This document was too large to scan as a whole document; therefore, it is required break into smaller sections.

EDMC NUMBER: 0047100

DOCUMENT NUMBER: NA

SECTION 5 OF _____

Sheet1 LAW - 15%, 1.25; HLW - 20%, 1.5
Sheet B-35
RDW 2-15-96

Sensitivity Case 2

	EX SITU INTERMEDIATE SEPARATIONS ALTERNATIVE						
RETRIEVAL							
Waste Transport					total		
Onsite Truck					1.25E+04		
						Total	1.25E+04
Construction							
Offsite Truck		trips/yr	km/trip	yr	total		
	concrete	4.80E+02	1.40E+02	2.00E+01	1.34E+06		
	raw material	4.50E+01	8.00E+02	2.00E+01	7.20E+05		
	equipment	2.50E+01	1.00E+04	2.00E+01	5.00E+06		
	miscellaneous	5.20E+03	1.40E+02	2.00E+01	1.46E+07		
	steel W-314	5.30E+01	8.00E+02		4.24E+04		
	cement W-314	1.00E+02	1.40E+02		1.40E+04	Total	2.17E+07
Offsite Rail		trips/yr	km/trip	yr	total		
	raw material	1.00E+01	8.00E+02	2.00E+01	1.60E+05	Total	1.60E+05
Onsite Truck							
	borrow W-314	1.38E+03	1.00E+01		1.38E+04	Total	1.38E+04
VITRIFICATION							
Construction							
Onsite Truck		trips	km/trip		total		
	borrow	1.38E+05	1.00E+01		5.20E+05		
						Total	5.20E+05
Offsite Truck		trips	km/trip		total		
	concrete	5.0E+04	1.40E+02		4.06E+06		
	steel	1.9E+04	8.00E+02		7.60E+06		
		trips/yr	km/trip	yr			
	miscellaneous	5.5E+03	1.40E+02	1.00E+01	7.28E+06		
						Total	1.89E+07
Processing							
Offsite Truck		trips/yr	km/trip	yr	total		
	glassformer/chem	1.63E+03	8.00E+02	1.95E+01	3.59E+05		
	miscellaneous	7.0E+03	1.40E+02	1.95E+01	1.42E+07		
						Total	1.46E+07
Offsite Rail		trips/yr	km/trip	yr	total		
	glassformer/chem	2.7E+02	8.00E+02	1.95E+01	4.06E+06		
						Total	4.06E+06
VITRIFIED HLW TRANSPORT							
Offsite Rail		trips	km/trip		total		
	Yucca Mountain	8.35E+02	2.93E+03		4.98E+05		
						Total	4.98E+05
CLOSURE							
Onsite Truck		cu yd	trip/cu yd	km/trip	total		
	fill	9.86E+05	1.00E-01	1.00E+01	9.86E+05		

LAW - 10%, 1.25; HLW - 15%, 1.5
Sheet B-36
RDJ 2-15-96

Sensitivity Case 3

	EX SITU INTERMEDIATE SEPARATIONS ALTERNATIVE						
RETRIEVAL							
Waste Transport					total		
Onsite Truck					1.25E+04		
						Total	1.25E+04
Construction							
Offsite Truck		trips/yr	km/trip	yr	total		
	concrete	4.80E+02	1.40E+02	2.00E+01	1.34E+06		
	raw material	4.50E+01	8.00E+02	2.00E+01	7.20E+05		
	equipment	2.50E+01	1.00E+04	2.00E+01	5.00E+06		
	miscellaneous	5.20E+03	1.40E+02	2.00E+01	1.46E+07		
	steel W-314	5.30E+01	8.00E+02		4.24E+04		
	cement W-314	1.00E+02	1.40E+02		1.40E+04	Total	2.17E+07
Offsite Rail		trips/yr	km/trip	yr	total		
	raw material	1.00E+01	8.00E+02	2.00E+01	1.60E+05	Total	1.60E+05
Onsite Truck							
	borrow W-314	1.38E+03	1.00E+01		1.38E+04	Total	1.38E+04
VITRIFICATION							
Construction							
Onsite Truck		trips	km/trip		total		
	borrow	2.18E+05	1.00E+01		5.20E+05		
						Total	5.20E+05
Offsite Truck		trips	km/trip		total		
	concrete	6.51E+04	1.40E+02		4.06E+06		
	steel	2.24E+04	8.00E+02		7.60E+06		
		trips/yr	km/trip	yr			
	miscellaneous	5.54E+03	1.40E+02	1.00E+01	7.28E+06		
						Total	1.89E+07
Processing							
Offsite Truck		trips/yr	km/trip	yr	total		
	glassformer/chem	2.03E+03	8.00E+02	1.95E+01	3.59E+05		
	miscellaneous	7.4E+03	1.40E+02	1.95E+01	1.42E+07		
						Total	1.46E+07
Offsite Rail		trips/yr	km/trip	yr	total		
	glassformer/chem	2.7E+02	8.00E+02	1.95E+01	4.06E+06		
						Total	4.06E+06
VITRIFIED HLW TRANSPORT							
Offsite Rail		trips	km/trip		total		
	Yucca Mountain	1113	2.93E+03		4.98E+05		
						Total	4.98E+05
CLOSURE							
Onsite Truck		cu yd	trip/cu yd	km/trip	total		
	fill	9.86E+05	1.00E-01	1.00E+01	9.86E+05		

Sheet B-37
RDW 2-15-96

	EX SITU INTERMEDIATE SEPARATIONS- ALTERNATIVE							
RETRIEVAL								
Waste Transport						total		
Onsite Truck						1.25E+04		
							Total	1.25E+04
Construction								
Offsite Truck			trips/yr	km/trip	yr	total		
	concrete		4.80E+02	1.40E+02	2.00E+01	1.34E+06		
	raw material		4.50E+01	8.00E+02	2.00E+01	7.20E+05		
	equipment		2.50E+01	1.00E+04	2.00E+01	5.00E+06		
	miscellaneous		5.20E+03	1.40E+02	2.00E+01	1.46E+07		
	steel W-314		5.30E+01	8.00E+02		4.24E+04		
	cement W-314		1.00E+02	1.40E+02		1.40E+04	Total	2.17E+07
Offsite Rail			trips/yr	km/trip	yr	total		
	raw material		1.00E+01	8.00E+02	2.00E+01	1.60E+05	Total	1.60E+05
Onsite Truck								
	borrow W-314		1.38E+03	1.00E+01		1.38E+04	Total	1.38E+04
VITRIFICATION								
Construction								
Onsite Truck			trips	km/trip		total		
	borrow	1.17E+05	~~5.20E+04~~	1.00E+01		5.20E+05		
							Total	5.20E+05
Offsite Truck			trips	km/trip		total		
	concrete	5.45E+04	2.90E+04	1.40E+02		4.06E+06		
	steel	1.31E+04	9.50E+03	8.00E+02		7.60E+06		
			trips/yr	km/trip	yr			
	miscellaneous	7.54E+04	~~5.20E+03~~	1.40E+02	1.00E+01	7.28E+06		
							Total	1.89E+07
Processing								
2.2E+04 Offsite Truck			trips/yr	km/trip	yr	total		
3.11E+04	glassformer/chem		~~2.30E+01~~	8.00E+02	1.95E+01	3.59E+05		
	miscellaneous	~~3.33E+04~~	5.20E+03	1.40E+02	1.95E+01	1.42E+07		
		6.7E+03					Total	1.46E+07
Offsite Rail		~~5.27E+02~~	trips/yr	km/trip	yr	total		
	glassformer/chem		~~2.60E+02~~	8.00E+02	1.95E+01	4.06E+06		
			2.74E+02				Total	4.06E+06
VITRIFIED HLW TRANSPORT								
Offsite Rail			trips	km/trip		total		
	Yucca Mountain		1.70E+02	2.93E+03		4.98E+05		
			9.35E+02				Total	4.98E+05
CLOSURE								
Onsite Truck			cu yd	trip/cu yd	km/trip	total		
	fill		9.86E+05	1.00E-01	1.00E+01	9.86E+05		

Sheet B-43	R=1.0	R=1.7	R=2.13
Concrete (storage pad) (m^3) RDW 6-15-96			
Cement	3.27E+03	8.8E+03	1.25E+04
Sand			
gravel.			
Concrete vaults (m^3)			
Cement	4.3E+04	1.89E+05	3.66E+06
Sand			
gravel			
Concrete prefab shapes. (m^3)	1.4E+05	3.07E+05	6.34E+06
~~Cement~~			
~~Sand.~~			
~~Gravel.~~			
Carbon Steel (storage pad)			
Rebar (m^T)	32.2	378	536.8
Carbon Steel (vaults)	5.0E+03	2.2E+04	4.25E+04
rebar (m^T)			
Carbon Steel prefab shapes (boxes) 4.2 m^3 (m^T)	6.37E+04	1.25E+05	1.58E+06

Trips (1) RJW 6-15-96 Sheet 13-39

Concrete (Storage Pad)				
Cement	20 Ton Truck	288	775	1100
Sand	6 cu yd dump Truck	714	1922	2730
Gravel	6 cu yd Dump Truck	714	1922	2730
Concrete (Storage Vaults)				
Cement	20 Ton Truck	3784	16630	32208
Sand	6 yd^3 dump Truck	9389	41265	79910
gravel	6 yd^3 dump Truck	9389	41265	79910
Concrete (Prefab Shapes)(2)				
Cement	20 Ton truck	12320	33176	46992
Sand.	6 yd^3 dump Truck	30567	82312	116590
gravel	6 yd^3 dump Truck	30567	82312	116590
Concrete (prefab Shapes)(3)				
Special Multiaxel Low boy Trailer		2470	6645	9420
1 unit each per Trailer ≅ 100 Tons				
Carbon Steel (Storage Pad)				
Rebar	20 Ton Truck	2	19	30
Carbon Steel (Storage Vaults)				
Rebar	20 Ton Truck	275	1210	2338
Carbon Steel (Prefab Steel boxes, 4.2 m^3)				
Steel boxes	20 Ton Truck	3504	6930	8690

(1) based on additional materials to original intermediate separations case.

(2) based on Casting shield Covers on Site.

(3) based on Casting Shield covers off Site.

LAW - 25%	LAW - 15%	LAW - 10
Na_2O Loading	Na_2O Loading	Loading
HLW - 40%	HLW - 20%	HLW - 15
Waste oxide	Waste oxide	waste oxi
Loading.	Loading.	Loading

Sheet B-40
RDW 2-15-96

Table B.10.0.3 Resourc

Resource	Phase	No Action Alternative	Ex Situ Intermediate Separations Alternative	Ratio 1.7 LAW 15% loading Blend 1.25 HLW-20% loading Blend 1.5	Ratio 2.13 LAW-10% Na_2O loading Blend 1.25 HLW-15% loading Blend 1.6	R = 1.25 LAW-25% Na_2O Loading Blend 1.25 HLW-40% loading Blend 1.5
Land, permanently committed (hectares) (Long-term commitment of radiologically contaminated area)	Total	17	40			
	Construction/ Operation	0	7			
	Closure	17	33			
Land, incremental temporarily committed (hectares) (area disturbed during construction and operations)	Total	0	108			
	Construction/ Operation	0	84			
	Closure	0	24			
Borrow Pit Disturbed Area (hectares) based on an excavation depth of 3 meters	McGee Ranch	N/A	21			
	Pit 30	N/A	57			
	Vernita Quarry	N/A	27			
Water, Total (cubic meters)	Sanitary plus Raw Water	1.52E+06	1.47E+07	2.40 E+07	3.5 E+07	1.77 E+07
Water, Sanitary (cubic meters)	Total	N/R	3.6E+06	5.83 E+06	7.16 E+06	4.4 E+06
	Construction	N/R	5.0E+05			
	Operation	N/R	3.1E+06	5.27 E+06	6.60 E+06	3.84 E+06
	Closure	N/R	6.0E+04			
Water, Raw (cubic meters)	Total	1.5E+06	1.07E+07	1.82 E+07	2.78 E+07	1.33 E+07
	Construction	N/A	N/R			
	Operation	1.5E+06	1.07E+07	1.82 E+07	2.78 E+07	1.33 E+07
	Closure	N/A	N/R			
Energy Electricity (Gwh)	Total	1.1E+03	9.07E+03	1.56 E+04	1.93 E+04	1.13 E+04
	Construction	N/A	7.4E+01			
	Operation	1.1E+03	9.0E+03	1.55 E+04	1.92 E+04	1.12 E+04
	Closure	N/A	N/R			
Gasoline (cubic meters)	Total	N/A	8.0E+03	8.0 E+03	8.07 E+03	8.00 E+03
	Construction	N/A	7.6E+03			
	Operation	N/R	N/R	5.46 E+01	77.3 E+00	9.1 E+00
	Closure	N/A	3.9E+02			

Sheet B-41
RDW 2-15-96

Table B.10.0.3 Resource Su

Resource	Phase	No Actio Alternati	Ex Situ Intermediate Separations Alternative	Ratio 1.0	Ratio 8.13	R = 1.25
Diesel (cubic meters)	Total	2.2E+04	3.32E+04	9.47E+04	1.01E+05	8.9E+04
	Construction	N/A	2.1E+04			
	Operation	2.2E+04	1.02E+03	7.53E+03	1.39E+04	2.24E+0
	Closure	N/A	6.62E+04			
Kerosene (cubic meters)	Operation	N/A	5.3E+04	9.86E+04	1.08E+05	7.2E+04
Materials: Concrete (cubic meters)	Total	N/A	7.29E+05	1.67E+06	1.64E+06	9.15E+05
	Construction	N/A	5.4E+05	6.49E+05	5.53E+05	6.43E+05
	Operation	N/A	1.7E+05	~~1.11E+06~~	1.07E+06	3.53E+05
	Closure	N/A	1.9E+04			
Carbon Steel (metric tons)	Total	1E+03	1.64E+05	1.78E+05	3.27E+05	1.95E+05
	Construction	N/A	1.07E+05	1.07E+05	1.07E+05	1.07E+05
	Operation	1E+03	N/R	5.16E+04	2.01E+05	6.87E+04
	Closure	N/R	1.9E+04 ??	??	??	??
Stainless Steel (mt) TOTAL	Construction	N/A	1.4E+04 1.9E+04 NR	4.41E+04 1.9E+04 2.51E+04	5.24E+04 1.9E+04 ~~3.31E+04~~	3.2E+04 1.9E+04 1.3E+04
Hastelloy/Inconel (mt)	Construction	N/R	2.3E+03			
Glass Formers (mt)	Operation	N/A	2.94E+05	5.0E+05	6.26E+05	3.65E+05
Process Chemicals (mt)	Operation	N/A	3.81E+05 1.90E+05 *	5.15E+05	5.97E+05	4.27E+0
Bulk sulfur cement	Operation	N/A				
sulfur (mt)			1.30E+05	2.21E+05	2.77E+05	1.61E+05
dicyclopentadine (mt)			3.4E+03	5.78E+03	7.24E+03	4.22E+03
oligomer (mt)			3.4E+03	5.78E+03	7.24E+03	4.22E+03
Ion exchange media (cubic meters)	Operation	N/A	2.2E+02			
Borrow Site Silt (cubic meters)	Closure	N/A	5.26E+05			
Borrow Site Sand and Gravel (cubic meters)	Total	N/A	1.68E+06			
	Construction	N/A	3.17E+05			
	Operation	N/A	N/A			
	Closure	N/A	1.36E+06			
Borrow Site Basalt (cubic meters)	Closure	N/A	3.05E+05			
Asphalt (cubic meters)	Closure	N/A	3.07E+04			

deistappenblaggenb.dll

* Includes Oxygen for Kerosene burning.

