)(170) = 5355 m^2

NUREG-0782

3.5 Natural Resources

The principal nonagricultural natural resources within the vicinity of the site are minerals and land.

3.5.1 Minerals

The predominant mineral resources within 50 km of the site are dimension stone, crushed stone, sand and gravel, and clay. Development of extensive mining efforts for metals has not been made in the area of the site. There are no known precious metals or fossil fuel mineral deposits within 8 km of the site. Withdrawing the surficial sandy layers at the site for industrial use is not cost-effective due to their poor construction quality. Sand is mined at a local borrow pit. This borrow pit produces an average of 680 metric tons (750 short tons) annually. A kaolin (clay) borrow pit is operated approximately 16 km (10 mi) to the southwest of the site. There is little potential at the site for cost-effective withdrawal of kaolin for construction-grade clay, although limited quantities are available for onsite use. The principal dimension stone mined in the state is limestone. However, the small thickness and poor quality of the limestone formation beneath the site makes it generally unattractive to major dimension stone producers.

3.5.2 Land

Within an 81 km (50 mi) radius of the site, there are three principal categories of land use: (1) woodland, (2) farmland, and (3) developed land. Approximately 25% of the land area is woodland (both private and government preserves), 55% is farmland (with an approximate 50:50 mixture of row crops and pasture), and 20% is developed land (light industry and residential dwellings). The area occupied by the site had been used for farming in the past. However, for the last several years the land has been lying uncultivated and a thick secondary growth has grown up.

4. REFERENCE FACILITY DESCRIPTION

The description of the reference disposal facility is divided into two sections: (1) the basic site design, and (2) the support facilities and structures.

4.1 Basic Design

To provide a base case against which alternatives can be analyzed in this environmental impact statement, the disposal facility is assumed to have a total capacity of up to one million m^3 (35.3 million ft) of waste which is delivered to the disposal site at an annual average rate of 50,000 m^3 (1.77 million ft^3) and randomly disposed into shallow land burial trenches having a design which is typical of current practices. This results in a base case amount of land which is committed for waste disposal. Alternatives considered in this environmental impact statement for waste form and disposal facility design and operation will vary the amount of land committed for waste disposal. For example, increased processing and volume reduction of waste decreases the amount of land needed for waste disposal, while the alternatives considered in

Land used by CRBRP (trench + rows)

$(5355 m^2)(0.197) = 1055 m^2 = 0.26$ acres

To allocate support areas to CRBRP

p. E-31 148 acres -- $600000 m^2$

$\left(\frac{3400 m^3}{1 \times 10^6 m^3}\right)(600000 m^2) \rightarrow 2040 m^2 = 0.51$ acres

B. FUEL

10 CFR 61 (NUREG-0782) p. 3-50

Fuel requirements (gallons)

1. 212,000 - Preoperational - Per unit volume
   $\left(\frac{7443}{10^6}\right)(212000) = 158$
2. 200,000 - Operational - Per unit volume
   $\left(\frac{7443}{10^6}\right)(200000) = 150$
3. 200 000 - Operational - per $10^6 m^3$ of disposal volume
   (150)

NUREG-0782

Table 3.8 Unit Rates for Impact Measures

Activity	Cost (thousand 1980 $)	Occupational* Exposure (person-mrem)	Energy Use (thousand gallons)	Units**
Preoperational				
Reference Base Case	7,452	--	212	Lump Sum
Additive Alternatives†				
Walled Trench	594	--	--	Lump Sum
Stacking	226	--	--	Lump Sum
Segregation	1	--	--	Lump Sum
Layering	132	--	--	Lump Sum
Decontainerized Disposal	924	--	--	Lump Sum
Hot Waste Facility	260	--	--	Lump Sum
Grouting	55	--	--	Lump Sum
Intruder Barrier	281	--	--	Lump Sum
Extreme Stabilization	10	--	--	Lump Sum
Operational				
Reference Base Case				
Trench (-Cover)	2,341	300	200	Disposal Vol.
Regular Cover	1,420	2,400	100	Disposal Area
Other	63,696	1,000	200	Lump Sum
Additive Alternatives†				
Walled Trench	74,438	700	300	Disposal Vol.
Stacking	12,758	100	100	Total Waste Vol.
Segregation	3,888	100	30	Total Waste Vol.
Layering	15,400	-100	30	Vol. Disp. by Layer
Decontainerized Disposal	48,975	400	100	Vol. Disp. by Decon
Hot Waste Facility	176,979	-200	450	Vol. Disp. by HWF
Grouting	72,405	2,550	800	Grout Volume
Sand Backfill	3,270	--	185	Sand Volume
Cover Options				
Thick	15,524	2,400	150	Disposal Area
Intruder Barrier	103,854	2,400	300	Disposal Area
Moderate Stabilization	3,465	4,800	300	Disposal Area
Extreme Stabilization	33,345	4,800	600	Disposal Area

Table 3.8 (continued)

Activity	Cost (thousand 1980 $)	Occupational* Exposure (person-mrem)	Energy Use (thousand gallons)	Units**
Postoperational				
Closure Period				
Regular Closure	1,010	500††	15	Lump Sum
Extensive Closure	3,025	1,000	60	Lump Sum
Institutional Period#				
Low Care Level				
Years 1-10	150	--	2	Per Year
Years 11-25	63	--	2	Per Year
Years 26-100	51	--	2	Per Year
Medium Care Level				
Years 1-10	303	--	6	Per Year
Years 11-25	150	--	6	Per Year
Years 26-100	63	--	6	Per Year
High Care Level				
Years 1-10	440##	--	10	Per Year
Years 11-25	303	--	10	Per Year
Years 26-100	150	--	10	Per Year

*Occupational exposures associated with operations other than waste unloading and disposal.

**Lump sum items are assumed to be independent of the waste volume. Disposal volume dependency is for 1 million m^3 of disposal (not waste) volume; grout volume dependency is for 1 million m^3 of grout injected; sand volume dependency is for 1 million m^3 of sand backfill; disposal area dependency is for 1 million m^2 of trench cover area.

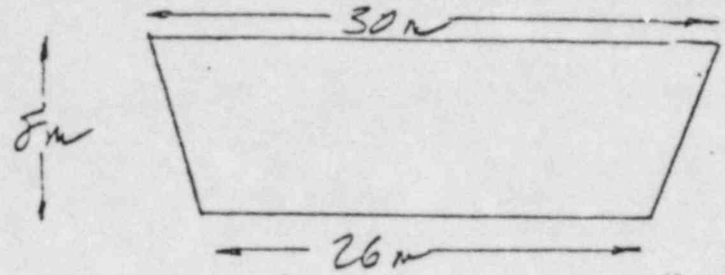
†Rates for alternatives are incremental rates in addition to the rates given for the reference system.

††Regular closure assumed to last 2 years, extensive closure is assumed to last four years. Both cases assume 5000 person-hours of field work per year in an average radiation field of 0.05 mR/hr.

#These costs are basic costs not considering inflation or interest. Details for complete calculation of the institutional period costs can be found in Appendix Q. The formulae given in Appendix Q are incorporated into the cost calculation procedure.

##To this cost, a contingency cost is added which depends on the soil conditions: $367,000 for medium-permeability soils; $168,000 for high-permeability soils; and, $1,007,000 for low-permeability soils.

Trench is 180m × 30m × 8m
with slope of 1 horizontal to 4 verticle



$V = (8m)(168m)(28m) = 37632\ m^3$/trench

accounts for 1/4 slope

CRBRP occupies 0.197 → 7420 m^3

$\frac{7420}{10^6}(200000) = 150$ gallons

4 100,000 Operational per $10^6\ m^2$ of trench area
(110)

$\frac{1055 m^2}{1 \times 10^6 m^2}(100000) = 110$ gallons

5. 60000 Post operational Per unit volume
$\left(\frac{7420}{10^6}\right)(60000) = 45$

6. 6000 Post Operational Per Year

Assume - Medium level care
- Proportional to waste stored
- 100 years

$6000/_{yr}(100\ yrs)\left(\frac{3400\ m^3}{1\times10^6\ m^3}\right)$ -- 2040

Total -- 150
-- 150
150
110
-- 45
2046

2659 gallons → $10 m^3$

Verify HLW similar to GEIS

GEIS -

$$\left(\frac{176\ kg}{MTHM}\right)\left(\frac{30\ MTHM}{GWe\text{-}yr}\right)\left(\frac{1\ cm^3}{3.0\ g}\right)\left(\frac{1000\ g}{kg}\right)\left(\frac{1\ m^3}{10^6\ cm^3}\right)$$

$\rightarrow 2.2\ m^3/GWe\text{-}yr$

CRBR

Assume similar parameters

$$\left(\frac{176\ kg}{MTHM}\right)\left(\frac{11.87\ MTHM}{350\ MWe\text{-}yr}\right)\left(\frac{1\ cm^3}{3.0\ g}\right)\left(\frac{1000\ g}{kg}\right)\left(\frac{1\ m^3}{10^6\ cm^3}\right)$$

$\rightarrow 0.00214\ m^3/MWe\text{-}yr \approx 2.14\ m^3/GWe\text{-}yr$

DOE assuming $\approx 1\ m^3 / 350\ MWe\text{-}yr$

Using GEIS parameters $\rightarrow (0.00214)(350) \approx 0.75\ m^3$

*6 canisters @ $0.21\ m^3 \rightarrow 1.335\ m^3$

∴ Generation rate of HLW not inconsistent w/ GEIS

MTHM throughput → 11.87 / yr

Thermal power - see ORIGEN (ORNL-DWG 82-11774)

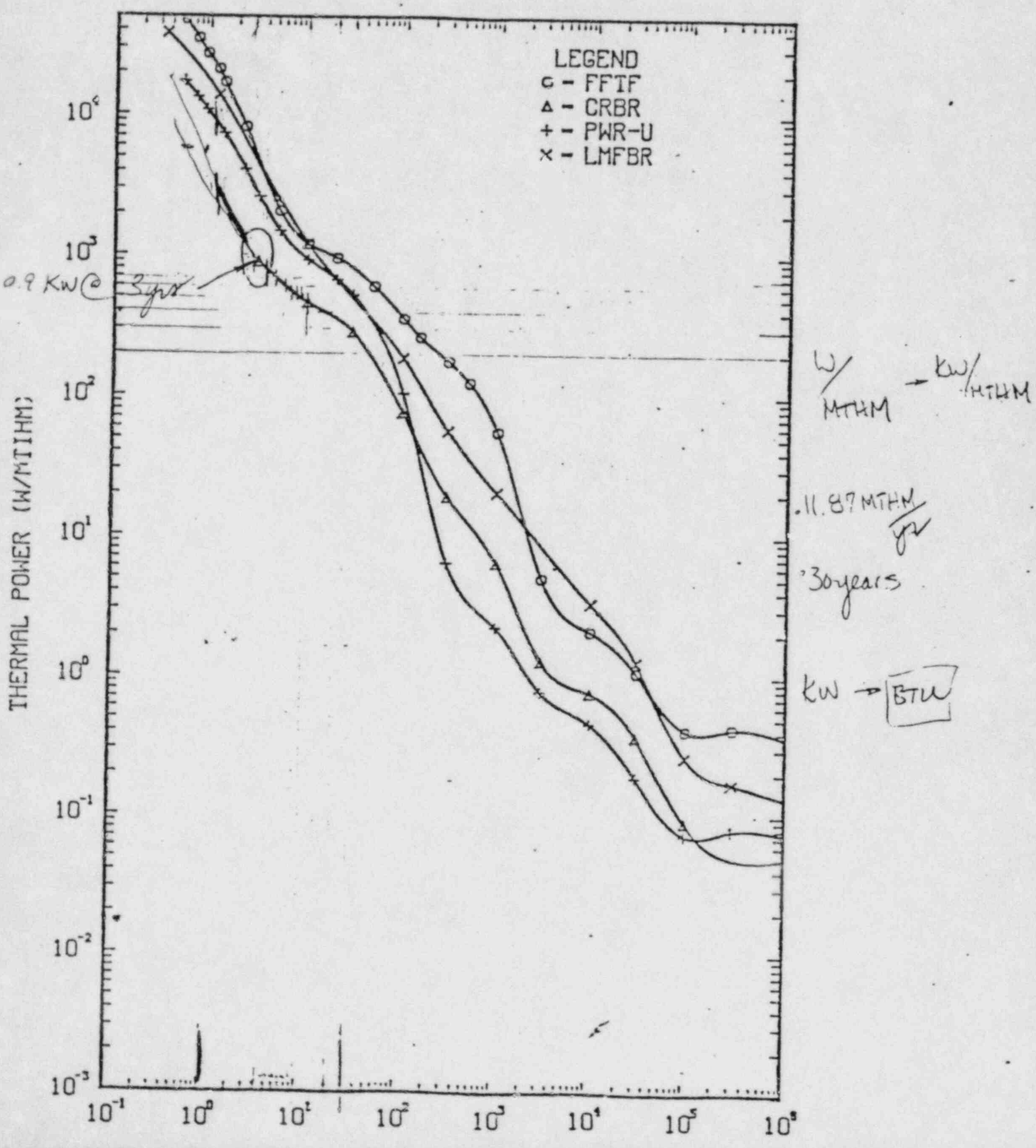
Time (yrs)	KW / MTHM	kW / Canister
1	6.5	12.9
1.5	4.6	9.1
2	3.4	6.7
3	0.9	1.8
4	0.8	1.6
5	0.7	1.4
6	0.6	1.2+
7	0.55	1.2 -
10	0.45	0.89

DOE → 5KW @ time of shipment to repository

6 canisters → 2 MTHM / canister (1.98)

ORNL-DWG 82-11774

HIGH-LEVEL WASTE THERMAL POWER



To use GEIS thermal limits, two approaches

1. Let canisters decay to limits prescribed in GEIS

2 Space canisters farther apart

Salt - 3.2 KW/canister

✓100 Kw/acre - p. 5.38, DOE/EIS-0046F

based on room + pillar area

DOE/ET-0028, p. 7.5.6-8

- room = (5.5 × 170) m² = } 3995 m²
- pillar = (18 × 170) m² = }
- # containers - 31

31 × 3.2 → 99.2 KWatts / 3995 m² → ✓100 KW/acre

In the case of reprocessing cycle high-level wastes there is a thermal limit for individual canisters in addition to the repository area thermal limits. These limits, which are derived from maximum temperatures, are identified in Table 5.3.5.

TABLE 5.3.4. Conceptual Repository Design Thermal Limits for Reprocessing Cycle Wastes

Medium	kW/ha[a]	kW/acre[a]
Salt[b]	250	100
Granite	320	130
Shale	200	80
Basalt	320	130

(a) Area occupied by the emplacement rooms and their associated pillars only.
(b) The placement of HLW in salt is not limited by long-term surface uplift as was the case for spent fuel in salt. Because the concentration of plutonium and its long-term heat contribution is much less in HLW, surface uplift is reduced and room and pillar integrity is the dominant concern. The integrity of rooms and pillars is dependent upon room and pillar area thermal density as listed in this table

TABLE 5.3.5. Conceptual Repository Thermal Limits for Individual HLW Waste Canisters

Medium	Maximum kW per Canister
Salt	3.2
Granite	1.7
Shale	1.2
Basalt	1.3

The conceptual repositories are designed to receive and emplace 6.5-year-old (time since reactor discharge) HLW. However, as was the case with spent fuel (Section 5.3.1.1), much of the HLW as it arrives at the repository will be older and cooler than 6.5 years. Because of this, estimates of waste emplacement for the reprocessing waste repositories are conservative because the repository could hold more waste if designed for the older and lower heat-generating rate wastes. As in the case of the spent fuel criteria, the criteria in Table 5.3.4 were developed for 10-year-old waste. Using these criteria for 6.5-year-old waste provides additional conservatism here also. However, the effect on capacity is smaller here because a substantial portion of the repository area is required for TRU wastes whose placement is not affected by the thermal criteria because they generate so little heat.