Totals this table				R= 1.0	R= 1.7	R=2.13
				RAS 2-15-96	52	13-42
Gasoline (m^3)	9.1E0 (2402)			NR	54.6	77.3
					~~20405~~ ~~2E+03~~ 14414	204073
Diesel (m^3)	2.23E3 588720			1.02E+03	7.53E+03	1.39E+0
				269250	1987920	3619600
Kerosene (m^3)	7.2E4 19008000			5.8E+04	9.86E+04	1.08E+0
				15312000	~~E0~~ 26030400	28512000
Concrete (m^3)	915E5	~~7.2E4~~ 1199680	TOTAL	7.29E+05	1.67E+06	1.64E+06
				959990	2137960	2145400
~~Cement~~	5.43E5	711330	Const.	5.4E+05	5.49E+05	5.53E+0
				707420	719190	724430
~~Sand~~	3.53E5	462430	operations	1.7E+05	1.11E+06	1.07E+06
				222760	1454160	1401700
~~Gravel~~	1.9E4	24890	closure	1.9E+04	1.9E+04	1.9E+04
				24890	24890	24890
Concrete Prefab Shapes (m^3)				NA	NA	NA
Carbon Steel ~~rebar~~ (m Tons)	1.95E+04	214500	Total	1.64E+06	2.72E+05 ~~177900~~ ~~1.78E+06~~	3.27E+06 ~~359700~~
	1.07E05	117700	Const	1.07E+05	117700 1.07E+05	117700 1.07E+05
Carbon Steel ~~prefab Shapes~~ (m Tons)	ops 6.97E4	75570		NR	67760 ~~5.16E+04~~ 1.46E+03	221100 2.01E+05
Stainless Steel Prefab Shapes (m Tons)	1.3E+04	14300		NR	27610 2.51E+04	36740 3.34E+04
Glass formers (m T)		3.65E+05	(yd^3)	365140 2.94E+05	655000 5.0E+05	820060 6.26E+05
sand		478150				
CaO						
MgO						
Boronoxide						
etc.		401500	(Tons)	323400	550000	684600
Process oxygen (m T)		260700 (2.37E+05)		210100 (1.91E+05)	337500 (3.25E+05)	447900 (4.07E+05)
Process Chemicals		4.27E+05 469900		3.81E+05 419100	5.15E+05 566500	5.97E+05 656900
Sulfur Cement						
Sulfur (m T)		177100 1.61E+05		143000 1.3E+05	243100 2.21E+05	304700 2.77E+05
dicyclopentadiene (m T)		(DCPD) 4.22E+03		3.4E+03	5.78E+03	7.24E+0
Oligomer (m T)		(DCP) 4.22E+03 4642		3.4E+03 3740	5.78E+03 6358	7.24E+0 7964

Sheet B-43	R=1.0	R=1.7	R=2.13
Concrete (storage pad) (m^3) RDW 6-15-96			
Cement	3.27E+03	8.8E+03	1.25E+04
Sand			
gravel.			
Concrete vaults (m^3)			
Cement	4.3E+04	1.89E+05	3.66E+06
Sand			
gravel			
Concrete prefab shapes. (m^3)	1.4E+05	3.07E+05	6.34E+06
~~Cement~~			
~~Sand.~~			
~~Gravel.~~			
Carbon Steel (storage pad)			
Rebar (m^T)	32.2	378	536.8
Carbon Steel (vaults)	5.0E+03	2.2E+04	4.25E+04
rebar (m^T)			
Carbon Steel prefab shapes (boxes) 4.2 m^3 (m^T)	6.37E+04	1.25E+05	1.58E+06

Number of trips by truck/Rail	R=1.0	R=1.7	R=2.13
	AW 2-15-86	Sheet	B-44
Gasoline 5000 gallon truck/Tricities (operations)	NR	3	5
Diesel 5000 gallon truck/Tricities (operations)	54	398	734
Kerosene 5000 gallon truck/Tricities (operations)	3,063	5,207	5,703
Concrete 6 cu yds/Truck Load.			
Total	159,165	364,617	358,067
Cost	117,900	119,865	120,739
operations	37,117	242,350	233,617
closure	4,149	4,149	4,149
Carbon Steel truck - 20 tons/load			
Total	9,020	9,790	17,985
Cost	5885	5885	5885
operations	NR	3388	11055
Stainless Steel 20 tons/truck load (operations)	NR	1381	1837
Blast Furnace			
sand ~~10 tons~~ 16 yd³/truck/Tricities (0.816)	19643	33405	41824
other materials 20 TONS/TRUCK (0.1837)	2971	5052	6325
process chemicals 20 tons/truck.	20955	28325	32835
Liquid oxygen at 20 tons/truck.	10505	17875	22385
Sulfur Cement			
Sulfur 45,000 lbs/tank truck.	6356	10805	13543
DCPD - Dicyclopentadiene 45 ton/rail tank car	84	142	177
DCP - Oligomer 20 tons/truck	187	318	399

NOTE BASED ON TOTAL quantities.

Concrete cover - Cost of site

Table B.10.0.7 Transportation Summary by Tank Waste Alternative

Alternative	Rail Transport, Distance (km)		Truck Transport, Distance (km)		Employee Vehicle Distance (km)
	Onsite	Offsite	Onsite	Offsite	
No Action	N/A	N/A	N/A	N/A	2.81E+09
Long-Term Management	0	0	3.24E+05	2.28E+07	2.91E+09
In Situ Fill and Cap	0	0	5.63E+06	1.29E+05	7.05E+08
In Situ Vitrification	N/A	2.10E+05	6.83E+06	2.27E+07	1.32E+09
Ex Situ Intermediate Separations	N/A	~~4.71E+06~~ 6.72E+06	~~7.79E+06~~ 1.50E+07 (1)	~~5.52E+07~~ 9.83E+07 (1)	2.31E+09
Ex Situ No Separations (Vitrification)	N/A	~~7.58E+06~~ 1.15E+07	~~5.93E+06~~ 6.66E+06 (1)	~~4.23E+07~~ 1.06E+08 (1)	1.06E+09
Ex Situ No Separations (Calcination)	N/A	~~4.33E+06~~ 9.15E+06	~~5.93E+06~~ 6.03E+06 (1)	4.23E+07 5.93E+07 (1)	1.06E+09
Ex Situ Extensive Separations	N/A	~~8.34E+06~~ 8.56E+06	~~7.88E+06~~ 9.83E+06 (1)	~~5.91E+07~~ 1.18E+08 (1)	2.19E+09
Ex Situ/In Situ Combination	N/A	~~2.36E+06~~ 3.36E+06	6.55E+06 7.33E+06 (1)	~~2.77E+07~~ 5.41E+07 (1)	1.44E+09
Phased Implementation (Phase 1)	N/A	1.74E+05	1.05E+06	1.71E+07	4.76E+08
Phased Implementation (Phase 2)	N/A	~~2.74E+06~~ 4.74E+06	~~6.30E+06~~ 9.01E+06 (1)	~~2.98E+07~~ 6.72E+07 (1)	1.72E+09

Notes:
N/A = Not Applicable
(1) additional concrete shielding cover - cost offsite.

Sheet 8-45
Rev 8-15-96

Table B.10.0.7 Transportation Summary by Tank Waste Alternative

Alternative	Rail Transport, Distance (km)		Truck Transport, Distance (km)		Employee Vehicle Distance (km)
	Onsite	Offsite	Onsite	Offsite	
No Action	N/A	N/A	N/A	N/A	2.81E+09
Long-Term Management	0	0	3.24E+05	2.28E+07	2.91E+09
In Situ Fill and Cap	0	0	5.63E+06	1.29E+05	7.05E+08
In Situ Vitrification	N/A	2.10E+05	6.83E+06	2.27E+07	1.32E+09
Ex Situ Intermediate Separations	N/A	~~4.71E+06~~ 6.72E+06	~~7.79E+06~~ 1.14E+07 (1)	~~5.52E+07~~ 1.20E+08 (1)	2.31E+09
Ex Situ No Separations (Vitrification)	N/A	~~7.58E+06~~ 11.5E+07	~~5.93E+06~~ 3.86E+07 (1)	~~4.23E+07~~ ~~5.08E+08~~ (1) 4.90	1.06E+09
Ex Situ No Separations (Calcination)	N/A	~~4.33E+06~~ 9.25E+06	~~5.93E+06~~ 1.01E+07 (1)	~~4.23E+07~~ 1.13E+08 (1)	1.06E+09
Ex Situ Extensive Separations	N/A	~~8.34E+06~~ 8.56E+06	~~7.88E+06~~ 9.86E+06 (1)	~~5.91E+07~~ ~~1.13E+08~~ (1) 1.22E+08	2.19E+09
Ex Situ/In Situ Combination	N/A	~~2.36E+06~~ 3.36E+06	~~6.55E+06~~ 8.15E+06 (1)	~~2.77E+07~~ ~~5.29E+07~~ 3.77E+07 (1)	1.44E+09
Phased Implementation (Phase 1)	N/A	1.74E+05	1.05E+06	1.71E+07	4.76E+08
Phased Implementation (Phase 2)	N/A	~~2.74E+06~~ 4.74E+06	~~6.30E+06~~ 9.65E+06 (1)	~~2.98E+07~~ 8.75E+07 (1)	1.72E+09

Notes:
N/A = Not Applicable
(1) Concrete shielding cover cast on site.

Sheet B-46
BR Rev 2-15-96

3035
3350/19

Table 5.10.2 Rail Traffic Volumes

Alternative	Construction/Operations Phases[1] Average Trips/Year	Construction/Operations Phases[1] Time Frame	HLW Shipments to Repository[2] Average Trips/Year	HLW Shipments to Repository[2] Time Frame
Tank Waste				
No Action	0	—	0	—
Long Term Management	0	—	0	—
In Situ Fill and Cap	0	—	0	—
In Situ Vitrification	12 ~~16~~	1997-~~[redacted]~~ 2016	0	—
Ex Situ Intermediate Separations	284 ~~200~~ 284	1997-2024	84	2019-2029
Ex Situ No Separations (Vitrification)	113 ~~80~~ 113	1997-2019	735	2017-2037
Ex Situ No Separations (Calcination)	113 ~~80~~ 113	1997-2019	271	2017-2027
Ex Situ Extensive Separations	687 ~~485~~ 687	1997-2024	40	2020-2029
Ex Situ/In Situ Combination	147 ~~100~~ 147	1997-2024	42	2019-2029
Phased Implementation (Phase I)	~~20~~ 218	1997-2012	0	—
Phased Implementation (Total)	321 ~~108~~ 321	1997-2028	83	2019-2029
Capsules				
Capsules No Action	0	—	0	—
Capsules On-Site Disposal	0	—	0	—
Capsules Overpack and Ship	0	2003-2028	6	[redacted] 2028-2029
Capsules Vitrify with Tank Waste	[redacted]	—	[redacted]	—

1 Rail trips during construction and operations phases would be trips to the Site delivering construction materials, chemicals used during waste processing, etc.
2 Capsules Vitrify with Tank Waste rail trips are included in total trips shown for the ex situ alternatives.

Insert T-1 p.2

Sheet 8-17 Rev 8-15-91

JACOBS ENGINEERING GROUP INC.
SUBJECT
JOB NO.
SHEET NO.
DATE
BY
CHK
FORM 81-0054 (4/81)

Insert (T) (1) (New text) Sheet B-48 RSW 2-15-96
Replaces existing 5.10.3

5.10.3 Rail Traffic

Rail traffic volumes would be relatively small for all EIS alternatives, and small impacts on the rail systems would be expected (Table 5.10.2). The No Action, Long-Term Management and In Situ Fill and Cap alternatives would involve no rail traffic. The In Situ Vitrification alternative would involve only 16 rail trips per year for transporting construction materials and chemicals used during operations to the Site.

The Ex Situ Intermediate Separations alternative would involve an average of 200 rail trips per year to deliver materials to the Site during construction and operations phases, and 84 rail trips per year to transport HLW to the nation's HLW repository. From 2019 to 2024, when both waste processing operations and HLW shipments are ongoing, total rail traffic would be 284 trips per year (24 trips per month).

The Ex Situ No Separations alternative (vitrification) would require 80 rail trips per year during construction and operations and 735 rail trips per year for HLW transport to the HLW repository. During the 2017 to 2019 period when operations and HLW shipments overlap, a total of 815 rail trips per year (68 rail trips per month) would be expected. The calcination option for the No Separations alternative would involve 80 trips per year during construction and operations, 271 HLW shipments per year to the national repository, and a combined peak (2017 to 2019) of 351 rail trips per year (29 trips per month).

The Ex Situ Extensive Separations alternative would involve the largest number of rail trips to the Site during construction and operations phases (485 trips per year), but the smallest number of HLW shipments to the national repository (40 trips per year). From 2020 to 2024, when both operations and HLW shipments are ongoing, rail trips would average 525 per year (44 per month). The Ex Situ/In Situ Combination alternative would require 100 rail trips to the Site during construction and operations and 42 HLW rail shipments per year to the repository. From 2019 to 2024, when both operations and HLW shipments are ongoing, rail trips would average 142 per year (12 per month).

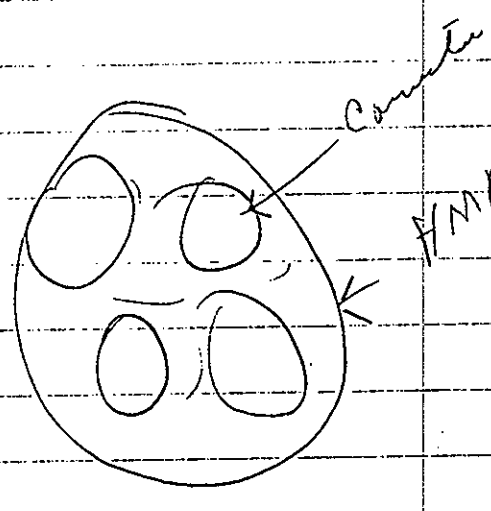
Phased Implementation (Phase I) would involve 20 rail shipments per year to bring materials onto the Site, but no offsite shipments of HLW. The total Phased Implementation alternative would require 108 rail shipments per year during construction and operations, 83 rail shipments per year to the HLW repository, with a peak of 191 rail trips per year (16 rail trips per month) from 2019 to 2028 when both operations activities and HLW shipments are ongoing.

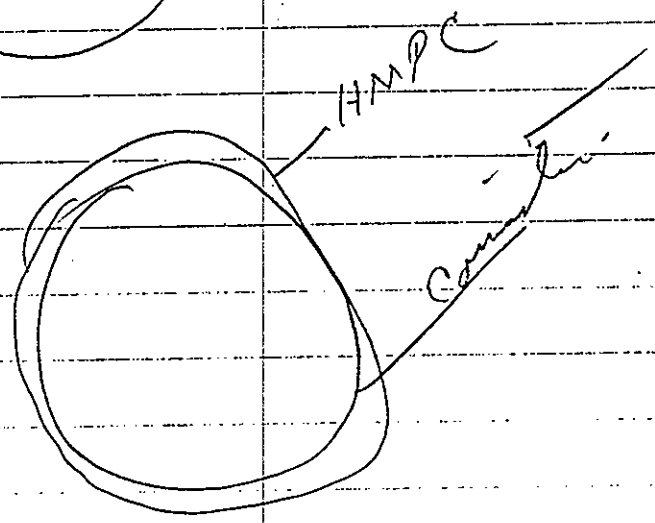
Rail traffic volumes associated with the capsule alternatives would be minimal. The Capsules No Action and On-Site Disposal alternatives would involve no rail traffic. The Overpack and Ship alternative would involve 6 rail shipments of HLW per year to the national repository in 2028 and 2029 only. Rail trips associated with the Vitrify With Tank Waste alternative are included in the rail trips estimated for the tank waste ex situ alternatives.

#

Sheet B-49
BDN 2-15-96

1.	10	260/19	(264)	Δ = 4	Rail Cars	18
2.	10	103/15		Δ = 0		7
3.	10	103/15		Δ = 0		7
4	10	637/19	(646)	Δ = 9	Rail Cars	637/19 = 43
5	5	130/19	(132)	Δ = 2	Rail Cars	130/19 = 9
6	0	218/10				218/10 22
7.	1	275/19	(281)	Δ = 6	Rail Cars.	275/19 +6 = 20
	6.3					
	10					





Sheet B-50
RGW 2-15-96

Table 9-7. Transportation in Support of Processing (Units as Indicated).

Item	Extensive Separation Alternative
Normal Operation Route location (State mileage)	Portland/Seattle (400 kilometers)
Roadtype (gravel or asphalt)	Asphalt
Number of trips per year [1] Truck Train [2]	 513 637
High-level waste transportation Route location (State mileage)	1,330 [3]
Number of overpack canisters	125 [4]
Number of total trips by train	10 [5]

Notes:

[1]Based on yearly loads of glass formers and other cold chemicals. Resins are transported by truck.

[2]Trains consist of 130-ton railcars with 20 cars per train.

[3]Mileage based on travel from Hanford to Yucca Mountain per Table 3-7 (TRW 1995).