Design and construction of the conceptual fuel reprocessing waste repositories are assumed to proceed in the same manner as described for the once-through fuel cycle in Section 5.3.1.1. The overall repository area is approximately 800 ha in all cases. Construction is completed during the first five years of repository operations while all wastes are emplaced retrievably.

DOE/ET-0028

TABLE 7.5.3. Repository Area Allocations and Arrangement

Fuel Cycle		Salt	Granite	Shale	Basalt
All cycles					
	Room Size, m[a]				
	HLW	5.5 x 6 x 170	5.5 x 6 x 170	5.5 x 6 x 170	5.5 x 6 x 170
	FRW/ILW	11 x 6 x 1000	5.5 x 6 x 170	8 x 6 x 170	5.5 x 6 x 170
	LLW	11 x 6 x 460	5.5 x 6 x 170	8 x 6 x 170	5.5 x 6 x 170
	Pillar Width, m				
	HLW	18	18	18	16.5
	FRW/ILW/LLW	9	7.6	18	8.2
IIa - Uranium only recycle, Plutonium in HLW					
	Number of Rooms				
	HLW	934	673	572	806
	FRW/ILW	64	1,192	620	1,005
	LLW	4	44	16	37
	Containers/Room[b]				
	HLW	17	73	66	86
	FRW	1,562	145	144	145
	ILW	5,220	435	432	435
	LLW	31,000	4,464	6,624	4,464
	Center to Center Hole Spacing, m				
	HLW	9.5, one row	2.2, one row	2.5, one row	1.8, one row
	FRW	2.6, four rows[c]	1, one row[d]	2.3, two rows[c]	1, one row[d]
	ILW	2.3, four rows[c]	1, one row[d]	2.3, two rows[c]	1, one row[d]
	Total Room and Pillar Area, ha				
	HLW	380	270	230	290
	FRW	20	35	40	36
	ILW	110	200	240	210
	LLW	4	9	7	9
	Total Emplacement Area, ha				
	HLW	500	360	300	380
	FRW	27	46	53	47
	ILW	140	270	31	270
	LLW	5	12	9	12
	Total Repository Area[e] per 1000 MTHM Equivalent ha				
	HLW	13 - 18[f]	4.1 - 11[f]	7.2 - 13[f]	4.7 - 8.4[f]
	FRW	0.45	0.50	1.1	0.60
	ILW	2.4	2.9	6.5	3.3
	LLW	0.08	0.12	0.19	0.14
	Total	15.9 - 20.9	7.6 - 14.5	15.0 - 20.8	8.7 - 12.4

DOE/ET-0028

TABLE 7.5.3. contd

Fuel Cycle	Salt	Granite	Shale	Basalt
IIb - Uranium only recycle, Plutonium stored				
Number of Rooms				
HLW	794	668	555	714
FRW/ILW	105	1,190	626	1,013
LLW	7	46	16	40
Containers/Room[b]				
HLW	31	73	66	86
FRW	1,562	145	144	145
ILW	5,220	435	532	435
LLW	31,000	4,464	6,624	4,464
Center to Center Hole Spacing, m				
HLW	5.3, one row	2.2, one row	2.5, one row	1.8, one row
FRW	2.6, four rows[c]	1, one row[d]	2.3, two rows[c]	1, one row[d]
ILW	2.3, four rows[c]	1, one row[d]	2.3, two rows[c]	1, one row[d]
Total Room and Pillar Area, ha				
HLW	320	270	220	260
LLW	36	35	40	36
ILW	170	205	240	210
LLW	6	9	7	10
Total Emplacement Area, ha				
HLW	420	350	290	340
FRW	47	46	53	47
ILW	230	270	310	280
LLW	8	12	10	13
Total Repository Area[e] per 1000 MTHM Equivalent ha				
HLW	6.6 - 9.3[f]	4.1 - 6.2[f]	7.2 - 13[f]	3.1 - 8.4[f]
FRW	0.45	0.50	1.1	0.60
ILW	2.4	2.9	6.5	3.5
LLW	0.08	0.12	0.19	0.14
Total	9.5 - 12.2	7.6 - 9.7	15.0 - 20.8	7.3 - 12.6
III - Uranium and Plutonium Recycle				
Number of Rooms				
HLW	830	668	555	738
FRW/ILW	95	1,190	626	1,013
LLW	10	84	29	72

DOE/ET-0028

TABLE 7.5.3. contd

Fuel Cycle	Salt	Granite	Shale	Basalt
III - Uranium and Plutonium Recycle (contd)				
Containers/Room [b]				
HLW	31	73	66	86
FRW	1,562	145	144	145
ILW	5,220	435	432	435
LLW	31,000	4,464	6,624	4,464
Center to Center Hole Spacing, m				
HLW	5.3, one row	2.2, one row	2.5, one row	1.8, one row
FRW	2.6, four rows [c]	1, one row [d]	2.3, two rows [c]	1, r e row [d]
ILW	2.3, four rows [c]	1, one row [d]	2.3, two rows [c]	1, one row [d]
Total Room and Pillar Area ha				
HLW	340	270	220	270
FRW	30	35	40	36
ILW	160	210	240	210
LLW	10	17	13	17
Total Emplacement Area ha	540	532	533	533
HLW	440	350	291	350
FRW	40	46	50	47
ILW	210	270	310	280
LLW	13	22	17	23
Total Repository Area [e] per 1000 MTHM Equivalent ha	[illegible]	[illegible]	[illegible]	[illegible]
HLW	6.6 - 15 [f]	4.1 - 11 [f]	7.2 - 13 [f]	3.1 - 8.4 [f]
FRW	0.45	0.50	1.1	0.60
ILW	2.4	2.9	6.5	3.5
LLW	0.08	0.12	0.19	0.14
Total	9.5 - 17.9	7.6 - 14.5	15.0 - 20.8	7.3 - 12.6

a. Width by height by length.
b. Canisters are not emplaced in the first 10 m of the rooms.
c. Multiple rows of holes are spaced 1.8 m center to center between the rows.
d. In granite and basalt formations, FRW and ILW are placed into trenches 1.7 m (5.6 ft) wide.
e. Amount of total repository area, including shaft, maintenance, corridor and emplacement areas required for emplacement of 1000 MTHM equivalent waste. Total area for a single repository (as conceptualized in this report) is approximately 800 ha (2000 acres).
f. As canister diameter changes to meet the kW/canister constraint (see Section 7.3), the number of MTHM equivalent per canister also changes. For the constant canister spacing assumed in these conception designs the amount of repository area per MTHM equivalent changes inversely with the canister size. The range of canister sizes used at the repositories are:

Canister Diameter, cm

Fuel Cycle	Salt	Granite	Shale	Basalt
IIa	25-30	15-25	15-20	15-20
IIb	25-30	20-25	15-20	15-25
III	20-30	15-25	15-20	15-25

The 30 cm (12 in.) diameter canister contains 3 MTHM equivalent waste while the 25, 20, and and 15 cm diameter canisters contain 2.1, 1.3, and 0.77 MTHM equivalent waste respectively.

Assume 6.4 KW/canister

but keep 100 KW/acre

$$100 \frac{KW}{acre} = \frac{(6.4\ KW/can)(X\ cans)}{(5.5+18)m\ (Y\ m)}$$

$\therefore$ if $X = 15$, $y = 170$ or if 2x heat loading per can then ½ emplacement density (ie double spacing or pitch).

Assume → canisters decay to appropriate limit before emplacement

p. 5.38, DOE/EIS-0046F

Medium	KW/Can	KW/acre
Salt	3.2	100
Granite	1.7	130
Shale	1.2	80
Basalt	1.3	130

Generic Calculation:

$$\frac{(\text{Room Width} + \text{Pillar Width})(\text{Room Depth})(\text{Repository area})(\#\text{ of canisters})}{(\text{Room} + \text{Pillar Area})(\text{Containers / Room})}$$

= Required area

Information is Shown as HLW/Metal Scrap/TRU

Input data

	Salt	Granite	Shale	Basalt
Room Width (m)	5.5/11/11 (a)	5.5	5.5/8/8	5.5
Pillar Width (m)	18/9/9	18/7.6/7.6	18	16.5/8.2/8.2
Room Depth (m)	170/1000/460	170	170	170
Room + Pillar Area (ha)	540	532	533	533
Repository Area (ha)	800	800	800	800
HLW Canisters	180	180	180	180
Metal Scrap Canisters	3060	3060	3060	3060
TRU Canisters	5850	5850	5850	5850

	Salt	Granite	Shale	Basalt
Containers/Room	31/1562/31000	73/145/4464	65/144/6624	86/145/4464

Other assumptions

- Metal Scrap (CRBR) ≈ FRW (GEIS)
- Canisters D's for metal scrap are 10"D vs 30"D
  - Granite / Basalt packed tight, therefore can pack CRBR at 3x density in GEIS
  - Shale / Salt spaced apart, therefore must check (see next several pages).
- Assumes all HLW canister D's = 12" (30cm)

∴ As limitation for canister emplacement is heat and not physical, then can use canister/room data shown in DOE/ET-0028 for HLW.