Information provided by Hanford Railroad - Transportation.

[4]Based on 4 canisters placed in a Hanford overpack canister.

[5]Based on the transportation of 10 multi-purpose canisters by 10 railcars per week from Hanford to future repository.

For additional information, see Appendix F, and also Jansen, G., 1995, *Backup Information for Data Tables in Extensive Separations Alternative Engineering Data Package*, WHC-SD-WM-DP-129, Rev. 0, Westinghouse Hanford Company, Richland, Washington.

TRW, 1995, *Assessment of Pre-Closure System Cost and Health and Safety Impacts of Hanford High-Level Waste Vitrification Options on the Civilian Radioactive Waste Management System A00000000-01717-5707-00003*, Rev. 0, TRW Environmental Safety Systems, Inc., Vienna, Virginia.

TWRS EIS
CALCULATION COVER SHEET

DISCIPLINE & TITLE RISK ASSESSMENT, LEAD RISK ASSESSOR

ORIGINATOR ALEX NAZARALI DATE 6-20-96

REVISION NO. _____

OBJECTIVE REVISE RISK RESULT FOR THE COLUMBIA RIVER USERS.

METHODOLOGY USE COMPUTER CODE DITTY

ASSUMPTIONS PER INPUT/OUTPUT PRINTOUT.

(Continue on another sheet if necessary)

6/20/96
SIGNATURE/DATE

6/21/96
CHECKED/DATE

CALCULATION & RESULTS
ATTACHED

JACOBS\FORMS\CALCVR.SHT

To	Marc Nelson
From	Alex Nazarali
Date	June 21, 1996
Subject	Cumulative Risk to the Columbia River User Local Population over 10,000 Years

The cumulative risk to the Columbia River user in the TWRS Draft EIS (Appendix D, Table D.5.14.3 and Volume One, Table 5.11.6) was calculated based on the unit dose factors generated by the DITTY computer code and published in Appendix F of the Disposal of Hanford Defense High-Level, Transuranic, and Tank Wastes Final Environmental Impact Statement (HDW-EIS).

The DITTY code has undergone significant modifications since the HDW-EIS was published. The new version of the DITTY code uses ICRP Publications 26 and 30 (ICRP 1977; ICRP 1979) instead of ICRP Publication 2 (ICRP 1959).

The new version of the DITTY code was run to estimate the cumulative dose for the TWRS Final EIS. The input/output of the DITTY code for each alternative and the new table that summarizes the cumulative dose and risk to the Columbia River users over 10,000 years are enclosed. The enclosed table will replace Tables D.5.14.3 and 5.11.6.

Note: The Ftrans.dat file in the DITTY code, which is the PNL food transport factors library was modified by Alex Nazarali on 6/16/96 for the new runs. In this modification, the leaching factors for neptunium and uranium changed from 3.3E-03 and 1.3E-03 respectively to 0.8. This change makes the leaching factors of neptunium and uranium consistent with carbon, iodine, and technetium. These five constituents are transported from the tanks to the receptors with the same transport properties. The leaching factors were different in the DITTY code, which should be the same for our analysis.

Table D.5.14.3 Estimated Fatality, Population Dose (person-rem), and Maximum Incremental Dose (mrem) for the Columbia River User over 10,000 Years for all Alternatives

Alternative	Total Fatality in 10,000 years	Cumulative Population Dose[1] (Person-rem)	Maximum Incremental Dose in mrem (Year Received)
No Action	2.7	5460	0.82 (2900)
Long-Term Management	2.2	4400	0.75 (2830)
In Situ Fill and Cap	25.4	50800	0.15 (12000)
In Situ Vitrification	1.00E-06	0.002	0
Ex Situ Intermediate Separation	0.5	896	0.005 (9060)
Ex Situ No Separation	0.5	896	0.005 (9060)
Ex Situ Extensive Separation	0.5	896	0.005 (9060)
Ex Situ/In Situ Combination	2.2	4420	0.02 (12000)
Phased Implementation	0.5	896	0.005 (9060)

1 The ICRP Publication 60 dose to risk conversion factor of 5.0E-04 cancer fatality per rem is used.

```
DITTY Long-Term Surface Water Release TWRS-EIS (No Action)
  5
C 14
I 129
NP237
TC99
U 238
 &INPUT IWAT=1, IPATH=2, LUW=1, IPOPL=2,
  CFLO=120000.,
  RM=1.0, TZ=1990., TZR=0.,
  PL1(1)=294830.,391538.,431210.,469891.,1273208.,4932964.,
  TL(1)=1990., 2100.,2200.,2300.,2990.,11900.,
  NTL=6,
  USAGE(1)=0.3,0.,0.,0.,438.,17.,17.,
  CONSUM(1)=15.,276.,20.,230.,40.,30.,8.5,
  EXTIM=2920.,MOPYR=6, RIRR=150.,
  GRWP(1)=90.,90.,90.,30.,3*90.,
  YELD(1)=1.5,4.,0.84,1.3,3*0.84,
 &END
  5
C 14       5
1990.   0.0
2219.   0.0
2220.   8.0125
2845.   8.0125
2846.   0.0
I 129      5
1990.   0.0
2219.   0.0
2220.   0.0256
2845.   0.0256
2846.   0.0
NP237      5
1990.   0.0
2219.   0.0
2220.   0.106
2845.   0.106
2846.   0.0
TC99       5
1990.   0.0
2219.   0.0
2220.   49.68
2845.   49.68
2846.   0.0
U 238      5
```

1990.	0.0
2219.	0.0
2220.	0.7696
2845.	0.7696
2846.	0.0

DITTY Dose Calculation Program
(GENII Version 1.485 3-Dec-90)

Integrated population dose calculated for chronic liquid release
Release from time 1990. A.D. onward for 10,000 years
Case title: DITTY Long-Term Surface Water Release TWRS-EIS (No Action)
Executed on: 06/18/96 at 10:54:15.6 Page 1

---- DATA LIBRARIES USED ----------(File)-----

Master Radionuclide Data: (2)
Radionuclide Master Library - Long Times (23-July-93 PDR)
Food Concentration Ratios: (8)
PNL Food Transfer Factor Library (by Z, Changed NP&U LF 6/18/96 AMN)
Fresh Water Bioaccumulation Factors: (9)
Bioaccumulation Factor Library - (30-Aug-88) RAP
External Exposure D.F.'s: (10)
External Dose Factors for GENII in person Sv/yr per Bq/X (8-May-90 RAP)
Inhalation/Ingestion D.F.'s: (30)
Worst-Case Solubilities, DITTY Internal Dose Factors (Sv/Bq) (23-Jul-93 PDR)
Waterborne Release Data: (31)
DITTY.IN

---- MASTER RADIONUCLIDE CONTROL LIST ----------
C 14 TC99 I 129 U 238 TH234 PA234 NP237
PA233

---- TERRESTRIAL/AQUATIC PATHWAY DATA FOR AN AVERAGE INDIVIDUAL

Pathway	Growing Period (days)	Yield (kg/m2)	Consumption (kg/yr)	Pathway	Usage (kg or hr/yr)
LEAFY VEG	9.0E+01	1.5E+00	1.5E+01	FISH	3.0E-01
OTHER VEG	9.0E+01	4.0E+00	2.8E+02	CRUSTACEA	0.0E+00
EGGS	9.0E+01	8.4E-01	2.0E+01	MOLLUSES	0.0E+00
MILK	3.0E+01	1.3E+00	2.3E+02	PLANTS	0.0E+00
BEEF	9.0E+01	8.4E-01	4.0E+01	DRINKING WATER	4.4E+02
PORK	9.0E+01	8.4E-01	3.0E+01	SEDIMENT EXPOSU	1.7E+01
POULTRY	9.0E+01	8.4E-01	8.5E+00	SWIMMING TIME	1.7E+01

External Exposure Time: 2.92E+03 hr/yr

---- LIQUID RELEASE PARAMETERS ----------

River Flow Rate, (ft3/sec) : 1.2E+05 Months/Year Irrigated : 6.0E+00
Reconcentration Ratio : 1.0E+00 Irrigation Rate
Mixing Ratio : 1.0E+00 (liters/m2/month) : 1.5E+02

Input Prepared By: _____ Date: _____

Input Checked By: _____ Date: _____

DITTY Dose Calculation Program
(GENII Version 1.485 3-Dec-90)

Integrated population dose calculated for chronic liquid release
Release from time 1990. A.D. onward for 10,000 years
Case title: DITTY Long-Term Surface Water Release TWRS-EIS (No Action)
Executed on: 06/18/96 at 10:54:15.6 Page 2

---- WATER RELEASE OF EACH RADIONCLIDE PER 70-YR PERIOD (Ci) ----------

Radio-nuclide	Period/ Activity	Period/ Activity	Period/ Activity	Period/ Activity	Period/ Activity
C 14	4 6.3E-01	5 8.8E-01	6 8.8E-01	7 8.8E-01	8 8.8E-01
	9 8.8E-01	10 8.8E-01	11 8.8E-01	12 8.8E-01	13 2.0E-01
TC99	4 4.9E+02	5 6.8E+02	6 6.8E+02	7 6.8E+02	8 6.8E+02
	9 6.8E+02	10 6.8E+02	11 6.8E+02	12 6.8E+02	13 1.5E+02
I 129	4 1.3E+00	5 1.8E+00	6 1.8E+00	7 1.8E+00	8 1.8E+00
	9 1.8E+00	10 1.8E+00	11 1.8E+00	12 1.8E+00	13 4.0E-01
U 238	4 3.9E+01	5 5.4E+01	6 5.4E+01	7 5.4E+01	8 5.4E+01
	9 5.4E+01	10 5.4E+01	11 5.4E+01	12 5.4E+01	13 1.2E+01
NP237	4 5.4E+00	5 7.4E+00	6 7.4E+00	7 7.4E+00	8 7.4E+00
	9 7.4E+00	10 7.4E+00	11 7.4E+00	12 7.4E+00	13 1.6E+00

---- POPULATION DATA ----

Population for Chronic Waterborne Release at the following Times A.D.:

Time	Population
1990.	2.9E+05
2100.	3.9E+05
2200.	4.3E+05
2300.	4.7E+05
2990.	1.3E+06
11900.	4.9E+06

DITTY Dose Calculation Program
(GENII Version 1.485 3-Dec-90)

Integrated population dose calculated for chronic liquid release
Release from time 1990. A.D. onward for 10,000 years
Case title: DITTY Long-Term Surface Water Release TWRS-EIS (No Action)
Executed on: 06/18/96 at 10:54:15.6 Page 4

Lifetime Effective Cumulative Dose Equivalent as a Function of Time

Period	Year	Dose
until	until	
5	2270.	2.63E+02
6	2340.	6.52E+02
7	2410.	1.11E+03
8	2480.	1.63E+03
9	2550.	2.22E+03
10	2620.	2.88E+03
11	2690.	3.60E+03
12	2760.	4.39E+03
13	2830.	5.25E+03
14	2900.	5.46E+03
until	until	
144	12000.	5.46E+03

Dose in units of person-rem;
that is the cumulative population dose received by the local population over 10,000 years with an assumed 70-yr individual lifetime.

Cumulative Population Dose Equivalent by Radionuclide

Radio-nuclide	Effective Dose Equivalent	Annual External Dose	Effective Dose Equivalent	Percent Of Total Dose
C 14	1.1E+00	5.0E-05	1.1E+00	0
TC 99	1.5E+03	9.3E-04	1.5E+03	27
I 129	9.2E+01	2.9E-04	9.2E+01	1
U 238	6.6E+02	1.4E-04	6.6E+02	12
TH 234	6.9E-02	9.0E-02	1.6E-01	0
PA 234	2.3E-04	1.4E-02	1.4E-02	0
NP 237	3.2E+03	1.6E-02	3.2E+03	58
PA 233	3.2E-02	3.8E-01	4.1E-01	0

Dose in units of person-rem;
that is the cumulative population dose received by the local population
with an assumed 70-yr individual lifetime.

DITTY Dose Calculation Program
(GENII Version 1.485 3-Dec-90)

Integrated population dose calculated for chronic liquid release
Release from time 1990. A.D. onward for 10,000 years
Case title: DITTY Long-Term Surface Water Release TWRS-EIS (No Action)
Executed on: 06/18/96 at 10:54:15.6 Page 6

Maximum Dose Increment Received By Population
In Year 2900 (70-yr Time Period Number No: 13)

Organ	Cumulative Dose Equivalent	Weighting Factors	Weighted Cumulative Dose Equivalent
Gonads	1.1E+02	2.5E-01	2.7E+01
Breast	2.9E+01	1.5E-01	4.3E+00
R Marrow	1.0E+03	1.2E-01	1.3E+02
Lung	2.9E+01	1.2E-01	3.5E+00
Thyroid	1.1E+03	3.0E-02	3.3E+01
Bone Sur	1.3E+04	3.0E-02	3.8E+02
Stomach	2.7E+03	6.0E-02	1.6E+02
Kidneys	6.9E+02	6.0E-02	4.1E+01
LL Int.	5.5E+02	6.0E-02	3.3E+01
Liver	5.3E+02	6.0E-02	3.2E+01
UL Int.	2.0E+02	6.0E-02	1.2E+01

Cumulative Effective Dose Equivalent 8.6E+02
External Dose 7.9E-02

Lifetime Effective Cumulative
Dose Equivalent 8.6E+02

Dose in units of person-rem;
that is the cumulative population dose received by the local population
with an assumed 70-yr individual lifetime.

Maximum Dose Increment Received By Individual (rem)
In Year 2900 (70-yr Time Period Number No: 13)

Radio-nuclide	Effective Dose Equivalent	Annual External Dose	Effective Dose Equivalent	Percent Of Total Dose
C 14	1.6E-07	7.5E-12	1.6E-07	0
TC 99	2.3E-04	1.4E-10	2.3E-04	27
I 129	1.4E-05	4.4E-11	1.4E-05	1
U 238	9.9E-05	2.0E-11	9.9E-05	12
TH 234	1.0E-08	1.4E-08	2.4E-08	0
PA 234	3.5E-11	2.1E-09	2.1E-09	0
NP 237	4.8E-04	2.4E-09	4.8E-04	58
PA 233	4.8E-09	5.7E-08	6.2E-08	0

8.232E-4

Population Internal Dose To Organ by Radionuclide
In Year 2900 (70-yr Time Period Number No: 13)

Radionuclide	Lung	Stomach	S Int.	UL Int.	LL Int.	Bone Su	R Marro	Testes
C 14	1.8E-01	1.8E-01	1.8E-01	1.8E-01	1.8E-01	2.2E-01	2.2E-01	1.8E-01
TC 99	2.5E+01	2.7E+03	4.9E+01	1.6E+02	4.4E+02	2.9E+01	2.9E+01	2.5E+01
I 129	3.2E-02	4.5E-02	2.8E-02	2.8E-02	2.8E-02	3.8E-02	4.2E-02	2.6E-02
U 238	4.0E+00	5.4E+00	7.8E+00	2.7E+01	7.8E+01	1.4E+03	9.3E+01	3.7E+00
TH 234	8.0E-05	3.0E-03	7.2E-03	4.3E-02	1.3E-01	6.0E-05	5.1E-05	6.8E-06
PA 234	9.4E-07	4.6E-05	9.4E-05	2.0E-04	1.6E-04	1.7E-06	4.8E-06	1.4E-06
NP 237	7.0E-02	6.5E-01	1.6E+00	8.5E+00	2.6E+01	1.1E+04	9.2E+02	7.8E+01
PA 233	2.2E-05	1.5E-03	4.1E-03	1.8E-02	5.3E-02	5.1E-04	3.6E-04	1.1E-04
Total internal	2.9E+01	2.7E+03	5.8E+01	2.0E+02	5.5E+02	1.3E+04	1.0E+03	1.1E+02

Radionuclide	Ovaries	Muscle	Thyroid	Kidneys	Liver
C 14	1.8E-01	1.8E-01	1.8E-01	0.0E+00	0.0E+00
TC 99	2.5E+01	2.5E+01	6.2E+02	0.0E+00	3.4E+01
I 129	2.8E-02	6.7E-02	4.8E+02	0.0E+00	0.0E+00
U 238	3.9E+00	3.7E+00	3.9E+00	6.9E+02	0.0E+00
TH 234	8.5E-05	9.8E-06	8.7E-07	0.0E+00	1.2E-05
PA 234	2.0E-05	3.1E-06	1.1E-07	5.1E-06	3.7E-06
NP 237	7.8E+01	6.2E-02	4.6E-02	0.0E+00	5.0E+02
PA 233	1.3E-03	1.4E-04	2.6E-06	1.8E-04	1.2E-04
Total internal	1.1E+02	2.9E+01	1.1E+03	6.9E+02	5.3E+02

Population Air Submersion and External Incremental Dose by Radionuclide
In Year 2900 (70-yr Time Period Number No: 13)

Radionuclide	Air Submer-sion	External
C 14	9.9E-12	7.9E-06
TC 99	1.2E-10	1.5E-04
I 129	7.5E-11	4.6E-05
U 238	3.5E-11	2.1E-05
TH 234	5.6E-09	1.4E-02
PA 234	8.0E-10	2.2E-03
NP 237	4.9E-10	2.5E-03
PA 233	7.9E-09	6.0E-02
Tot l external	1.5E-08	7.9E-02

Dose in units of person-rem;
that is the cumulative population dose received by the local population with an assumed 70-yr individual lifetime.