FRW - SALT / SHALE - Check packing density for CRBR

Shale:

GEIS - 144 - 30"D canisters in room

2.3 m center to center or 1.3 m between edges of canisters

1.8 m center to center between rows or 0.8 m between edges

(2.3 m)(71) + 1m → 164.1m

(164.1 m)(2.8 m) → 459 m²

CRBRP

(1.8m)(71) + 0.5(72) → 127.3

(127.3)(1.8) → 229.14

Density Increase ≈ $\frac{459}{229}$ → 2X

If assume 3 rows for CRBRP → 3X density

Salt:

GEIS:

$(2.6)(390)+1 = 1015$

$(1015)(6.4) \rightarrow 6496\ m^2$

CRBRP

$(1.6)(390)+(0.5)(391) = 819$

$(819)(5.4) \rightarrow 4422\ m^2$

Density increase $\frac{6496}{4422} \approx 1.47$

$\therefore$

1.47 X density in GEIS

If assume 5 rows for CRBRP $\rightarrow$ 1.8

Equivalent Area Required (ha)

	Salt	Granite	Shale	Basalt
HLW	3.42	1.48	1.79	1.17
ital Scrap	3.26-3.95	2.36	4.70-7.06	2.45
2ue	0.26	0.44	0.59	0.45
Total	6.94-7.63 ha	4.08 ha	7.08-9.44 ha	4.07 ha
% of ?00 ha repository	0.87-0.95	0.51	0.89-1.18	0.51

Assume ≈ 1% for conservatism

Assume ≈ 1%

DOE/EIS-0046F, Section 5.4, Data Sources

Table 5.4.1 Land use - surface facilities

Table 5.4.3 Resources - Const'n

Table 5.4.4 Non-Rad Emissions - Const'n

Table 5.4.9 Rad. Emissions during Const'n

Table 5.4.10 Dose from Rad em

Table 5.4.13 Resources - Operational

Table 5.4.15 Non-Rad - Operational

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5.4 ENVIRONMENTAL IMPACTS RELATED TO REPOSITORY CONSTRUCTION AND OPERATION

Environmental impacts related to repository construction are those estimated for construction of surface facilities and mining of the entire repository, whereas those for operation are associated with waste emplacement, backfilling and decommissioning of surface facilities. Additional details are presented in DOE/ET-0029.

5.4.1 Resource Commitments

Land use commitments for single conceptual repositories in the four geologic media are summarized in Table 5.4.1 for both spent fuel and reprocessing wastes. Other resource commitments are tabulated in Table 5.4.2 for spent fuel repositories and in Table 5.4.3 for reprocessing waste repositories. The same size (areal extent) of repository (800 ha) is postulated for each rock type; however, thermal criteria (heat loading of rock) allow spent fuel containers to be stored closer together in granite and basalt than in salt and shale, thus greater quantities of high-level waste can be stored in granite and basalt repositories for a given area than in salt and shale repositories.[a]

TABLE 5.4.1. Land Use Commitments For Construction of 800-ha Single Geologic Repositories

Land Use	Salt & Shale	Granite & Basalt
Surface facilites, ha		
Spent fuel repository	180	280
Reprocessing waste repository	180	220
Access roads and railroads, ha	8	8
Mineral and surface rights, ha (fenced restricted area)	800	800
Additional land on which only subsurface activities will be restricted, ha	3,200	3,200

Land use conflicts will be highly site specific; however, most restrictions on surface use of land need not continue after repository closure. Thus, most uses of the land could resume after decommissioning of the surface facilities.

Water used during construction of a repository will range from about 1×10^5 to 5×10^5 m^3 (depending on geologic medium) over the 7-yr construction period. As long as water can be supplied from rivers such as the R River in the midwest reference environment (Appendix F), water use will represent a small fraction (0.001) of the average river flow

(a) Note, however, that waste emplacement has not been optimized in an engineering sense for this generic Statement.

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TABLE 5.4.2. Resource Commitments Necessary for Construction of a Spent Fuel Repository in Salt, Granite, Shale, and Basalt

Resource	Salt (51,000 MTHM)	Granite (122,000 MTHM)	Shale (64,000 MTHM)	Basalt (122,000 MTHM)
Water Use, m^3	240,000	710,000	360,000	610,000
Materials				
Concrete, m^3	100,000	300,000	150,000	250,000
Steel, MT	16,000	48,000	24,000	40,000
Copper, MT	220	660	330	560
Zinc, MT	55	160	80	140
Aluminum, MT	41	120	64	110
Lumber, m^3	2,300	6,900	3,000	5,900
Energy Rescources				
Propane, m^3	2,200	6,400	3,200	5,400
Diesel fuel, m^3	22,000	64,000	32,000	54,000
Gasoline, m^3	16,000	47,000	21,000	40,000
Electricity				
Peak demand, kW	3,400	11,000	5,100	8,800
Total consumption, kWh	14,000,000	43,000,000	21,000,000	36,000,000
Manpower, man-yr	10,000	30,000	14,000	37,000

TABLE 5.4.3. Resource Commitments Necessary for Construction of a Fuel Reprocessing Waste Repository in Salt, Granite, Shale, and Basalt[(a)]

Resource	Salt (62,000 MTHM HLW)	Granite (69,000 MTHM HLW)	Shale (30,000 MTHM HLW)	Basalt (56,000 MTHM HLW)
Water use, m^3	270,000	510,000	290,000	450,000
Materials				
Concrete, m^3	110,000	210,000	120,000	190,000
Steel, MT	18,000	33,000	19,000	30,000
Copper, MT	240	470	260	420
Zinc, MT	62	120	67	110
Aluminum, MT	46	90	50	77
Lumber, m^3	2,600	4,900	2,800	4,400
Energy resources				
Propane, m^3	2,400	4,500	2,600	4,000
Diesel fuel, m^3	24,000	45,000	26,000	40,000
Gasoline, m^3	18,000	33,000	19,000	30,000
Electricity				
Peak demand, kW	3,900	7,300	4,100	6,600
Total Consumption, kWh	16,000,000	30,000,000	17,000,000	27,000,000
Manpower, man-yr	11,000	22,000	13,000	26,000

(a) Only HLW are indicated in this and subsequent tables referring to reprocessing wastes sent to repositories. In addition to HLW, about 100,000 MTHM equivalent of TRU wastes are placed in the "first" salt repository and about 110,000, 56,000 and 92,000 MTHM equivalent in "first" repositories in other media, respectively. Subsequent repositories would undoubtedly receive a dif-

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and no significant impacts are expected from its withdrawal. If a repository was to be built in an arid region, water might need to be transported to the site from areas of abundant supply.

5.4.2 Nonradiological Effluents

Nonradiological effluents from repository construction include dust and pollutants generated from machinery operation during surface facility construction and mining operations. Burning the quantities of fossil fuels listed in Tables 5.4.2 and 5.4.3 results in air pollutant emissions, but concentrations in air at the fenceline are not expected to result in any air quality degradation outside applicable limits (40 CFR 50). Estimates of pollutant totals released to the atmosphere from operating equipment during construction are given in Table 5.4.4. These quantities are developed from the total quantities of fuel burned and emission factors for a given effluent (URS 1977).