Population Internal Dose To Organ by Exposure Pathway

In Year 2900 (70-yr Time Period Number No: 13)

Pathway	Lung	Stomach	S Int.	UL Int.	LL Int.	Bone	Su R	Marro	Testes
Inhalation	2.8E-01	8.0E-05	1.3E-05	3.4E-05	8.4E-05	4.6E-01	3.6E-02	3.4E-03	
Ingestion (Terr)	2.7E+01	2.7E+03	5.3E+01	1.8E+02	4.9E+02	5.8E+03	4.8E+02	6.0E+01	
Ingestion (Aqua)	2.1E-01	2.0E+00	9.0E-01	4.1E+00	1.2E+01	4.6E+03	3.8E+02	3.2E+01	
Drinking Water	1.8E+00	5.3E+01	3.9E+00	1.4E+01	4.0E+01	2.4E+03	1.9E+02	1.5E+01	
Total internal	2.9E+01	2.7E+03	5.8E+01	2.0E+02	5.5E+02	1.3E+04	1.0E+03	1.1E+02	

Pathway	Ovaries	Muscle	Thyroid	Kidneys	Liver
Inhalation	3.4E-03	9.6E-06	8.1E-05	4.7E-04	2.0E-02
Ingestion (Terr)	6.0E+01	2.7E+01	1.0E+03	4.4E+02	2.5E+02
Ingestion (Aqua)	3.2E+01	2.1E-01	9.6E-01	1.2E+01	2.0E+02
Drinking Water	1.5E+01	1.8E+00	6.2E+01	2.4E+02	8.3E+01
Total internal	1.1E+02	2.9E+01	1.1E+03	6.9E+02	5.3E+02

Dose in units of person-rem;
that is the cumulative population dose received by the local population
with an assumed 70-yr individual lifetime.

```
DITTY Long-Term Surface Water Release TWRS-EIS (Long Term Management)
  5
C 14
I 129
NP237
TC99
U 238
 &INPUT IWAT=1, IPATH=2, LUW=1, IPOPL=2,
  CFLO=120000.,
  RM=1.0, TZ=1990., TZR=0.,
  PL1(1)=294830.,391538.,431210.,469891.,1273208.,4932964.,
  TL(1)=1990., 2100.,2200.,2300.,2990.,11900.,
  NTL=6,
  USAGE(1)=0.3,0.,0.,0.,438.,17.,17.,
  CONSUM(1)=15.,276.,20.,230.,40.,30.,8.5,
  EXTIM=2920.,MOPYR=6, RIRR=150.,
  GRWP(1)=90.,90.,90.,30.,3*90.,
  YELD(1)=1.5,4.,0.84,1.3,3*0.84,
 &END
  5
C 14       5
1990.   0.0
2219.   0.0
2220.   8.7092
2795.   8.7092
2796.   0.0
I 129      5
1990.   0.0
2219.   0.0
2220.   0.0278
2795.   0.0278
2796.   0.0
NP237      5
1990.   0.0
2219.   0.0
2220.   0.1151
2795.   0.1151
2796.   0.0
TC99       5
1990.   0.0
2219.   0.0
2220.   54.00
2795.   54.00
2796.   0.0
U 238      5
```

1990.	0.0
2219.	0.0
2220.	0.8365
2795.	0.8365
2796.	0.0

DITTY Dose Calculation Program
(GENII Version 1.485 3-Dec-90)

Integrated population dose calculated for chronic liquid release
Release from time 1990. A.D. onward for 10,000 years
Case title: DITTY Long-Term Surface Water Release TWRS-EIS (Long Term Management)
Executed on: 06/18/96 at 10:54:24.7 Page 1

---- DATA LIBRARIES USED ----------(File)-----

Master Radionuclide Data: (2)
Radionuclide Master Library - Long Times (23-July-93 PDR)
Food Concentration Ratios: (8)
PNL Food Transfer Factor Library (by Z, Changed NP&U LF 6/18/96 AMN)
Fresh Water Bioaccumulation Factors: (9)
Bioaccumulation Factor Library - (30-Aug-88) RAP
External Exposure D.F.'s: (10)
External Dose Factors for GENII in person Sv/yr per Bq/X (8-May-90 RAP)
Inhalation/Ingestion D.F.'s: (30)
Worst-Case Solubilities, DITTY Internal Dose Factors (Sv/Bq) (23-Jul-93 PDR)
Waterborne Release Data: (31)
DITTY.IN

---- MASTER RADIONUCLIDE CONTROL LIST ----------
C 14 TC99 I 129 U 238 TH234 PA234 NP237
PA233

---- TERRESTRIAL/AQUATIC PATHWAY DATA FOR AN AVERAGE INDIVIDUAL

Pathway	Growing Period (days)	Yield (kg/m2)	Consumption (kg/yr)	Pathway (kg or hr/yr)	Usage
LEAFY VEG	9.0E+01	1.5E+00	1.5E+01	FISH	3.0E-01
OTHER VEG	9.0E+01	4.0E+00	2.8E+02	CRUSTACEA	0.0E+00
EGGS	9.0E+01	8.4E-01	2.0E+01	MOLLUSES	0.0E+00
MILK	3.0E+01	1.3E+00	2.3E+02	PLANTS	0.0E+00
BEEF	9.0E+01	8.4E-01	4.0E+01	DRINKING WATER	4.4E+02
PORK	9.0E+01	8.4E-01	3.0E+01	SEDIMENT EXPOSU	1.7E+01
POULTRY	9.0E+01	8.4E-01	8.5E+00	SWIMMING TIME	1.7E+01

External Exposure Time: 2.92E+03 hr/yr

---- LIQUID RELEASE PARAMETERS ----------

River Flow Rate, (ft3/sec) : 1.2E+05 Months/Year Irrigated : 6.0E+00
Reconcentration Ratio : 1.0E+00 Irrigation Rate
Mixing Ratio : 1.0E+00 (liters/m2/month) : 1.5E+02

Input Prepared By: _____ Date: _____

Input Checked By: _____ Date: _____

DITTY Dose Calculation Program
(GENII Version 1.485 3-Dec-90)

Integrated population dose calculated for chronic liquid release
Release from time 1990. A.D. onward for 10,000 years
Case title: DITTY Long-Term Surface Water Release TWRS-EIS (Long Term Management)
Executed on: 06/18/96 at 10:54:24.7 Page 2

---- WATER RELEASE OF EACH RADIONCLIDE PER 70-YR PERIOD (Ci) ----------

Radio-nuclide	Period/ Activity	Period/ Activity	Period/ Activity	Period/ Activity	Period/ Activity
C 14	4 3.6E+01	5 5.0E+01	6 5.0E+01	7 5.0E+01	8 5.0E+01
	9 5.0E+01	10 5.0E+01	11 5.0E+01	12 2.5E+01	
TC99	4 2.0E+02	5 2.8E+02	6 2.8E+02	7 2.8E+02	8 2.8E+02
	9 2.8E+02	10 2.8E+02	11 2.8E+02	12 1.4E+02	
I 129	4 1.4E+00	5 1.9E+00	6 1.9E+00	7 1.9E+00	8 1.9E+00
	9 1.9E+00	10 1.9E+00	11 1.9E+00	12 9.9E-01	
U 238	4 4.2E+01	5 5.9E+01	6 5.9E+01	7 5.9E+01	8 5.9E+01
	9 5.9E+01	10 5.9E+01	11 5.9E+01	12 3.0E+01	
NP237	4 5.8E+00	5 8.1E+00	6 8.1E+00	7 8.1E+00	8 8.1E+00
	9 8.1E+00	10 8.1E+00	11 8.1E+00	12 4.1E+00	

---- POPULATION DATA ----

Population for Chronic Waterborne Release at the following Times A.D.:

Time	Population
1990.	2.9E+05
2100.	3.9E+05
2200.	4.3E+05
2300.	4.7E+05
2990.	1.3E+06
11900.	4.9E+06

DITTY Dose Calculation Program
(GENII Version 1.485 3-Dec-90)

Integrated population dose calculated for chronic liquid release
Release from time 1990. A.D. onward for 10,000 years
Case title: DITTY Long-Term Surface Water Release TWRS-EIS (Long Term Management)
Executed on: 06/18/96 at 10:54:24.7

Lifetime Effective Cumulative Dose Equivalent as a Function of Time

Period	Year	Dose
until	until	
5	2270.	2.39E+02
6	2340.	5.94E+02
7	2410.	1.01E+03
8	2480.	1.49E+03
9	2550.	2.02E+03
10	2620.	2.62E+03
11	2690.	3.28E+03
12	2760.	4.00E+03
13	2830.	4.40E+03
until	until	
144	12000.	4.40E+03

Dose in units of person-rem;
that is the cumulative population dose received by the local population
over 10,000 years with an assumed 70-yr individual lifetime.

Cumulative Population Dose Equivalent by Radionuclide

Radio-nuclide	Effective Dose Equivalent	Annual Effective External Dose	Effective Dose Equivalent	Percent Of Total Dose
C 14	5.5E+01	2.5E-03	5.5E+01	1
TC 99	5.6E+02	3.4E-04	5.6E+02	12
I 129	8.8E+01	2.8E-04	8.8E+01	2
U 238	6.3E+02	1.3E-04	6.3E+02	14
TH 234	6.7E-02	8.7E-02	1.5E-01	0
PA 234	2.2E-04	1.3E-02	1.4E-02	0
NP 237	3.1E+03	1.5E-02	3.1E+03	69
PA 233	3.1E-02	3.6E-01	4.0E-01	0

Dose in units of person-rem;
that is the cumulative population dose received by the local population
with an assumed 70-yr individual lifetime.

Maximum Dose Increment Received By Population
In Year 2830 (70-yr Time Period Number No: 12)

Organ	Cumulative Dose Equivalent	Weighting Factors	Weighted Cumulative Dose Equivalent
Gonads	1.0E+02	2.5E-01	2.5E+01
Breast	2.3E+01	1.5E-01	3.4E+00
R Marrow	1.0E+03	1.2E-01	1.2E+02
Lung	2.3E+01	1.2E-01	2.7E+00
Thyroid	7.3E+02	3.0E-02	2.2E+01
Bone Sur	1.3E+04	3.0E-02	3.8E+02
Stomach	1.0E+03	6.0E-02	6.3E+01
Kidneys	6.9E+02	6.0E-02	4.1E+01
Liver	5.1E+02	6.0E-02	3.1E+01
LL Int.	2.8E+02	6.0E-02	1.7E+01
UL Int.	1.1E+02	6.0E-02	6.4E+00

Cumulative Effective Dose Equivalent 7.2E+02
External Dose 7.9E-02

Lifetime Effective Cumulative
Dose Equivalent 7.2E+02

Dose in units of person-rem;
that is the cumulative population dose received by the local population
with an assumed 70-yr individual lifetime.

Maximum Dose Increment Received By Individual (rem)
In Year 2830 (70-yr Time Period Number No: 12)

Radio-nuclide	Effective Dose Equivalent	Annual External Dose	Effective Dose Equivalent	Percent Of Total Dose
C 14	9.3E-06	4.3E-10	9.3E-06	1
TC 99	9.5E-05	5.8E-11	9.5E-05	12
I 129	1.5E-05	4.7E-11	1.5E-05	2
U 238	1.1E-04	2.2E-11	1.1E-04	14
TH 234	1.1E-08	1.5E-08	2.6E-08	0
PA 234	3.8E-11	2.3E-09	2.3E-09	0
NP 237	5.2E-04	2.6E-09	5.2E-04	69
PA 233	5.2E-09	6.2E-08	6.7E-08	0

7.494e-4

Population Internal Dose To Organ by Radionuclide
In Year 2830 (70-yr Time Period Number No: 12)

Radionuclide	Lung	Stomach S Int.	UL Int.	LL Int.	Bone Su	R Marro	Testes
C 14	9.2E+00	9.2E+00	9.2E+00	9.2E+00	9.2E+00	1.1E+01	1.1E+01	9.2E+00
TC 99	9.5E+00	1.0E+03	1.9E+01	6.2E+01	1.7E+02	1.1E+01	1.1E+01	9.5E+00
I 129	3.2E-02	4.5E-02	2.8E-02	2.8E-02	2.8E-02	3.9E-02	4.2E-02	2.6E-02
U 238	4.0E+00	5.4E+00	7.9E+00	2.7E+01	7.9E+01	1.4E+03	9.3E+01	3.7E+00
TH 234	8.1E-05	3.0E-03	7.3E-03	4.3E-02	1.3E-01	6.0E-05	5.1E-05	6.8E-06
PA 234	9.4E-07	4.6E-05	9.4E-05	2.0E-04	1.6E-04	1.7E-06	4.9E-06	1.4E-06
NP 237	7.0E-02	6.5E-01	1.6E+00	8.5E+00	2.6E+01	1.1E+04	9.2E+02	7.8E+01
PA 233	2.2E-05	1.5E-03	4.1E-03	1.8E-02	5.3E-02	5.1E-04	3.6E-04	1.1E-04
Total internal	2.3E+01	1.0E+03	3.7E+01	1.1E+02	2.8E+02	1.3E+04	1.0E+03	1.0E+02

Radionuclide	Ovaries	Muscle	Thyroid	Kidneys	Liver
C 14	9.2E+00	9.2E+00	9.2E+00	0.0E+00	0.0E+00
TC 99	9.5E+00	9.5E+00	2.4E+02	0.0E+00	1.3E+01
I 129	2.8E-02	6.7E-02	4.8E+02	0.0E+00	0.0E+00
U 238	3.9E+00	3.7E+00	3.9E+00	6.9E+02	0.0E+00
TH 234	8.5E-05	9.8E-06	8.7E-07	0.0E+00	1.2E-05
PA 234	2.0E-05	3.1E-06	1.1E-07	5.1E-06	3.7E-06
NP 237	7.8E+01	6.3E-02	4.6E-02	0.0E+00	5.0E+02
PA 233	1.3E-03	1.4E-04	2.6E-06	1.8E-04	1.2E-04
Total internal	1.0E+02	2.3E+01	7.3E+02	6.9E+02	5.1E+02

Population Air Submersion and External Incremental Dose by Radionuclide
In Year 2830 (70-yr Time Period Number No: 12)

Radionuclide	Air Submer-sion	External
C 14	5.2E-10	4.1E-04
TC 99	4.6E-11	5.6E-05
I 129	7.5E-11	4.6E-05
U 238	3.5E-11	2.1E-05
TH 234	5.6E-09	1.4E-02
PA 234	8.0E-10	2.2E-03
NP 237	4.9E-10	2.5E-03
PA 233	8.0E-09	6.0E-02
Total external	1.6E-08	7.9E-02

Dose in units of person-rem;
that is the cumulative population dose received by the local population with an assumed 70-yr individual lifetime.