TABLE 5.4.4. Quantities of Effluents Released to the Atmosphere During Construction of a Geologic Repository

Pollutant, MT	Salt	Granite	Shale	Basalt
	for Spent Fuel			
	(51,000 MTHM)	(122,000 MTHM)	(64,000 MTHM)	(122,000 MTHM)
CO	7,900	23,000	10,000	20,000
Hydrocarbons	360	1,100	480	890
NO_x	1,500	4,500	2,200	3,800
SO_x	92	270	130	230
Particulates	94	270	130	230
	for Reprocessing Wastes			
	(62,000 MTHM)	(69,000 MTHM)	(30,000 MTHM)	(56,000 MTHM)
CO	8,800	16,000	9,300	15,000
Hydrocarbons	400	740	420	660
NO_x	1,700	3,100	1,800	2,800
SO_x	100	190	110	170
Particulates	100	190	110	170

Emissions from oil burning space heaters in a town of 30,000 population (about 8,000 heaters) were estimated for a 20-yr period (the approximate time surface facilities at a repository are operating) in an effort to provide some perspective for effluents released during construction of a repository. The calculated emissions were:

CO, MT	220
Hydrocarbons, MT	120
NO_x, MT	540
Particulates, MT	6,000
SO_x, MT	460

Swap

5.4.3 Radiological Effects

The release to the atmosphere of naturally occurring radon and its decay products will increase during mining of the repositories. Estimated quantities of these radionuclides likely to be released annually to the biosphere for the various geologic media are listed in Tables 5.4.8 and 5.4.9.

TABLE 5.4.8. Annual Releases of Naturally Occurring Radionuclides to Air for Construction of Geologic Repository for Spent Fuel, Ci

	Geologic Media			
Nuclide	Salt (51,000 MTHM)	Granite (122,000 MTHM)	Shale (64,000 MTHM)	Basalt (122,000 MTHM)
^{220}Rn	9.3×10^{-4}	2.0×10^{1}	6.1	3.1
^{222}Rn	1.3×10^{-3}	1.9×10^{1}	7.0	2.7
^{210}Pb	1.1×10^{-7}	1.6×10^{-3}	5.9×10^{-4}	2.3×10^{-4}
^{212}Pb	1.4×10^{-6}	3.0×10^{-2}	9.2×10^{-3}	4.7×10^{-3}
^{214}Pb	1.3×10^{-3}	1.9×10^{1}	7.0	2.7
^{210}Bi	1.3×10^{-3}	1.9×10^{1}	7.0	2.7

TABLE 5.4.9. Annual Releases of Naturally Occurring Radionuclides to Air for Construction of Geologic Repository for Fuel Reprocessing Waste, Ci

	Geologic Media			
Nuclide	Salt (62,000 MTHM)	Granite (69,000 MTHM)	Shale (30,000 MTHM)	Basalt (56,000 MTHM)
^{220}Rn	1.1×10^{-3}	1.4×10^{1}	5.1	2.0
^{222}Rn	1.6×10^{-3}	1.3×10^{1}	6.0	1.7
^{210}Pb	1.3×10^{-7}	1.1×10^{-3}	2.5×10^{-4}	1.4×10^{-4}
^{212}Pb	1.7×10^{-6}	2.1×10^{-2}	7.7×10^{-3}	3.0×10^{-3}
^{214}Pb	1.6×10^{-3}	1.3×10^{1}	6.0	1.7
^{210}Bi	1.6×10^{-3}	1.3×10^{1}	6.0	1.7

A summary of 70-yr whole-body doses to the construction work force and to the regional population from the releases of "enhanced" quantities of naturally occurring radionuclides is given in Table 5.4.10.

The 70-yr dose from undisturbed naturally occurring radionuclides is about 7 rem/person. The 70-yr dose to the regional population is about 14,000,000 man-rem from undisturbed naturally occurring sources.

In this report, 100 to 800 health effects are postulated to result in the exposed population per million man-rem. Based on the calculated doses to the regional population, no health effects are expected to result from construction of a geologic repository for spent fuel or for reprocessing wastes.

TABLE 5.4.10. Summary of 70-Yr Whole-Body Dose Commitments from Naturally Occurring Radioactive Sources During Mining Operations at a Repository, man-rem

	Spent Fuel Repositories			
	Salt	Granite	Basalt	Shale
Repository				
Work force (7 yr in the repository mine)	0.18	5000	6200	1900
Population (within 80 km)	0.007	100	15	38

5.4.4 Evaluation of Ecological Impacts Related to Repositories[a]

Construction of surface facilities at repositories will involve the removal of vegetation and displacement of birds and small mammals from the site areas. Weedy species of plants would invade cleared areas unless revegetation practices are applied. Localized dust problems would occur until vegetation cover is re-established.

Soil erosion control measures will be needed to prevent surface runoff from adding suspended solids to nearby land and surface waters. If only reasonably good practices were used, effects from construction of the surface facilities on aquatic biota should be negligible.

5.4.4.1 Ecological Effects Related to Repositories in Salt

The major ecological impact would be from fugitive dust depositions which might occur from surface handling operations of mined material. Of most concern are the estimated salt depositions at the repository fenceline of 8.4 and 84 g/m^2-yr for the reference and arid environment, respectively. These depositions were calculated from the case where 3.0×10^7 MT of salt was mined with 1.3×10^7 MT remaining on the surface for final disposal.

Adverse biotic effects on vegetation would depend upon many factors, including rate of uptake, short- and long-term sensitivity of species to effluent concentrations, period of exposure, the physiological condition of the vegetation during the time exposure and buildup of salt over time. Impingement upon vegetation with subsequent foliar absorption appears to be the most hazardous mode of entry. Uptake of salt solutions by foliage is a rapid and relatively efficient process (Bukocac and Wittier 1957). Crops particularly sensitive to salt effects are alfalfa, oats, clover, wheat, Indian rye grass, and ponderosa pine. These plants are seriously damaged during germination and young-leaf stage development. Ornamental vegetation types that are susceptible to salt concentrations are dogwood, red-maple, Virginia creeper and wild black cherry. Visual symptoms of toxicity are foliar necrosis, short-time dieback and "molded" growth habits. Beans are particularly sensitive showing wilting of areas on primary leaves followed by necrosis of previously wilted areas and

(a) In the following discussion of ecological impacts it is assumed that no precautions are taken. Impacts presented can be reduced to insignificant levels through application of available engineering techniques. DOE is committed to discovery and resolution of any potentially significant specific ecological effects.

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TABLE 5.4.13. Resource Commitments for the Operational Phase of Fuel Reprocessing Waste Geologic Repositories

Materials	Salt (62,000 MTHM)	Granite (69,000 MTHM)	Shale (30,000 MTHM)	Basalt (56,000 MTHM)
HLW canister overpacks, MT steel[a,b]	6.4	8.2	4.8	9.0
RH-TRU canister overpacks, MT steel	1.5×10^1	1.6×10^1	1.0×10^1	1.4×10^1
RH-TRU drum packs, MT steel	5.3×10^4	5.8×10^4	3.0×10^4	4.9×10^4
HLW retrievability sleeves, MT steel[b,c]	7.3×10^2	9.6×10^2	1.3×10^3	1.3×10^3
RH-TRU retrievability sleeves, MT steel[c]	2.9×10^4	1.9×10^5	2.9×10^4	1.6×10^5
HLW concrete plug,[c] MT	8.0×10^2	1.0×10^3	1.4×10^3	1.4×10^3
RH-TRU concrete plug, MT concrete[c]	7.2×10^4	7.2×10^4	7.2×10^4	7.2×10^4
Energy				
Electricity, kWh	2.1×10^9	2.6×10^9	1.4×10^9	2.3×10^9
Coal, MT	1.4×10^6	1.4×10^6	9.4×10^5	1.3×10^6
Diesel fuel, m^3	2.5×10^5	2.6×10^5	1.7×10^5	2.3×10^5
Steam, MT	1.5×10^7	1.6×10^7	1.0×10^7	1.4×10^7
Manpower, man-yr	1.9×10^4	2.4×10^4	1.3×10^4	2.1×10^4

(a) Overpack requirements are based on 0.1% of canisters received leaking or damaged.
(b) HLW canister and sleeve diameters change with time as necessary to maintain canister heat output within limits.
(c) Sleeves and plugs needed for first five years only.