Population Internal Dose To Organ by Exposure Pathway

In Year 2830 (70-yr Time Period Number No: 12)

Pathway	Lung	Stomach	S Int.	UL Int.	LL Int.	Bone	Su R	Marro	Testes
Inhalation	2.8E-01	2.1E-04	1.9E-04	2.1E-04	2.5E-04	4.6E-01	3.6E-02	3.5E-03	
Ingestion (Terr)	1.5E+01	1.0E+03	2.7E+01	8.5E+01	2.3E+02	5.8E+03	4.7E+02	4.8E+01	
Ingestion (Aqua)	5.8E+00	6.6E+00	6.4E+00	9.6E+00	1.8E+01	4.6E+03	3.8E+02	3.7E+01	
Drinking Water	1.9E+00	2.2E+01	3.8E+00	1.2E+01	3.5E+01	2.4E+03	1.9E+02	1.5E+01	
Total internal	2.3E+01	1.0E+03	3.7E+01	1.1E+02	2.8E+02	1.3E+04	1.0E+03	1.0E+02	

Pathway	Ovaries	Muscle	Thyroid	Kidneys	Liver
Inhalation	3.5E-03	1.8E-04	2.4E-04	4.7E-04	2.0E-02
Ingestion (Terr)	4.9E+01	1.5E+01	6.7E+02	4 4E+02	2.3E+02
Ingestion (Aqua)	3.7E+01	5.8E+00	6.3E+00	1.2E+01	2.0E+02
Drinking Water	1.5E+01	1.9E+00	5.5E+01	2.4E+02	8.3E+01
Total internal	1.0E+02	2.3E+01	7.3E+02	6.9E+02	5.1E+02

Dose in units of person-rem;
that is the cumulative population dose received by the local population
with an assumed 70-yr individual lifetime.

```
DITTY Long-Term Surface Water Release TWRS-EIS (In Situ Fill & Cap)
  5
C 14
I 129
NP237
TC99
U 238
 &INPUT IWAT=1, IPATH=2, LUW=1, IPOPL=2,
  CFLO=120000.,
  RM=1.0, TZ=1990., TZR=0.,
  PL1(1)=294830.,391538.,431210.,469891.,1273208.,4932964.,
  TL(1)=1990., 2100.,2200.,2300.,2990.,11900.,
  NTL=6,
  USAGE(1)=0.3,0.,0.,0.,438.,17.,17.,
  CONSUM(1)=15.,276.,20.,230.,40.,30.,8.5,
  EXTIM=2920.,MOPYR=6, RIRR=150.,
  GRWP(1)=90.,90.,90.,30.,3*90.,
  YELD(1)=1.5,4.,0.84,1.3,3*0.84,
 &END
  5
C 14       5
 1990.   0.0
 4994.   0.0
 4995.   0.3518
11995.   0.3518
11996.   0.0
I 129      5
 1990.   0.0
 4994.   0.0
 4995.   0.0021
11995.   0.0021
11996.   0.0
NP237      5
 1990.   0.0
 4994.   0.0
 4995.   0.0085
11995.   0.0085
11996.   0.0
TC99       5
 1990.   0.0
 4994.   0.0
 4995.   3.929
11995.   3.929
11996.   0.0
U 238      5
```

1990.	0.0
4994.	0.0
4995.	0.0619
11995.	0.0619
11996.	0.0

DITTY Dose Calculation Program
(GENII Version 1.485 3-Dec-90)

Integrated population dose calculated for chronic liquid release
Release from time 1990. A.D. onward for 10,000 years
Case title: DITTY Long-Term Surface Water Release TWRS-EIS (In Situ Fill & Cap)
Executed on: 06/18/96 at 10:54:36.0 Page 1

---- DATA LIBRARIES USED ----------(File)-----

Master Radionuclide Data: (2)
Radionuclide Master Library - Long Times (23-July-93 PDR)
Food Concentration Ratios: (8)
PNL Food Transfer Factor Library (by Z, Changed NP&U LF 6/18/96 AMN)
Fresh Water Bioaccumulation Factors: (9)
Bioaccumulation Factor Library - (30-Aug-88) RAP
External Exposure D.F.'s: (10)
External Dose Factors for GENII in person Sv/yr per Bq/X (8-May-90 RAP)
Inhalation/Ingestion D.F.'s: (30)
Worst-Case Solubilities, DITTY Internal Dose Factors (Sv/Bq) (23-Jul-93 PDR)
Waterborne Release Data: (31)
DITTY.IN

---- MASTER RADIONUCLIDE CONTROL LIST ----------
C 14 TC99 I 129 U 238 TH234 PA234 NP237
PA233

---- TERRESTRIAL/AQUATIC PATHWAY DATA FOR AN AVERAGE INDIVIDUAL

Pathway	Growing Period (days)	Yield (kg/m2)	Consumption (kg/yr)	Pathway	Usage (kg or hr/yr)
LEAFY VEG	9.0E+01	1.5E+00	1.5E+01	FISH	3.0E-01
OTHER VEG	9.0E+01	4.0E+00	2.8E+02	CRUSTACEA	0.0E+00
EGGS	9.0E+01	8.4E-01	2.0E+01	MOLLUSES	0.0E+00
MILK	3.0E+01	1.3E+00	2.3E+02	PLANTS	0.0E+00
BEEF	9.0E+01	8.4E-01	4.0E+01	DRINKING WATER	4.4E+02
PORK	9.0E+01	8.4E-01	3.0E+01	SEDIMENT EXPOSU	1.7E+01
POULTRY	9.0E+01	8.4E-01	8.5E+00	SWIMMING TIME	1.7E+01

External Exposure Time: 2.92E+03 hr/yr

---- LIQUID RELEASE PARAMETERS ----------

River Flow Rate, (ft3/sec) : 1.2E+05 Months/Year Irrigated : 6.0E+00
Reconcentration Ratio : 1.0E+00 Irrigation Rate
Mixing Ratio : 1.0E+00 (liters/m2/month) : 1.5E+02

Input Prepared By: _____ Date: _____

Input Checked By: _____ Date: _____

DITTY Dose Calculation Program
(GENII Version 1.485 3-Dec-90)

Integrated population dose calculated for chronic liquid release
Release from time 1990. A.D. onward for 10,000 years
Case title: DITTY Long-Term Surface Water Release TWRS-EIS (In Situ Fill & Cap)
Executed on: 06/18/96 at 10:54:36.0

---- WATER RELEASE OF EACH RADIONCLIDE PER 70-YR PERIOD (Ci) ----------

Radio-nuclide	Period/ Activity	Period/ Activity	Period/ Activity	Period/ Activity	Period/ Activity
C 14	43 1.9E+00	44 2.5E+01	45 2.5E+01	46 2.5E+01	47 2.5E+01
	48 2.5E+01	49 2.5E+01	50 2.5E+01	51 2.5E+01	52 2.5E+01
	53 2.5E+01	54 2.5E+01	55 2.5E+01	56 2.5E+01	57 2.5E+01
	58 2.5E+01	59 2.5E+01	60 2.5E+01	61 2.5E+01	62 2.5E+01
	63 2.5E+01	64 2.5E+01	65 2.5E+01	66 2.5E+01	67 2.5E+01
	68 2.5E+01	69 2.5E+01	70 2.5E+01	71 2.5E+01	72 2.5E+01
	73 2.5E+01	74 2.5E+01	75 2.5E+01	76 2.5E+01	77 2.5E+01
	78 2.5E+01	79 2.5E+01	80 2.5E+01	81 2.5E+01	82 2.5E+01
	83 2.5E+01	84 2.5E+01	85 2.5E+01	86 2.5E+01	87 2.5E+01
	88 2.5E+01	89 2.5E+01	90 2.5E+01	91 2.5E+01	92 2.5E+01
	93 .5E+01	94 2.5E+01	95 2.5E+01	96 2.5E+01	97 2.5E+01
	98 2.5E+01	99 2.5E+01	100 2.5E+01	101 2.5E+01	102 2.5E+01
	103 2.5E+01	104 2.5E+01	105 2.5E+01	106 2.5E+01	107 2.5E+01
	108 2.5E+01	109 2.5E+01	110 2.5E+01	111 2.5E+01	112 2.5E+01
	113 2.5E+01	114 2.5E+01	115 2.5E+01	116 2.5E+01	117 2.5E+01
	118 2.5E+01	119 2.5E+01	120 2.5E+01	121 2.5E+01	122 2.5E+01
	123 2.5E+01	124 2.5E+01	125 2.5E+01	126 2.5E+01	127 2.5E+01
	128 2.5E+01	129 2.5E+01	130 2.5E+01	131 2.5E+01	132 2.5E+01
	133 2.5E+01	134 2.5E+01	135 2.5E+01	136 2.5E+01	137 2.5E+01
	138 2.5E+01	139 2.5E+01	140 2.5E+01	141 2.5E+01	142 2.5E+01
	143 2.3E+01				
TC99	43 2.2E+01	44 2.8E+02	45 2.8E+02	46 2.8E+02	47 2.8E+02
	48 2.8E+02	49 2.8E+02	50 2.8E+02	51 2.8E+02	52 2.8E+02
	53 2.8E+02	54 2.8E+02	55 2.8E+02	56 2.8E+02	57 2.8E+02
	58 2.8E+02	59 2.8E+02	60 2.8E+02	61 2.8E+02	62 2.8E+02
	63 2.8E+02	64 2.8E+02	65 2.8E+02	66 2.8E+02	67 2.8E+02
	68 2.8E+02	69 2.8E+02	70 2.8E+02	71 2.8E+02	72 2.8E+02
	73 2.8E+02	74 2.8E+02	75 2.8E+02	76 2.8E+02	77 2.8E+02
	78 2.8E+02	79 2.8E+02	80 2.8E+02	81 2.8E+02	82 2.8E+02
	83 2.8E+02	84 2.8E+02	85 2.8E+02	86 2.8E+02	87 2.8E+02

88 2.8E+02 89 2.8E+02 90 2.8E+02 91 2.8E+02 92 2.8E+02
93 2.8E+02 94 2.8E+02 95 2.8E+02 96 2.8E+02 97 2.8E+02
98 2.8E+02 99 2.8E+02 100 2.8E+02 101 2.8E+02 102 2.8E+02
103 2.8E+02 104 2.8E+02 105 2.8E+02 106 2.8E+02 107 2.8E+02
108 2.8E+02 109 2.8E+02 110 2.8E+02 111 2.8E+02 112 2.8E+02
113 2.8E+02 114 2.8E+02 115 2.8E+02 116 2.8E+02 117 2.8E+02
118 2.8E+02 119 2.8E+02 120 2.8E+02 121 2.8E+02 122 2.8E+02
123 2.8E+02 124 2.8E+02 125 2.8E+02 126 2.8E+02 127 2.8E+02
128 2.8E+02 129 2.8E+02 130 2.8E+02 131 2.8E+02 132 2.8E+02
133 2.8E+02 134 2.8E+02 135 2.8E+02 136 2.8E+02 137 2.8E+02
138 2.8E+02 139 2.8E+02 140 2.8E+02 141 2.8E+02 142 2.8E+02
143 2.6E+02

I 129 43 1.2E-02 44 1.5E-01 45 1.5E-01 46 1.5E-01 47 1.5E-01
48 1.5E-01 49 1.5E-01 50 1.5E-01 51 1.5E-01 52 1.5E-01
53 1.5E-01 54 1.5E-01 55 1.5E-01 56 1.5E-01 57 1.5E-01
58 1.5E-01 59 1.5E-01 60 1.5E-01 61 1.5E-01 62 1.5E-01
63 1.5E-01 64 1.5E-01 65 1.5E-01 66 1.5E-01 67 1.5E-01
68 1.5E-01 69 1.5E-01 70 1.5E-01 71 1.5E-01 72 1.5E-01
73 1.5E-01 74 1.5E-01 75 1.5E-01 76 1.5E-01 77 1.5E-01
78 1.5E-01 79 1.5E-01 80 1.5E-01 81 1.5E-01 82 1.5E-01
83 1.5E-01 84 1.5E-01 85 1.5E-01 86 1.5E-01 87 1.5E-01
88 1.5E-01 89 1.5E-01 90 1.5E-01 91 1.5E-01 92 1.5E-01
93 1.5E-01 94 1.5E-01 95 1.5E-01 96 1.5E-01 97 1.5E-01
98 1.5E-01 99 1.5E-01 100 1.5E-01 101 1.5E-01 102 1.5E-01
103 1.5E-01 104 1.5E-01 105 1.5E-01 106 1.5E-01 107 1.5E-01
108 1.5E-01 109 1.5E-01 110 1.5E-01 111 1.5E-01 112 1.5E-01
113 1.5E-01 114 1.5E-01 115 1.5E-01 116 1.5E-01 117 1.5E-01
118 1.5E-01 119 1.5E-01 120 1.5E-01 121 1.5E-01 122 1.5E-01
123 1.5E-01 124 1.5E-01 125 1.5E-01 126 1.5E-01 127 1.5E-01
128 1.5E-01 129 1.5E-01 130 1.5E-01 131 1.5E-01 132 1.5E-01
133 1.5E-01 134 1.5E-01 135 1.5E-01 136 1.5E-01 137 1.5E-01
138 1.5E-01 139 1.5E-01 140 1.5E-01 141 1.5E-01 142 1.5E-01
143 1.4E-01

U 238 43 3.4E-01 44 4.3E+00 45 4.3E+00 46 4.3E+00 47 4.3E+00
48 4.3E+00 49 4.3E+00 50 4.3E+00 51 4.3E+00 52 4.3E+00
53 4.3E+00 54 4.3E+00 55 4.3E+00 56 4.3E+00 57 4.3E+00
58 4.3E+00 59 4.3E+00 60 4.3E+00 61 4.3E+00 62 4.3E+00
63 4.3E+00 64 4.3E+00 65 4.3E+00 66 4.3E+00 67 4.3E+00
68 4.3E+00 69 4.3E+00 70 4.3E+00 71 4.3E+00 72 4.3E+00
73 4.3E+00 74 4.3E+00 75 4.3E+00 76 4.3E+00 77 4.3E+00
78 4.3E+00 79 4.3E+00 80 4.3E+00 81 4.3E+00 82 4.3E+00
83 4.3E+00 84 4.3E+00 85 4.3E+00 86 4.3E+00 87 4.3E+00
88 4.3E+00 89 4.3E+00 90 4.3E+00 91 4.3E+00 92 4.3E+00
93 4.3E+00 94 4.3E+00 95 4.3E+00 96 4.3E+00 97 4.3E+00
98 4.3E+00 99 4.3E+00 100 4.3E+00 101 4.3E+00 102 4.3E+00

103 4.3E+00 104 4.3E+00 105 4.3E+00 106 4.3E+00 107 4.3E+00
108 4.3E+00 109 4.3E+00 110 4.3E+00 111 4.3E+00 112 4.3E+00
113 4.3E+00 114 4.3E+00 115 4.3E+00 116 4.3E+00 117 4.3E+00
118 4.3E+00 119 4.3E+00 120 4.3E+00 121 4.3E+00 122 4.3E+00
123 4.3E+00 124 4.3E+00 125 4.3E+00 126 4.3E+00 127 4.3E+00
128 4.3E+00 129 4.3E+00 130 4.3E+00 131 4.3E+00 132 4.3E+00
133 4.3E+00 134 4.3E+00 135 4.3E+00 136 4.3E+00 137 4.3E+00
138 4.3E+00 139 4.3E+00 140 4.3E+00 141 4.3E+00 142 4.3E+00
143 4.1E+00

NP237 43 4.7E-02 44 6.0E-01 45 6.0E-01 46 6.0E-01 47 6.0E-01
48 6.0E-01 49 6.0E-01 50 6.0E-01 51 6.0E-01 52 6.0E-01
53 6.0E-01 54 6.0E-01 55 6.0E-01 56 6.0E-01 57 6.0E-01
58 6.0E-01 59 6.0E-01 60 6.0E-01 61 6.0E-01 62 6.0E-01
63 6.0E-01 64 6.0E-01 65 6.0E-01 66 6.0E-01 67 6.0E-01
68 6.0E-01 69 6.0E-01 70 6.0E-01 71 6.0E-01 72 6.0E-01
73 6.0E-01 74 6.0E-01 75 6.0E-01 76 6.0E-01 77 6.0E-01
78 6.0E-01 79 6.0E-01 80 6.0E-01 81 6.0E-01 82 6.0E-01
83 6.0E-01 84 6.0E-01 85 6.0E-01 86 6.0E-01 87 6.0E-01
88 6.0E-01 89 6.0E-01 90 6.0E-01 91 6.0E-01 92 6.0E-01
93 6.0E-01 94 6.0E-01 95 6.0E-01 96 6.0E-01 97 6.0E-01
98 6.0E-01 99 6.0E-01 100 6.0E-01 101 6.0E-01 102 6.0E-01
103 6.0E-01 104 6.0E-01 105 6.0E-01 106 6.0E-01 107 6.0E-01
108 6.0E-01 109 6.0E-01 110 6.0E-01 111 6.0E-01 112 6.0E-01
113 6.0E-01 114 6.0E-01 115 6.0E-01 116 6.0E-01 117 6.0E-01
118 6.0E-01 119 6.0E-01 120 6.0E-01 121 6.0E-01 122 6.0E-01
123 6.0E-01 124 6.0E-01 125 6.0E-01 126 6.0E-01 127 6.0E-01
128 6.0E-01 129 6.0E-01 130 6.0E-01 131 6.0E-01 132 6.0E-01
133 6.0E-01 134 6.0E-01 135 6.0E-01 136 6.0E-01 137 6.0E-01
138 6.0E-01 139 6.0E-01 140 6.0E-01 141 6.0E-01 142 6.0E-01
143 5.6E-01