TABLE 5.4.14. Total Quantities of Effluents Released to the Atmosphere During Operation of a Geologic Repository for Spent Fuel

Effluent	Geologic Medium: Salt	Granite	Shale	Basalt
Particulates, MT	430	670	480	670
SO_x, MT	9,700	15,000	11,000	15,000
CO, MT	2,400	3,700	2,700	3,700
Hydrocarbons, MT	870	1,400	980	1,400
NO_x, MT	15,000	24,000	17,000	24,000
Heat, MJ	3.9×10^8	9.3×10^8	4.9×10^8	9.3×10^8

formation. The heat will eventually be transferred to the atmosphere and, if the temperatures and temperature gradients have not exceeded values that would cause damage to the formation or adversely affect the containment integrity or the environment, the formation will return essentially to its initial state. The maximum surface temperature increase in any case is not expected to exceed about 0.5°C. This aspect is discussed more fully in Section 5.5 and in DOE/ET-0029.

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TABLE 5.4.15 Total Quantities of Effluents Released to the Atmosphere During Operation of Geologic Repository for Reprocessing Wastes

Effluent	Geologic Medium			
	Salt	Granite	Shale	Basalt
Particulates, MT	510	540	350	480
SO_x, MT	12,000	12,000	7,800	11,000
CO, MT	2,900	3,000	2,000	2,700
Hydrocarbons, MT	1,000	1,100	710	980
NO_x, MT	17,000	19,000	12,000	17,000
Heat, MJ	7.6×10^8	8.3×10^8	4.3×10^8	7.0×10^8

5.4.6.3 Radiological Releases

Routine radiological releases from geologic repositories during normal operation will consist principally of radon emanating from exposed rock faces and radon's decay products. These releases will also occur from backfilling operations but are negligible compared to radon releases during repository construction. Occasionally, external contamination may occur on canisters as a result of some minor accident. The population dose from decontamination activities would be much less than that from operation at a spent fuel packaging and storing facility, for which the 70-yr whole-body population dose was determined to be about 1 man-rem (DOE/ET-0029).

Doses to the work force during repository operation will include contributions from receiving, handling, and placement of waste canisters into subterranean storage areas. Doses estimated to result from operations, based on expected time of operation and permissible exposure limits, are presented below for disposal of wastes for the various geologic media:

Geologic Media	70-Year Whole-Body Dose (man-rem)	
	Spent Fuel Repository	Reprocessing Waste Repository
Salt	4.3×10^3	1.4×10^5
Granite	1.1×10^4	1.6×10^5
Shale	5.6×10^3	8.0×10^4
Basalt	1.1×10^4	1.3×10^5

Radiation-related health effects using the conversion factor of 100 to 800 health effects per million man-rem (Appendix E) suggests a range of zero to 130 health effects among a workforce of about 8000. The doses tabulated suggest individual worker doses of about 1 rem per year over a 15-year repository loading period.

5.4.6.4 Ecological Impacts

The major ecological impact of repository operation would be from the handling of mined materials at the surface during repository mining and backfilling. Impacts would be caused by the airborne transfer of mined particulates to the environment near the site. These

Other impact is land occupied by salt pile on surface

Assume 10m high pile
$L = W$
Slope is 1 vertical : 2 horizontal

$V = 7.1 \times 10^6 m^3$

4 corner pieces : $(10m)(20m)(20m) = 4000 m^2$

$7.1 \times 10^6 = 4.0 \times 10^3 + 4(\frac{1}{2})(20m)(10m)(L)$
$+ (L)(L)\ 10m$

$10L^2 + 400L - 7.096 \times 10^6 = 0$

$$L = \frac{-400 \pm \sqrt{(400)^2 - 4(10)(7.096 \times 10^6)}}{2(10)}$$

$L = (-400 \pm 16852.30)/20 = 822.61\ m$

$(822.61\,m)^2 + 4(20)(822.61) + 4(\frac{1}{2})(20)(20)$

676687.21
65808.80
800.00

} 743,296 m^2

1% → 7433 m^2 → 1.84 acres → 0.7 ha

For granite, shale, basalt piles are

11×10^6, 5.1×10^6, and 11×10^6 m^3

respectively

Granite / Basalt

$11.0 \times 10^6 = 4.0 \times 10^3 + 4(\frac{1}{2})(20)(10)L + L(L)10$

$10L^2 + 400L - 11.096 \times 10^6 = 0$

$$L = \frac{-400 \pm \sqrt{(400)^2 - 4(10)(-11.096 \times 10^6)}}{2(10)}$$

$L = (-400 \pm 2.14 \times 10^4)/20 = 1033.57\ m$

$(1033.57\ m)^2 + 4(20)(1033.57) + 4(\frac{1}{2})(20)(20) =$

$1068267 + 82685 + 800 = 1151752\ m^2$

$+1\% - 11518\ m^2 = 2.84$ acres $= 1.15$ ha

Shale

$5.1\times10^6 = 4.0\times10^3 + 4(\frac{1}{2})(20)10\,L + (L)(L)\,10$

$10L^2 + 400L - 5.096\times10^6 = 0$

$$L = \frac{-400 \pm \sqrt{(400)^2 - 4(10)(-5.096\times10^6)}}{2(10)}$$

$L = (-400 \pm 1.43\times10^4)/20 = 694$

$(694)^2 + 4(20)(694) + 4(\frac{1}{2})20(20)$

$481834 + 55520 + 800 = 538154\ m^2$

$1\% \rightarrow 5382\ m^2 = 1.33$ acres $\cdot$ 0.5 ha

Annualization Technique

All impacts were divided by CLBRP operating period (30 years). However when either resources were consummed or effluents released disproportionately during the construction or operation period, separate annual averages were calculated

Construction Period - 7 years

Operating Period - 19 yrs - Salt
13 yrs - Shale
20 yrs - Granite
17 yrs - Basalt

Non-radiological effluents

Determined that effluents from coal should be added to 1% of non-rad effluents in GEIS.

For each rock type multiplied emission factor times coal combusted and added to 1% of non-rad effluents

(ie (.01)(Table 5.4.4 + 5.4.15)

Emission Factors (MT/MT Coal)

CO - 2.3×10^{-4}

HC - 1.0×10^{-4}

NO_x - 1.0×10^{-2}

SO_x - 3.5×10^{-2}

Particulates - 1.0×10^{-2}

Radon Emissions

Determined it was preferable to denote enhanced releases of natural radioactivity as the sum of ^{220}Rn and ^{222}Rn

As a result, did following:

1. Added ^{220}Rn + ^{222}Rn in Table 5.4.9 (GEIS)
2. Multiplied by 0.01

This gives annualized value based on 7-year construction period.

(81)

Battelle
Pacific Northwest Laboratories

Project Number

Internal Distribution

EC Watson
File

DATE: June 21, 1981

TO: I. C. Nelson

FROM: D. L. Strenge

SUBJECT: CR R - EIS Back-up Notes

I have reviewed my notes for the CRBR project and have compiled the following list of references and notes that relate to material contributed the the CRBR EIS.

Napier, B.A. 1981. Standardized Input for Hanford Environmental Impact Statements - Part 1.PNL-3509 PT1. Pacific Northwest Laboratory, Richland, WA.

Letter: DL Strenge to DL DeMott (HEDL), January 21, 1981, FMEF Environmental Assessment Dose Calculations. (Copy attached).

Note to File: DL Strenge, April 9, 1982, Radiological Impact from Mixed Oxide CRBR Fabrication. (Copy attached).

Memo: DL Strenge to OF Hill, April 16, 1982, CRBRES - MOX and FRP Site Parameters. (Copy attached).

Telephone Conversation Note: Tom Clark (NRC) to DL Strenge, April 23, 1982, X/Q Values for FRP. (Copy attached).

Memo: DL Strenge to IC Nelson, May 20, 1982, CRBR-EIS Update - Radiological Review. (Copy attached).