---- POPULATION DATA ----

Population for Chronic Waterborne Release at the following Times A.D.:

Time	Population
1990.	2.9E+05
2100.	3.9E+05
2200.	4.3E+05
2300.	4.7E+05
2990.	1.3E+06
11900.	4.9E+06

Lifetime Effective Cumulative Dose Equivalent as a Function of Time

Period	Year	Dose
until	until	
44	5000.	2.36E+01
45	5070.	3.27E+02
46	5140.	6.36E+02
47	5210.	9.48E+02
48	5280.	1.26E+03
49	5350.	1.58E+03
50	5420.	1.91E+03
51	5490.	2.24E+03
52	5560.	2.57E+03
53	5630.	2.91E+03
54	5700.	3.25E+03
55	5770.	3.59E+03
56	5840.	3.94E+03
57	5910.	4.30E+03
58	5980.	4.65E+03
59	6050.	5.02E+03
60	6120.	5.38E+03
61	6190.	5.75E+03
62	6260.	6.13E+03
63	6330.	6.51E+03
64	6400.	6.89E+03
65	6470.	7.27E+03
66	6540.	7.66E+03
67	6610.	8.06E+03
68	6680.	8.46E+03
69	6750.	8.86E+03
70	6820.	9.27E+03
71	6890.	9.68E+03
72	6960.	1.01E+04

73	7030.	1.05E+04
74	7100.	1.09E+04
75	7170.	1.14E+04
76	7240.	1.18E+04
77	7310.	1.22E+04
78	7380.	1.27E+04
79	7450.	1.31E+04
80	7520.	1.36E+04
81	7590.	1.40E+04
82	7660.	1.45E+04
83	7730.	1.49E+04
84	7800.	1.54E+04
85	7870.	1.59E+04

Lifetime Effective Cumulative Dose Equivalent as a Function of Time

Period	Year	Dose
86	7940.	1.63E+04
87	8010.	1.68E+04
88	8080.	1.73E+04
89	8150.	1.78E+04
90	8220.	1.83E+04
91	8290.	1.88E+04
92	8360.	1.93E+04
93	8430.	1.98E+04
94	8500.	2.03E+04
95	8570.	2.08E+04
96	8640.	2.13E+04
97	8710.	2.18E+04
98	8780.	2.24E+04
99	8850.	2.29E+04
100	8920.	2.34E+04
101	8990.	2.39E+04
102	9060.	2.45E+04
103	9130.	2.50E+04
104	9200.	2.56E+04
105	9270.	2.61E+04
106	9340.	2.67E+04
107	9410.	2.72E+04
108	9480.	2.78E+04
109	9550.	2.84E+04
110	9620.	2.90E+04
111	9690.	2.95E+04
112	9760.	3.01E+04
113	9830.	3.07E+04
114	9900.	3.13E+04
115	9970.	3.19E+04

116	10040.	3.25E+04
117	10110.	3.31E+04
118	10180.	3.37E+04
119	10250.	3.43E+04
120	10320.	3.49E+04
121	10390.	3.55E+04
122	10460.	3.61E+04
123	10530.	3.68E+04
124	10600.	3.74E+04
125	10670.	3.80E+04
126	10740.	3.87E+04
127	10810.	3.93E+04
128	10880.	4.00E+04
---	---	---

NO See Next page

DITTY Dose Calculation Program
(GENII Version 1.485 3-Dec-90)

Integrated population dose calculated for chronic liquid release
Release from time 1990. A.D. onward for 10,000 years
Case title: DITTY Long-Term Surface Water Release TWRS-EIS (In Situ Fill & Cap)
Executed on: 06/18/96 at 10:54:36.0 Page 6

Lifetime Effective Cumulative Dose Equivalent as a Function of Time

Period	Year	Dose
129	10950.	4.06E+04
130	11020.	4.13E+04
131	11090.	4.19E+04
132	11160.	4.26E+04
133	11230.	4.33E+04
134	11300.	4.39E+04
135	11370.	4.46E+04
136	11440.	4.53E+04
137	11510.	4.60E+04
138	11580.	4.67E+04
139	11650.	4.74E+04
140	11720.	4.81E+04
141	11790.	4.88E+04
142	11860.	4.95E+04
143	11930.	5.02E+04
144	12000.	5.08E+04

Dose in units of person-rem;
that is the cumulative population dose received by the local population over 10,000 years with an assumed 70-yr individual lifetime.

DITTY Dose Calculation Program
(GENII Version 1.485 3-Dec-90)

Integrated population dose calculated for chronic liquid release
Release from time 1990. A.D. onward for 10,000 years
Case title: DITTY Long-Term Surface Water Release TWRS-EIS (In Situ Fill & Cap)
Executed on: 06/18/96 at 10:54:36.0

Cumulative Population Dose Equivalent by Radionuclide

Radio-nuclide	Effective Dose Equivalent	Annual External Dose	Effective Dose Equivalent	Percent Of Total Dose
C 14	1.6E+03	7.5E-02	1.6E+03	3
TC 99	3.3E+04	2.0E-02	3.3E+04	64
I 129	4.0E+02	1.3E-03	4.0E+02	0
U 238	2.8E+03	5.8E-04	2.8E+03	5
TH 234	3.0E-01	3.8E-01	6.8E-01	0
PA 234	9.9E-04	6.0E-02	6.1E-02	0
NP 237	1.4E+04	6.8E-02	1.4E+04	26
PA 233	1.4E-01	1.6E+00	1.8E+00	0

Dose in units of person-rem;
that is the cumulative population dose received by the local population
with an assumed 70-yr individual lifetime.

Maximum Dose Increment Received By Population
In Year 12000 (70-yr Time Period Number No: 143)

Organ	Cumulative Dose Equivalent	Weighting Factors	Weighted Cumulative Dose Equivalent
Gonads	1.0E+02	2.5E-01	2.5E+01
Breast	7.2E+01	1.5E-01	1.1E+01
R Marrow	4.7E+02	1.2E-01	5.6E+01
Lung	7.2E+01	1.2E-01	8.7E+00
Thyroid	1.4E+03	3.0E-02	4.2E+01
Bone Sur	4.9E+03	3.0E-02	1.5E+02
Stomach	5.2E+03	6.0E-02	3.1E+02
LL Int.	9.1E+02	6.0E-02	5.4E+01
UL Int.	3.5E+02	6.0E-02	2.1E+01
Kidneys	2.6E+02	6.0E-02	1.6E+01
Liver	2.5E+02	6.0E-02	1.5E+01

Cumulative Effective Dose Equivalent 7.1E+02
External Dose 3.1E-02

Lifetime Effective Cumulative
Dose Equivalent 7.1E+02

Dose in units of person-rem;
that is the cumulative population dose received by the local population
with an assumed 70-yr individual lifetime.

Maximum Dose Increment Received By Individual (rem)
In Year 12000 (70-yr Time Period Number No: 143)

Radio-nuclide	Effective Dose Equivalent	Annual External Dose	Effective Dose Equivalent	Percent Of Total Dose
C 14	4.6E-06	2.1E-10	4.6E-06	3
TC 99	9.3E-05	5.7E-11	9.3E-05	64
I 129	1.1E-06	3.6E-12	1.1E-06	0
U 238	8.0E-06	1.6E-12	8.0E-06	5
TH 234	8.4E-10	1.1E-09	1.9E-09	0
PA 234	2.8E-12	1.7E-10	1.7E-10	0
NP 237	3.9E-05	1.9E-10	3.9E-05	26
PA 233	3.8E-10	4.6E-09	5.0E-09	0

1.457E-4

Population Internal Dose To Organ by Radionuclide
In Year 12000 (70-yr Time Period Number No: 143)

Radionuclide	Lung	Stomach	S Int.	UL Int.	LL Int.	Bone Su	R Marro	Testes
C 14	2.3E+01	2.3E+01	2.3E+01	2.3E+01	2.3E+01	2.9E+01	2.9E+01	2.3E+01
TC 99	4.8E+01	5.2E+03	9.3E+01	3.1E+02	8.4E+02	5.6E+01	5.6E+01	4.8E+01
I 129	1.2E-02	1.7E-02	1.1E-02	1.1E-02	1.1E-02	1.5E-02	1.6E-02	9.9E-03
U 238	1.5E+00	2.0E+00	3.0E+00	1.0E+01	3.0E+01	5.3E+02	3.5E+01	1.4E+00
TH 234	3.0E-05	1.1E-03	2.7E-03	1.6E-02	4.8E-02	2.3E-05	1.9E-05	2.6E-06
PA 234	3.6E-07	1.7E-05	3.5E-05	7.4E-05	6.1E-05	6.5E-07	1.8E-06	5.5E-07
NP 237	2.6E-02	2.5E-01	5.9E-01	3.2E+00	9.9E+00	4.3E+03	3.5E+02	3.0E+01
PA 233	8.3E-06	5.5E-04	1.5E-03	6.9E-03	2.0E-02	1.9E-04	1.4E-04	4.2E-05
Total internal	7.2E+01	5.2E+03	1.2E+02	3.5E+02	9.1E+02	4.9E+03	4.7E+02	1.0E+02

Radionuclide	Ovaries	Muscle	Thyroid	Kidneys	Liver
C 14	2.3E+01	2.3E+01	2.3E+01	0.0E+00	0.0E+00
TC 99	4.8E+01	4.8E+01	1.2E+03	0.0E+00	6.5E+01
I 129	1.1E-02	2.6E-02	1.9E+02	0.0E+00	0.0E+00
U 238	1.5E+00	1.4E+00	1.5E+00	2.6E+02	0.0E+00
TH 234	3.2E-05	3.7E-06	3.3E-07	0.0E+00	4.5E-06
PA 234	7.7E-06	1.2E-06	4.2E-08	1.9E-06	1.4E-06
NP 237	3.0E+01	2.4E-02	1.7E-02	0.0E+00	1.9E+02
PA 233	5.0E-04	5.3E-05	9.7E-07	6.6E-05	4.7E-05
Total internal	1.0E+02	7.2E+01	1.4E+03	2.6E+02	2.5E+02

Population Air Submersion and External Incremental Dose by Radionuclide
In Year 12000 (70-yr Time Period Number No: 143)

Radionuclide	Air Submer-sion	External
C 14	1.3E-09	1.0E-03
TC 99	2.3E-10	2.8E-04
I 129	2.9E-11	1.8E-05
U 238	1.3E-11	8.1E-06
TH 234	2.1E-09	5.4E-03
PA 234	3.0E-10	8.4E-04
NP 237	1.8E-10	9.5E-04
PA 233	3.0E-09	2.3E-02
Total external	7.2E-09	3.1E-02

Dose in units of person-rem;
that is the cumulative population dose received by the local population with an assumed 70-yr individual lifetime.

Population Internal Dose To Organ by Exposure Pathway

In Year 12000 (70-yr Time Period Number No: 143)

Pathway	Lung	Stomach	S Int.	UL Int.	LL Int.	Bone	Su R	Marro	Testes
Inhalation	1.1E-01	5.9E-04	4.5E-04	4.7E-04	4.9E-04	1.7E-01	1.4E-02	1.7E-03	
Ingestion (Terr)	5.6E+01	5.1E+03	1.0E+02	3.2E+02	8.6E+02	2.2E+03	2.4E+02	6.8E+01	
Ingestion (Aqua)	1.4E+01	1.7E+01	1.5E+01	1.6E+01	1.9E+01	1.8E+03	1.6E+02	2.6E+01	
Drinking Water	2.4E+00	1.0E+02	3.9E+00	1.1E+01	2.9E+01	9.0E+02	7.2E+01	7.3E+00	
Total internal	7.2E+01	5.2E+03	1.2E+02	3.5E+02	9.1E+02	4.9E+03	4.7E+02	1.0E+02	

Pathway	Ovaries	Muscle	Thyroid	Kidneys	Liver
Inhalation	1.7E-03	4.5E-04	5.0E-04	1.8E-04	7.6E-03
Ingestion (Terr)	6.8E+01	5.6E+01	1.3E+03	1.7E+02	1.4E+02
Ingestion (Aqua)	2.6E+01	1.4E+01	1.5E+01	4.4E+00	7.6E+01
Drinking Water	7.4E+00	2.4E+00	4.3E+01	9.0E+01	3.2E+01
Total internal	1.0E+02	7.2E+01	1.4E+03	2.6E+02	2.5E+02

Dose in units of person-rem;
that is the cumulative population dose received by the local population
with an assumed 70-yr individual lifetime.

```
DITTY Long-Term Surface Water Release TWRS-EIS (Ex Situ In Situ Combo)
   5
C 14
I 129
NP237
TC99
U 238
 &INPUT IWAT=1, IPATH=2, LUW=1, IPOPL=2,
  CFLO=120000.,
  RM=1.0, TZ=1990., TZR=0.,
  PL1(1)=294830.,391538.,431210.,469891.,1273208.,4932964.,
  TL(1)=1990., 2100.,2200.,2300.,2990.,11900.,
  NTL=6,
  USAGE(1)=0.3,0.,0.,0.,438.,17.,17.,
  CONSUM(1)=15.,276.,20.,230.,40.,30.,8.5,
  EXTIM=2920.,MOPYR=6, RIRR=150.,
  GRWP(1)=90.,90.,90.,30.,3*90.,
  YELD(1)=1.5,4.,0.84,1.3,3*0.84,
 &END
   5
C 14        5
 1990.   0.0
 4244.   0.0
 4245.   0.0199
11995.   0.0199
11996.   0.0
I 129       5
 1990.   0.0
 4244.   0.0
 4245.   0.0002
11995.   0.0002
11996.   0.0
NP237       5
 1990.   0.0
 4244.   0.0
 4245.   0.0006
11995.   0.0006
11996.   0.0
TC99        5
 1990.   0.0
 4244.   0.0
 4245.   0.3326
11995.   0.3326
11996.   0.0
U 238       5
```

1990.	0.0
4244.	0.0
4245.	0.0075
11995.	0.0075
11996.	0.0

DITTY Dose Calculation Program
(GENII Version 1.485 3-Dec-90)

Integrated population dose calculated for chronic liquid release
Release from time 1990. A.D. onward for 10,000 years
Case title: DITTY Long-Term Surface Water Release TWRS-EIS (Ex Situ In Situ Combo)
Executed on: 06/18/96 at 10:54:54.8 Page 1

---- DATA LIBRARIES USED ----------(File)-----

Master Radionuclide Data: (2)
Radionuclide Master Library - Long Times (23-July-93 PDR)
Food Concentration Ratios: (8)
PNL Food Transfer Factor Library (by Z, Changed NP&U LF 6/18/96 AMN)
Fresh Water Bioaccumulation Factors: (9)
Bioaccumulation Factor Library - (30-Aug-88) RAP
External Exposure D.F.'s: (10)
External Dose Factors for GENII in person Sv/yr per Bq/X (8-May-90 RAP)
Inhalation/Ingestion D.F.'s: (30)
Worst-Case Solubilities, DITTY Internal Dose Factors (Sv/Bq) (23-Jul-93 PDR)
Waterborne Release Data: (31)
DITTY.IN