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JUN 22 1982
IRAL C. NELSON

PNL-3509 PT1

TABLE 8. Standard Terrestrial Exposure Pathway Data

Exposure Pathway	Growing Period (Days)	Yield (kg/m)	Irrigation Rate (L/m /month)	Holdup (days)		Consumption (kg/year)	
				Average	Minimum	Average	Maximum
Leafy Veg.	9.0 E+01	1.5 E+00	1.5 E+02	1.4 E+01	1.0 E+00	1.5 E+01	3.0 E+01
O.A.G. Veg.*	9.0 E+01	7.0 E-01	1.6 E+02	1.4 E+01	1.0 E+00	1.5 E+01	3.0 E+01
Root Veg.	9.0 E+01	4.0 E+00	1.5 E+02	1.4 E+01	1.0 E+01	1.2 E+02	1.8 E+02
Orch. Fruit	9.0 E+01	2.0 E+00	1.5 E+02	1.4 E+01	1.0 E+01	6.4 E+01	3.4 E+02
Grain	9.0 E+01	1.0 E+00	1.5 E+02	1.4 E+01	1.0 E+00	8.0 E+01	8.8 E+01
Eggs	9.0 E+01	8.4 E-01	1.5 E+02	1.8 E+01	1.0 E+00	2.0 E+01	3.0 E+01
Milk	3.0 E+01	1.3 E+00	1.5 E+02	4.0 E+00	1.0 E+00	2.3 E+02	2.7 E+02
Beef	9.0 E+01	8.4 E-01	1.4 E+02	3.4 E+01	1.5 E+01	4.0 E+01	4.0 E+01
Pork	9.0 E+01	8.4 E-01	1.4 E+02	3.4 E+01	1.5 E+01	3.0 E+01	4.0 E+01
Poultry	9.0 E+01	8.4 E-01	1.4 E+02	3.4 E+01	1.0 E+00	8.5 E+00	1.8 E+01
External			1.5 E+02				

* Other above ground vegetables.

TABLE 9. Standard Aquatic Exposure Pathway Data

Exposure Pathway	Mixing Ratio	Holdup (Days)	Usage		
			Average	Maximum	Units
Fish	1.0 + 000	1.0 + 000	1.5 + 003*	4.0 + 001	(kg/yr)
Drinking Water	1.0 + 000	1.0 + 000	4.4 + 002	7.3 + 002	(L/yr)
Shoreline	1.0 + 000	3.3 - 001	1.7 + 001	5.0 + 002	(hr/yr)
Swimming	1.0 + 000	3.3 - 001	1.0 + 001	1.0 + 002	(hr/yr)
Boating	1.0 + 000	3.3 - 001	5.0 + 000	1.0 + 002	(hr/yr)

* Total production from Columbia River; must be distributed among total population.

Some caution must be used in setting up the population dose calculations. The populations exposed may vary with the scenario. For atmospheric releases, the entire 80 km (50 mile) population is used. However, for releases to the Columbia River, a more limited population can be assumed. While the 80 km population along the Columbia River is assumed for recreational activities on the river, only 50,000 Tri-Citians obtain drinking water from the river. Three areas of farmland are irrigated directly from the Columbia directly downstream of Hanford, 1) Franklin County Irrigation District with production sufficient to feed only about 2,000 people with fresh produce, meat, and milk, 2) a few small farms at Ringold, mostly orchards, with some pasture land, and 3) a small acreage of hay near Burbank. The total fish harvest from the Columbia below Hanford totals 15,000 kg, which can be prorated among any size population desired, since it is the amount consumed, not the number of people consuming it, that defines the collective dose.

Other required parameters that are needed to perform Hanford Site dose calculations are given in Table 10. For these parameters, if different values can be justified for specific uses, they may be used. Additional parameters needed to run the codes and control input and printing are described in the relevant code documentation.

TABLE 10. General Exposure Pathway Data

Individual external ground exposure time	4383 hr/yr
Population external ground exposure time	2920 hr/yr
Air submersion time	8766 hr/yr
Inhalation time	8766 hr/yr
Individual breathing rate, routine	250 cm^3/sec
Individual breathing rate, accident	350 cm^3/sec
Default aerosol particle size	1.0 micron
Average Columbia River flow rate	120,000 cfs

bcc: EC Watson
→ ~~File~~
LB

Battelle
Pacific Northwest Laboratories
P.O. Box 999
Richland, Washington U.S.A. 99352
Telephone (509)

Telex 15-2874

January 21, 1981

Ms. D. L. DeMott
Hanford Engineering Development Laboratory
FMEF Systems Engineering
P. O. Box 1970
Richland, WA 99352

Dear Ms. DeMott:

FMEF Environmental Assessment Dose Calculations

The attached table presents results of dose calculations for routine postulated releases from the FMEF. The table includes doses for operation of the SAF plus recalculated doses for normal FMEF opertions. Identification of computer codes and data files used for the calculation is also attached.

If you have any questions on the calculations, please call me (376-4323).

Sincerely,

Dennis L. Strenge
Environmental Analysis Section
Ecological Sciences Department

DLS:pf
Attachment

FIFTY-YEAR DOSE COMMITMENT TO THE MAXIMUM EXPOSED INDIVIDUAL FROM ONE-YEAR RELEASE (MREM)

Organ of Reference	SAF Operation	FMEF Operation
Total Body	2.0×10^{-4}	1.1×10^{-3}
Liver	2.1×10^{-3}	1.1×10^{-3}
Bone	4.7×10^{-3}	9.7×10^{-5}
Lung	8.9×10^{-4}	1.1×10^{-3}
Thyroid	2.6×10^{-12}	2.2×10^{-4}

FIFTY-YEAR DOSE COMMITMENT TO YEAR 2000 POPULATION LIVING WITHIN 50 MILES OF FMEF FOR ONE-YEAR RELEASE (PERSON-REM)

Organ of Reference	SAF Operation	FMEF Operation
Total Body	8×10^{-4}	3×10^{-3}
Liver	9×10^{-3}	3×10^{-3}
Bone	2×10^{-2}	4×10^{-4}
Lung	4×10^{-3}	3×10^{-3}
Thyroid	1×10^{-11}	9×10^{-4}

The annual average exposure rate (for FMEF operation) at the 400 Area visitor center from external radiation is 2.5×10^{-8} mrem/hr. The 50-year inhalation dose commitment at this site is 2.9×10^{-8} mrem per hour of inhalation uptake. The corresponding values for SAF operation are 8.7×10^{-16} mrem/hour for external radiation and 6.7×10^{-8} mrem per hour of inhalation uptake.

CODES AND PARAMETERS USED FOR FMEF DOSE CALCULATIONS

Meteorological Conditions: WPPSS 2-year data, annual average

Dispersion Model: Gaussian, Pasquill parameters

χ/Q: 400 area visitor center 5.9×10^{-6} sec/m^3 @ 610 m E, maximum individual 2.0×10^{-6} sec/m^3 @ 8.1 km E, 80 km population 8.4×10^{-3} person sec/m^3

Release Height: Ground level

Population Distribution: Year 2000, 251,000

Computer Code: DACRIN, Rev. 8-4-80

Calculated Dose: Chronic inhalation, maximum individual and 80 km population, first-year dose and 50-year dose commitment

Files Addressed: Organ data library 5-19-80
Radionuclide library, Rev. 1-15-81

Computer Code: PABLM, Rev. 10-15-80

Calculated Doses: Chronic Ingestion and ground contamination exposure, maximum individual and 80 km population, first-year and 50-year dose commitment

Files Addressed: Radionuclide library Rev. 1-15-81
Food transfer library Rev. 2-27-78
Organ data library Rev. 5-19-80
Ground dose factor library Rev. 3-15-78
Bioaccumulation factor library: Hanford specific

Computer Code: SUBDOSA, Rev. 11-3-76

Calculated Dose: Chronic external dose conversion factors for air submersion

Files Addressed: Radionuclide library RNDBET Rev. 11-3-76
Photon data library, GISLIBS Rev. 11-3-76

Apr. 9, 1982
PJD

RADIOLOGICAL IMPACT FROM MIXED OXIDE CRBR FABRICATION

Mixed oxide fuel fabrication is to be performed in the Secure Automated Facility (SAF) in the Fuels and Materials Examination Facility (FMEF) currently being built at Hanford. The FMEF Environmental Analysis provides information on radiological consequences from this portion of the CRBR fuel cycle. The annual capacity of the SAF line is designed to be 4 MT of plutonium of which 23% (0.9 MT) will be devoted to supplying CRBR fuel. The radiological consequences for CRBR mixed oxide fuel fabrication would be approximately 23% of the SAF line radiological consequences. The SAF line consequences from routine releases scaled to CRBR fuel production are given in the table below. The dose to the maximum individual (at the nearest offsite residence) and the general population (year 2000) either 50 miles of the FMEF are presented.