---- MASTER RADIONUCLIDE CONTROL LIST ----------
C 14 TC99 I 129 U 238 TH234 PA234 NP237
PA233

---- TERRESTRIAL/AQUATIC PATHWAY DATA FOR AN AVERAGE INDIVIDUAL ----------

Pathway	Growing Period (days)	Yield (kg/m2)	Consumption (kg/yr)	Pathway (kg or hr/yr)	Usage
LEAFY VEG	9.0E+01	1.5E+00	1.5E+01	FISH	3.0E-01
OTHER VEG	9.0E+01	4.0E+00	2.8E+02	CRUSTACEA	0.0E+00
EGGS	9.0E+01	8.4E-01	2.0E+01	MOLLUSES	0.0E+00
MILK	3.0E+01	1.3E+00	2.3E+02	PLANTS	0.0E+00
BEEF	9.0E+01	8.4E-01	4.0E+01	DRINKING WATER	4.4E+02
PORK	9.0E+01	8.4E-01	3.0E+01	SEDIMENT EXPOSU	1.7E+01
POULTRY	9.0E+01	8.4E-01	8.5E+00	SWIMMING TIME	1.7E+01

External Exposure Time: 2.92E+03 hr/yr

---- LIQUID RELEASE PARAMETERS ----------

River Flow Rate, (ft3/sec) : 1.2E+05 Months/Year Irrigated : 6.0E+00
Reconcentration Ratio : 1.0E+00 Irrigation Rate
Mixing Ratio : 1.0E+00 (liters/m2/month) : 1.5E+02

Input Prepared By: _____ Date: _____

Input Checked By: _____ Date: _____

DITTY Dose Calculation Program
(GENII Version 1.485 3-Dec-90)

Integrated population dose calculated for chronic liquid release
Release from time 1990. A.D. onward for 10,000 years
Case title: DITTY Long-Term Surface Water Release TWRS-EIS (Ex Situ In Situ Combo)
Executed on: 06/18/96 at 10:54:54.8 Page 2

---- WATER RELEASE OF EACH RADIONCLIDE PER 70-YR PERIOD (Ci) ----------

Radio-nuclide	Period/ Activity	Period/ Activity	Period/ Activity	Period/ Activity	Period/ Activity
C 14	33 1.1E+00	34 1.4E+00	35 1.4E+00	36 1.4E+00	37 1.4E+00
	38 1.4E+00	39 1.4E+00	40 1.4E+00	41 1.4E+00	42 1.4E+00
	43 1.4E+00	44 1.4E+00	45 1.4E+00	46 1.4E+00	47 1.4E+00
	48 1.4E+00	49 1.4E+00	50 1.4E+00	51 1.4E+00	52 1.4E+00
	53 1.4E+00	54 1.4E+00	55 1.4E+00	56 1.4E+00	57 1.4E+00
	58 1.4E+00	59 1.4E+00	60 1.4E+00	61 1.4E+00	62 1.4E+00
	63 1.4E+00	64 1.4E+00	65 1.4E+00	66 1.4E+00	67 1.4E+00
	68 1.4E+00	69 1.4E+00	70 1.4E+00	71 1.4E+00	72 1.4E+00
	73 1.4E+00	74 1.4E+00	75 1.4E+00	76 1.4E+00	77 1.4E+00
	78 1.4E+00	79 1.4E+00	80 1.4E+00	81 1.4E+00	82 1.4E+00
	83 1.4E+00	84 1.4E+00	85 1.4E+00	86 1.4E+00	87 1.4E+00
	88 1.4E+00	89 1.4E+00	90 1.4E+00	91 1.4E+00	92 1.4E+00
	93 1.4E+00	94 1.4E+00	95 1.4E+00	96 1.4E+00	97 1.4E+00
	98 1.4E+00	99 1.4E+00	100 1.4E+00	101 1.4E+00	102 1.4E+00
	103 1.4E+00	104 1.4E+00	105 1.4E+00	106 1.4E+00	107 1.4E+00
	108 1.4E+00	109 1.4E+00	110 1.4E+00	111 1.4E+00	112 1.4E+00
	113 1.4E+00	114 1.4E+00	115 1.4E+00	116 1.4E+00	117 1.4E+00
	118 1.4E+00	119 1.4E+00	120 1.4E+00	121 1.4E+00	122 1.4E+00
	123 1.4E+00	124 1.4E+00	125 1.4E+00	126 1.4E+00	127 1.4E+00
	128 1.4E+00	129 1.4E+00	130 1.4E+00	131 1.4E+00	132 1.4E+00
	133 1.4E+00	134 1.4E+00	135 1.4E+00	136 1.4E+00	137 1.4E+00
	138 1.4E+00	139 1.4E+00	140 1.4E+00	141 1.4E+00	142 1.4E+00
	143 1.3E+00				
TC99	33 1.8E+01	34 2.3E+01	35 2.3E+01	36 2.3E+01	37 2.3E+01
	38 2.3E+01	39 2.3E+01	40 2.3E+01	41 2.3E+01	42 2.3E+01
	43 2.3E+01	44 2.3E+01	45 2.3E+01	46 2.3E+01	47 2.3E+01
	48 2.3E+01	49 2.3E+01	50 2.3E+01	51 2.3E+01	52 2.3E+01
	53 2.3E+01	54 2.3E+01	55 2.3E+01	56 2.3E+01	57 2.3E+01
	58 2.3E+01	59 2.3E+01	60 2.3E+01	61 2.3E+01	62 2.3E+01
	63 2.3E+01	64 2.3E+01	65 2.3E+01	66 2.3E+01	67 2.3E+01

68 2.3E+01 69 2.3E+01 70 2.3E+01 71 2.3E+01 72 2.3E+01
73 2.3E+01 74 2.3E+01 75 2.3E+01 76 2.3E+01 77 2.3E+01
78 2.3E+01 79 2.3E+01 80 2.3E+01 81 2.3E+01 82 2.3E+01
83 2.3E+01 84 2.3E+01 85 2.3E+01 86 2.3E+01 87 2.3E+01
88 2.3E+01 89 2.3E+01 90 2.3E+01 91 2.3E+01 92 2.3E+01
93 2.3E+01 94 2.3E+01 95 2.3E+01 96 2.3E+01 97 2.3E+01
98 2.3E+01 99 2.3E+01 100 2.3E+01 101 2.3E+01 102 2.3E+01
103 2.3E+01 104 2.3E+01 105 2.3E+01 106 2.3E+01 107 2.3E+01
108 2.3E+01 109 2.3E+01 110 2.3E+01 111 2.3E+01 112 2.3E+01
113 2.3E+01 114 2.3E+01 115 2.3E+01 116 2.3E+01 117 2.3E+01
118 2.3E+01 119 2.3E+01 120 2.3E+01 121 2.3E+01 122 2.3E+01
123 2.3E+01 124 2.3E+01 125 2.3E+01 126 2.3E+01 127 2.3E+01
128 2.3E+01 129 2.3E+01 130 2.3E+01 131 2.3E+01 132 2.3E+01
133 2.3E+01 134 2.3E+01 135 2.3E+01 136 2.3E+01 137 2.3E+01
138 2.3E+01 139 2.3E+01 140 2.3E+01 141 2.3E+01 142 2.3E+01
143 2.2E+01

I 129 33 1.1E-02 34 1.4E-02 35 1.4E-02 36 1.4E-02 37 1.4E-02
38 1.4E-02 39 1.4E-02 40 1.4E-02 41 1.4E-02 42 1.4E-02
43 1.4E-02 44 1.4E-02 45 1.4E-02 46 1.4E-02 47 1.4E-02
48 1.4E-02 49 1.4E-02 50 1.4E-02 51 1.4E-02 52 1.4E-02
53 1.4E-02 54 1.4E-02 55 1.4E-02 56 1.4E-02 57 1.4E-02
58 1.4E-02 59 1.4E-02 60 1.4E-02 61 1.4E-02 62 1.4E-02
63 1.4E-02 64 1.4E-02 65 1.4E-02 66 1.4E-02 67 1.4E-02
68 1.4E-02 69 1.4E-02 70 1.4E-02 71 1.4E-02 72 1.4E-02
73 1.4E-02 74 1.4E-02 75 1.4E-02 76 1.4E-02 77 1.4E-02
78 1.4E-02 79 1.4E-02 80 1.4E-02 81 1.4E-02 82 1.4E-02
83 1.4E-02 84 1.4E-02 85 1.4E-02 86 1.4E-02 87 1.4E-02
88 1.4E-02 89 1.4E-02 90 1.4E-02 91 1.4E-02 92 1.4E-02
93 1.4E-02 94 1.4E-02 95 1.4E-02 96 1.4E-02 97 1.4E-02
98 1.4E-02 99 1.4E-02 100 1.4E-02 101 1.4E-02 102 1.4E-02
103 1.4E-02 104 1.4E-02 105 1.4E-02 106 1.4E-02 107 1.4E-02
108 1.4E-02 109 1.4E-02 110 1.4E-02 111 1.4E-02 112 1.4E-02
113 1.4E-02 114 1.4E-02 115 1.4E-02 116 1.4E-02 117 1.4E-02
118 1.4E-02 119 1.4E-02 120 1.4E-02 121 1.4E-02 122 1.4E-02
123 1.4E-02 124 1.4E-02 125 1.4E-02 126 1.4E-02 127 1.4E-02
128 1.4E-02 129 1.4E-02 130 1.4E-02 131 1.4E-02 132 1.4E-02
133 1.4E-02 134 1.4E-02 135 1.4E-02 136 1.4E-02 137 1.4E-02
138 1.4E-02 139 1.4E-02 140 1.4E-02 141 1.4E-02 142 1.4E-02
143 1.3E-02

U 238 33 4.2E-01 34 5.2E-01 35 5.2E-01 36 5.2E-01 37 5.2E-01
38 5.2E-01 39 5.2E-01 40 5.2E-01 41 5.2E-01 42 5.2E-01
43 5.2E-01 44 5.2E-01 45 5.2E-01 46 5.2E-01 47 5.2E-01
48 5.2E-01 49 5.2E-01 50 5.2E-01 51 5.2E-01 52 5.2E-01
53 5.2E-01 54 5.2E-01 55 5.2E-01 56 5.2E-01 57 5.2E-01
58 5.2E-01 59 5.2E-01 60 5.2E-01 61 5.2E-01 62 5.2E-01

63 5.2E-01 64 5.2E-01 65 5.2E-01 66 5.2E-01 67 5.2E-01
68 5.2E-01 69 5.2E-01 70 5.2E-01 71 5.2E-01 72 5.2E-01
73 5.2E-01 74 5.2E-01 75 5.2E-01 76 5.2E-01 77 5.2E-01
78 5.2E-01 79 5.2E-01 80 5.2E-01 81 5.2E-01 82 5.2E-01
83 5.2E-01 84 5.2E-01 85 5.2E-01 86 5.2E-01 87 5.2E-01
88 5.2E-01 89 5.2E-01 90 5.2E-01 91 5.2E-01 92 5.2E-01
93 5.2E-01 94 5.2E-01 95 5.2E-01 96 5.2E-01 97 5.2E-01
98 5.2E-01 99 5.2E-01 100 5.2E-01 101 5.2E-01 102 5.2E-01
103 5.2E-01 104 5.2E-01 105 5.2E-01 106 5.2E-01 107 5.2E-01
108 5.2E-01 109 5.2E-01 110 5.2E-01 111 5.2E-01 112 5.2E-01
113 5.2E-01 114 5.2E-01 115 5.2E-01 116 5.2E-01 117 5.2E-01
118 5.2E-01 119 5.2E-01 120 5.2E-01 121 5.2E-01 122 5.2E-01
123 5.2E-01 124 5.2E-01 125 5.2E-01 126 5.2E-01 127 5.2E-01
128 5.2E-01 129 5.2E-01 130 5.2E-01 131 5.2E-01 132 5.2E-01
133 5.2E-01 134 5.2E-01 135 5.2E-01 136 5.2E-01 137 5.2E-01
138 5.2E-01 139 5.2E-01 140 5.2E-01 141 5.2E-01 142 5.2E-01
143 4.9E-01

NP237 33 3.3E-02 34 4.2E-02 35 4.2E-02 36 4.2E-02 37 4.2E-02
38 4.2E-02 39 4.2E-02 40 4.2E-02 41 4.2E-02 42 4.2E-02
43 4.2E-02 44 4.2E-02 45 4.2E-02 46 4.2E-02 47 4.2E-02
48 4.2E-02 49 4.2E-02 50 4.2E-02 51 4.2E-02 52 4.2E-02
53 4.2E-02 54 4.2E-02 55 4.2E-02 56 4.2E-02 57 4.2E-02
58 4.2E-02 59 4.2E-02 60 4.2E-02 61 4.2E-02 62 4.2E-02
63 4.2E-02 64 4.2E-02 65 4.2E-02 66 4.2E-02 67 4.2E-02
68 4.2E-02 69 4.2E-02 70 4.2E-02 71 4.2E-02 72 4.2E-02
73 4.2E-02 74 4.2E-02 75 4.2E-02 76 4.2E-02 77 4.2E-02
78 4.2E-02 79 4.2E-02 80 4.2E-02 81 4.2E-02 82 4.2E-02
83 4.2E-02 84 4.2E-02 85 4.2E-02 86 4.2E-02 87 4.2E-02
88 4.2E-02 89 4.2E-02 90 4.2E-02 91 4.2E-02 92 4.2E-02
93 4.2E-02 94 4.2E-02 95 4.2E-02 96 4.2E-02 97 4.2E-02
98 4.2E-02 99 4.2E-02 100 4.2E-02 101 4.2E-02 102 4.2E-02
103 4.2E-02 104 4.2E-02 105 4.2E-02 106 4.2E-02 107 4.2E-02
108 4.2E-02 109 4.2E-02 110 4.2E-02 111 4.2E-02 112 4.2E-02
113 4.2E-02 114 4.2E-02 115 4.2E-02 116 4.2E-02 117 4.2E-02
118 4.2E-02 119 4.2E-02 120 4.2E-02 121 4.2E-02 122 4.2E-02
123 4.2E-02 124 4.2E-02 125 4.2E-02 126 4.2E-02 127 4.2E-02
128 4.2E-02 129 4.2E-02 130 4.2E-02 131 4.2E-02 132 4.2E-02
133 4.2E-02 134 4.2E-02 135 4.2E-02 136 4.2E-02 137 4.2E-02
138 4.2E-02 139 4.2E-02 140 4.2E-02 141 4.2E-02 142 4.2E-02
143 3.9E-02

DITTY Dose Calculation Program
(GENII Version 1.485 3-Dec-90)

Integrated population dose calculated for chronic liquid release
Release from time 1990. A.D. onward for 10,000 years
Case title: DITTY Long-Term Surface Water Release TWRS-EIS (Ex Situ In Situ Combo)
Executed on: 06/18/96 at 10:54:54.8 Page 3

---- POPULATION DATA ----------

Population for Chronic Waterborne Release at the following Times A.D.:

Time	Population
1990.	2.9E+05
2100.	3.9E+05
2200.	4.3E+05
2300.	4.7E+05
2990.	1.3E+06
11900.	4.9E+06

Lifetime Effective Cumulative Dose Equivalent as a Function of Time

Period	Year	Dose
until	until	
34	4300.	1.68E+01
35	4370.	3.84E+01
36	4440.	6.03E+01
37	4510.	8.25E+01
38	4580.	1.05E+02
39	4650.	1.28E+02
40	4720.	1.51E+02
41	4790.	1.75E+02
42	4860.	1.99E+02
43	4930.	2.23E+02
44	5000.	2.48E+02
45	5070.	2.73E+02
46	5140.	2.98E+02
47	5210.	3.24E+02
48	5280.	3.50E+02
49	5350.	3.76E+02
50	5420.	4.03E+02
51	5490.	4.30E+02
52	5560.	4.57E+02
53	5630.	4.85E+02
54	5700.	5.13E+02
55	5770.	5.41E+02
56	5840.	5.70E+02
57	5910.	5.99E+02
58	5980.	6.28E+02
59	6050.	6.58E+02
60	6120.	6.88E+02
61	6190.	7.18E+02
62	6260.	7.49E+02

63	6330.	7.80E+02
64	6400.	8.11E+02
65	6470.	8.43E+02
66	6540.	8.75E+02
67	6610.	9.08E+02
68	6680.	9.41E+02
69	6750.	9.74E+02
70	6820.	1.01E+03
71	6890.	1.04E+03
72	6960.	1.08E+03
73	7030.	1.11E+03
74	7100.	1.14E+03
75	7170.	1.18E+03