Fifty-Year Dose Commitment from SAF Line Routine Operation for CRBR Fuel Production

Organ of Reference	Maximum Individual (mrem)	Population (man-rem)
Total body	9.2×10^{-5}	3.7×10^{-4}
Liver	9.7×10^{-4}	4.1×10^{-3}
Bone	2.2×10^{-3}	9.2×10^{-3}
Lung	4.1×10^{-4}	1.8×10^{-3}

The dose values include contributions from external exposure to the plume, inhalation of the plume and ingestion of farm products contaminated from deposition onto plants and soil. The ingestion pathway also includes contributions from uptake of contamination produce after the first year due to residual soil contamination. The methodology used for ingestion pathways is that of Napier et al. (1980) which is similar to the models presented by NRC (1977). The inhalation dose calculations were performed according to Houston, et al. (1976) based on the ICRP Task Group Lung Model (ICRP 1972) and the simple exponential organ retention functions of ICRP Publications 2 and 6 (ICRP 1959; ICRP 1962).

Environmental consequences from accidents in FMEF (and SAF) were analyzed and the worst case accident was found to be a postulated cask-drop accident. This accident could result in a 77-millirem, whole-body, 50-year

dose commitment to an individual 1.5 miles from FMEF (the nearest distance for public approach) and 180 man-rem, whole-body, 50-year dose commitment to the year 2000 population within 50 miles of FMEF. The 77-millirem, individual, whole-body dose commitment is less than the 500 millirem allowed by DOE for routine operations. The 180 man-rem, 50-year population dose commitment is small compared to the annual whole-body population dose from natural radioactivity of about 25,000 man-rem (ERDA-1975).

REFERENCE

Napier, B. A., W. E. Kennedy, Jr., and J. K. Soldat. 1980. PABLM - A Computer Program to Calculate Accumulated Radiation Doses from Radionuclides in the Environment. PNL-3209, Pacific Northwest Laboratory, Richland, Washington.

USNRC. 1977. Calculation of Annual Doses to Man from Routine Releases of Reactor Effluents for the Purpose of Evaluating Compliance with 10 CFR Part 50, Appendix I. Regulatory Guide 1.109, Rev. 1, U. S. Nuclear Regulatory Commission, Washington, D.C.

ICRP. 1959. Report of Committee II on Permissible Dose for Internal Radiation. International Commission on Radiological Protection, ICRP Publication 2, Pergamon Press.

ICRP. 1962. Recommendations of the International Commission on Radiological Protection. International Commission on Radiological Protection. ICRP Publication 6, Pergamon Press.

ICRP. 1972. The Metabolism of Compounds of Plutonium and Other Actinides. International Commission on Radiological Protection. ICRP Publication 19, Pergamon Press.

ERDA. 1975. Final Environmental Impact Statement, Waste Management Operations. Energy Research and Development Administration, Report ERDA-1538, Richland, Washington.

+ FMEF EA and suppliment

Battelle
Pacific Northwest Laboratories

Project Number

Internal Distribution

DATE: April 16, 1982

TO: O. F. Hill

FROM: D. L. Strenge

SUBJECT: CRBRES - MOX and FRP Site Parameters

IC Nelson
EC Watson
File
LB

Parameters needed in the radiological consequence analysis for airborne releases from the MOX and FRP facilities are presented here. This information should be included in your transmittals to Jim Ayer. The MOX facility parameters are for the FMEF site (SAF) at Hanford located at the 400 Area (FFTF complex). The FRP facility parameters are defined for the 2000-acre generic FRP site described in the Commercial Waste Management GEIS (DOE/EIS-0046F Appendix F).

Parameters for MOX Facility

The atmospheric dispersion parameter at the location of the maximum individual (8.1 km east of the 400 Area) is 2.0×10^{-6} sec/m^3. The average atmospheric dispersion parameter (for estimating population exposures is 3.3×10^{-8} based on a population of 251,000 people in the year 2000 (within 50 miles). These values were derived from joint frequency of occurrence meteorological data presented in Table 7 of PNL-3509, Pt. 1 (copy attached).

Terrestrial exposure pathway parameters for the Hanford site are given in Table 8 of PNL-3509, Pt. 1. The values in this table labeled "averages" are to be used for population exposure calculations and the values labeled "minimum" or "maximum" are to be used for the maximum individual dose calculations.

Parameters for FRP Facility

The atmospheric dispersion parameter (for stack release from the FRP) at the location of the maximum individual is 1.5×10^{-8} sec/m^3. The average atmospheric dispersion parameter (based on 2×10^6 people) is 1.8×10^{-9} sec/m^3.

The terrestrial pathway parameters for the generic FRP site are given in the attached table. The "average" values are to be used for population dose estimates and the "maximum" or "minimum" values are for the maximum individual dose estimates.

DLS:pf
Attachment

54-1900-001 (3-71)
U.S. GOVERNMENT PRINTING OFFICE 1981—796-298/9

FRP TERRESTRIAL EXPOSURE PATHWAY DATA

Exposure Pathway	Growing Period (Days)	Yield (kg/m)	Holdup (days) Average	Holdup (days) Minimum	Consumption (kg/yr) Average	Consumption (kg/yr) Maximum
Leafy Veg.	90	1.5	14	1	10	21
O.A.G. Veg.	60	0.7	14	1	12	33
Root Veg.	90	4	14	10	66	180
Fruit	90	2	14	10	42	115
Grain	90	1	14	10	46	125
Eggs	90	0.84	18	1	20	30
Milk	30	1.3	4	1	64	181
Meat	90	0.84	34	15	95	110

Call from Tom Clark - 4/23/82

Tom suggested FRP X/Q' values be based on information from ORNL region as presented in EXXON PSAR for FRP. These X/Q' values are about 1 order of magnitude above the X/Q' values I suggested from the CWM GEIS. I indicated the ORNL values would be good to use provided sufficient documentation exists for them. The ORNL values are:

Maximum Individual : 1.7×10^{-7} sec/m^3

Population average : 2.2×10^{-8} sec/m^3

Dennis Strenge

Battelle
Pacific Northwest Laboratories

Project Number ______________

Internal Distribution

DATE: May 20, 1982

TO: IC Nelson

FROM: DL Strenge

OF Hill
RF McCallum
EC Watson
File/LB

Subject: CRBR-EIS Update - Radiological Review

I have reviewed sections 5.7.2.7, D.2.4 and 7.2 as provided in the May 17th transmission to Homer Lowenberg. The discussions give a reasonable description of the consequences from the CRBR fuel cycle. I would like to note, however, that the calculations provided by Ed Branagan of NRC for the SAF line environmental consequences appear to be quite conservative. The assumptions presented in Appendix D indicate that he did not use the Hanford site specific data provided, but used state production values and average population data. This is not a significant problem as the resulting doses are so small even when his conservative values are used.

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FREEDOM OF INFORMATION
ACT REQUEST
FOIA-82-290
Rec'd 7-1-82

June 28, 1982

Joseph M. Felton, Director
Division of Rules and Records
Office of Administration
U. S. Nuclear Regulatory Commission
Washington, D.C. 20555

Subject: Freedom of Information Act Request

Dear Mr. Felton:

Pursuant to the Federal Freedom of Information Act, I hereby request the following:

1. All comments, evaluation, or other documents from the Office of Nuclear Material Safety and Safeguards (NMSS) relative to the environmental impact statement for the Clinch River Breeder Reactor Plant.

2. All comments, evaluations or other documents from BPNL relative to the environmental impact statement for the Clinch River Breeder Reactor Plant.

Very truly yours,

Ellyn R. Weiss

cc: Tom Cochran

ERW:law

8206270077