Lifetime Effective Cumulative Dose Equivalent as a Function of Time

Period	Year	Dose
76	7240.	1.21E+03
77	7310.	1.25E+03
78	7380.	1.29E+03
79	7450.	1.32E+03
80	7520.	1.36E+03
81	7590.	1.40E+03
82	7660.	1.44E+03
83	7730.	1.47E+03
84	7800.	1.51E+03
85	7870.	1.55E+03
86	7940.	1.59E+03
87	8010.	1.63E+03
88	8080.	1.67E+03
89	8150.	1.71E+03
90	8220.	1.75E+03
91	8290.	1.79E+03
92	8360.	1.83E+03
93	8430.	1.87E+03
94	8500.	1.91E+03
95	8570.	1.95E+03
96	8640.	2.00E+03
97	8710.	2.04E+03
98	8780.	2.08E+03
99	8850.	2.12E+03
100	8920.	2.17E+03
101	8990.	2.21E+03
102	9060.	2.26E+03
103	9130.	2.30E+03
104	9200.	2.35E+03
105	9270.	2.39E+03

106	9340.	2.44E+03
107	9410.	2.48E+03
108	9480.	2.53E+03
109	9550.	2.58E+03
110	9620.	2.62E+03
111	9690.	2.67E+03
112	9760.	2.72E+03
113	9830.	2.77E+03
114	9900.	2.82E+03
115	9970.	2.86E+03
116	10040.	2.91E+03
117	10110.	2.96E+03
118	10180.	3.01E+03

DITTY Dose Calculation Program
(GENII Version 1.485 3-Dec-90)

Integrated population dose calculated for chronic liquid release
Release from time 1990. A.D. onward for 10,000 years
Case title: DITTY Long-Term Surface Water Release TWRS-EIS (Ex Situ In Situ Combo)
Executed on: 06/18/96 at 10:54:54.8

Lifetime Effective Cumulative Dose Equivalent as a Function of Time

Period	Year	Dose
119	10250.	3.06E+03
120	10320.	3.11E+03
121	10390.	3.16E+03
122	10460.	3.21E+03
123	10530.	3.27E+03
124	10600.	3.32E+03
125	10670.	3.37E+03
126	10740.	3.42E+03
127	10810.	3.48E+03
128	10880.	3.53E+03
129	10950.	3.58E+03
130	11020.	3.64E+03
131	11090.	3.69E+03
132	11160.	3.74E+03
133	11230.	3.80E+03
134	11300.	3.85E+03
135	11370.	3.91E+03
136	11440.	3.97E+03
137	11510.	4.02E+03
138	11580.	4.08E+03
139	11650.	4.14E+03
140	11720.	4.19E+03
141	11790.	4.25E+03
142	11860.	4.31E+03
143	11930.	4.37E+03
144	12000.	4.42E+03

Dose in units of person-rem;

that is the cumulative population dose received by the local population over 10,000 years with an assumed 70-yr individual lifetime.

Cumulative Population Dose Equivalent by Radionuclide

Radio-nuclide	Effective Dose Equivalent	Annual External Dose	Effective Dose Equivalent	Percent Of Total Dose
C 14	9.8E+01	4.5E-03	9.8E+01	2
TC 99	2.9E+03	1.8E-03	2.9E+03	66
I 129	4.0E+01	1.3E-04	4.0E+01	0
U 238	3.6E+02	7.4E-05	3.6E+02	8
TH 234	3.8E-02	4.9E-02	8.7E-02	0
PA 234	1.3E-04	7.7E-03	7.8E-03	0
NP 237	1.0E+03	5.1E-03	1.0E+03	23
PA 233	1.0E-02	1.2E-01	1.3E-01	0

Dose in units of person-rem;
that is the cumulative population dose received by the local population
with an assumed 70-yr individual lifetime.

Maximum Dose Increment Received By Population
In Year 12000 (70-yr Time Period Number No: 143)

Organ	Cumulative Dose Equivalent	Weighting Factors	Weighted Cumulative Dose Equivalent
Gonads	7.6E+00	2.5E-01	1.9E+00
Breast	5.5E+00	1.5E-01	8.3E-01
R Marrow	3.5E+01	1.2E-01	4.2E+00
Lung	5.5E+00	1.2E-01	6.6E-01
Thyroid	1.2E+02	3.0E-02	3.6E+00
Bone Sur	3.7E+02	3.0E-02	1.1E+01
Stomach	4.4E+02	6.0E-02	2.6E+01
LL Int.	7.7E+01	6.0E-02	4.6E+00
Kidneys	3.2E+01	6.0E-02	1.9E+00
UL Int.	2.9E+01	6.0E-02	1.8E+00
Liver	1.9E+01	6.0E-02	1.1E+00

Cumulative Effective Dose Equivalent 5.8E+01
External Dose 2.5E-03

Lifetime Effective Cumulative
Dose Equivalent 5.8E+01

Dose in units of person-rem;
that is the cumulative population dose received by the local population
with an assumed 70-yr individual lifetime.

DITTY Dose Calculation Program
(GENII Version 1.485 3-Dec-90)

Integrated population dose calculated for chronic liquid release
Release from time 1990. A.D. onward for 10,000 years
Case title: DITTY Long-Term Surface Water Release TWRS-EIS (Ex Situ In Situ Combo)
Executed on: 06/18/96 at 10:54:54.8

Maximum Dose Increment Received By Individual (rem)
In Year 12000 (70-yr Time Period Number No: 43)

Radio-nuclide	Effective Dose Equivalent	Annual External Dose	Effective Dose Equivalent	Percent Of Total Dose
C 14	2.6E-07	1.2E-11	2.6E-07	2
TC 99	7.9E-06	4.8E-12	7.9E-06	66
I 129	1.1E-07	3.4E-13	1.1E-07	0
U 238	9.6E-07	2.0E-13	9.6E-07	8
TH 234	1.0E-10	1.3E-10	2.3E-10	0
PA 234	3.4E-13	2.1E-11	2.1E-11	0
NP 237	2.7E-06	1.4E-11	2.7E-06	23
PA 233	2.7E-11	3.2E-10	3.5E-10	0

1.193E-5

Population Internal Dose To Organ by Radionuclide
In Year 12000 (70-yr Time Period Number No: 143)

Radionuclide	Lung	Stomach S Int.	UL Int.	LL Int.	Bone Su	R Marro	Testes
C 14	1.3E+00	1.3E+00	1.3E+00	1.3E+00	1.3E+00	1.6E+00	1.6E+00	1.3E+00
TC 99	4.0E+00	4.4E+02	7.9E+00	2.7E+01	7.1E+01	4.8E+00	4.8E+00	4.0E+00
I 129	1.2E-03	1.7E-03	1.0E-03	1.0E-03	1.0E-03	1.4E-03	1.5E-03	9.4E-04
U 238	1.8E-01	2.5E-01	3.6E-01	1.2E+00	3.6E+00	6.4E+01	4.3E+00	1.7E-01
TH 234	3.7E-06	1.4E-04	3.3E-04	2.0E-03	5.9E-03	2.8E-06	2.4E-06	3.1E-07
PA 234	4.3E-08	2.1E-06	4.3E-06	9.0E-06	7.4E-06	7.8E-08	2.2E-07	6.6E-08
NP 237	1.9E-03	1.7E-02	4.2E-02	2.3E-01	7.0E-01	3.0E+02	2.5E+01	2.1E+00
PA 233	5.8E-07	3.9E-05	1.1E-04	4.9E-04	1.4E-03	1.4E-05	9.6E-06	2.9E-06
Total internal	5.5E+00	4.4E+02	9.6E+00	2.9E+01	7.7E+01	3.7E+02	3.5E+01	7.6E+00

Radionuclide	Ovaries	Muscle	Thyroid	Kidneys	Liver
C 14	1.3E+00	1.3E+00	1.3E+00	0.0E+00	0.0E+00
TC 99	4.0E+00	4.0E+00	1.0E+02	0.0E+00	5.5E+00
I 129	1.0E-03	2.5E-03	1.8E+01	0.0E+00	0.0E+00
U 238	1.8E-01	1.7E-01	1.8E-01	3.2E+01	0.0E+00
TH 234	3.9E-06	4.5E-07	4.0E-08	0.0E+00	5.5E-07
PA 234	9.4E-07	1.4E-07	5.1E-09	2.3E-07	1.7E-07
NP 237	2.1E+00	1.7E-03	1.2E-03	0.0E+00	1.3E+01
PA 233	3.5E-05	3.7E-06	6.9E-08	4.7E-06	3.3E-06
Total internal	7.6E+00	5.5E+00	1.2E+02	3.2E+01	1.9E+01

Population Air Submersion and External Incremental Dose by Radionuclide
In Year 12000 (70-yr Time Period Number No: 143)

Radionuclide	Air Submer-sion	External
C 14	7.4E-11	5.9E-05
TC 99	2.0E-11	2.4E-05
I 129	2.8E-12	1.7E-06
U 238	1.6E-12	9.8E-07
TH 234	2.6E-10	6.5E-04
PA 234	3.7E-11	1.0E-04
NP 237	1.3E-11	6.7E-05
PA 233	2.1E-10	1.6E-03
Total external	6.2E-10	2.5E-03

Dose in units of person-rem;
that is the cumulative population dose received by the local population with an assumed 70-yr individual lifetime.

Population Internal Dose To Organ by Exposure Pathway

In Year 12000 (70-yr Time Period Number No: 143)

Pathway	Lung	Stomach	S Int.	UL Int.	LL Int.	Bone	Su R	Marro	Testes
Inhalation	1.3E-02	3.7E-05	2.6E-05	2.7E-05	3.0E-05	1.2E-02	9.9E-04	1.2E-04	
Ingestion (Terr)	4.5E+00	4.3E+02	8.4E+00	2.7E+01	7.3E+01	1.8E+02	1.9E+01	5.4E+00	
Ingestion (Aqua)	8.2E-01	1.1E+00	8.4E-01	9.4E-01	1.2E+00	1.2E+02	1.1E+01	1.7E+00	
Drinking Water	1.9E-01	8.5E+00	3.4E-01	1.0E+00	2.8E+00	7.3E+01	5.7E+00	5.4E-01	
Total internal	5.5E+00	4.4E+02	9.6E+00	2.9E+01	7.7E+01	3.7E+02	3.5E+01	7.6E+00	

Pathway	Ovaries	Muscle	Thyroid	Kidneys	Liver
Inhalation	1.2E-04	2.6E-05	3.0E-05	2.2E-05	5.4E-04
Ingestion (Terr)	5.4E+00	4.5E+00	1.2E+02	2.0E+01	1.1E+01
Ingestion (Aqua)	1.7E+00	8.2E-01	8.9E-01	5.4E-01	5.4E+00
Drinking Water	5.4E-01	2.0E-01	3.8E+00	1.1E+01	2.3E+00
Total internal	7.6E+00	5.5E+00	1.2E+02	3.2E+01	1.9E+01

Dose in units of person-rem;
that is the cumulative population dose received by the local population
with an assumed 70-yr individual lifetime.

```
DITTY Long-Term Surface Water Release TWRS-EIS (Ex Situ Exten. Sepa.)
   5
C 14
I 129
NP237
TC99
U 238
 &INPUT IWAT=1, IPATH=2, LUW=1, IPOPL=2,
  CFLO=120000.,
  RM=1.0, TZ=1990., TZR=0.,
  PL1(1)=294830.,391538.,431210.,469891.,1273208.,4932964.,
  TL(1)=1990., 2100.,2200.,2300.,2990.,11900.,
  NTL=6,
  USAGE(1)=0.3,0.,0.,0.,438.,17.,17.,
  CONSUM(1)=15.,276.,20.,230.,40.,30.,8.5,
  EXTIM=2920.,MOPYR=6, RIRR=150.,
  GRWP(1)=90.,90.,90.,30.,3*90.,
  YELD(1)=1.5,4.,0.84,1.3,3*0.84,
 &END
   5
C 14        5
1990.   0.0
4244.   0.0
4245.   0.0183
8995.   0.0183
8996.   0.0
I 129       5
1990.   0.0
4244.   0.0
4245.   0.0001
8995.   0.0001
8996.   0.0
NP237       5
1990.   0.0
4244.   0.0
4245.   0.00023
8995.   0.00023
8996.   0.0
TC99        5
1990.   0.0
4244.   0.0
4245.   0.1126
8995.   0.1126
8996.   0.0
U 238       5
```

1990.	0.0
4244.	0.0
4245.	0.0064
8995.	0.0064
8996.	0.0

DITTY Dose Calculation Program
(GENII Version 1.485 3-Dec-90)

Integrated population dose calculated for chronic liquid release
Release from time 1990. A.D. onward for 10,000 years
Case title: DITTY Long-Term Surface Water Release TWRS-EIS (Ex Situ Exten. Sepa.)
Executed on: 06/21/96 at 07:04:30.8 Page 1

---- DATA LIBRARIES USED ----------(File)-----

Master Radionuclide Data: (2)
Radionuclide Master Library - Long Times (23-July-93 PDR)
Food Concentration Ratios: (8)
PNL Food Transfer Factor Library (by Z, Changed NP&U LF 6/18/96 AMN)
Fresh Water Bioaccumulation Factors: (9)
Bioaccumulation Factor Library - (30-Aug-88) RAP
External Exposure D.F.'s: (10)
External Dose Factors for GENII in person Sv/yr per Bq/X (8-May-90 RAP)
Inhalation/Ingestion D.F.'s: (30)
Worst-Case Solubilities, DITTY Internal Dose Factors (Sv/Bq) (23-Jul-93 PDR)
Waterborne Release Data: (31)
DITTY.IN

---- MASTER RADIONUCLIDE CONTROL LIST ----------

C 14 TC99 I 129 U 238 TH234 PA234 NP237
PA233

---- TERRESTRIAL/AQUATIC PATHWAY DATA FOR AN AVERAGE INDIVIDUAL ----------

Pathway	Growing Period (days)	Yield (kg/m2)	Consumption (kg/yr)	Pathway (kg or hr/yr)	Usage
LEAFY VEG	9.0E+01	1.5E+00	1.5E+01	FISH	3.0E-01
OTHER VEG	9.0E+01	4.0E+00	2.8E+02	CRUSTACEA	0.0E+00
EGGS	9.0E+01	8.4E-01	2.0E+01	MOLLUSES	0.0E+00
MILK	3.0E+01	1.3E+00	2.3E+02	PLANTS	0.0E+00
BEEF	9.0E+01	8.4E-01	4.0E+01	DRINKING WATER	4.4E+02
PORK	9.0E+01	8.4E-01	3.0E+01	SEDIMENT EXPOSU	1.7E+01
POULTRY	9.0E+01	8.4E-01	8.5E+00	SWIMMING TIME	1.7E+01

External Exposure Time: 2.92E+03 hr/yr

---- LIQUID RELEASE PARAMETERS ----------

River Flow Rate, (ft3/sec) : 1.2E+05 Months/Year Irrigated : 6.0E+00
Reconcentration Ratio : 1.0E+00 Irrigation Rate
Mixing Ratio : 1.0E+00 (liters/m2/month) : 1.5E+02

Input Prepared By: _____ Date: _____

Input Checked By: _____ Date: _____

DITTY Dose Calculation Program
(GENII Version 1.485 3-Dec-90)

Integrated population dose calculated for chronic liquid release
Release from time 1990. A.D. onward for 10,000 years
Case title: DITTY Long-Term Surface Water Release TWRS-EIS (Ex Situ Exten. Sepa.)
Executed on: 06/21/96 at 07:04:30.8 Page 2

---- WATER RELEASE OF EACH RADIONCLIDE PER 70-YR PERIOD (Ci) ----------

Radio-nuclide	Period/ Activity	Period/ Activity	Period/ Activity	Period/ Activity	Period/ Activity
C 14	33 1.0E+00	34 1.3E+00	35 1.3E+00	36 1.3E+00	37 1.3E+00
	38 1.3E+00	39 1.3E+00	40 1.3E+00	41 1.3E+00	42 1.3E+00
	43 1.3E+00	44 1.3E+00	45 1.3E+00	46 1.3E+00	47 1.3E+00
	48 1.3E+00	49 1.3E+00	50 1.3E+00	51 1.3E+00	52 1.3E+00
	53 1.3E+00	54 1.3E+00	55 1.3E+00	56 1.3E+00	57 1.3E+00
	58 1.3E+00	59 1.3E+00	60 1.3E+00	61 1.3E+00	62 1.3E+00
	63 1.3E+00	64 1.3E+00	65 1.3E+00	66 1.3E+00	67 1.3E+00
	68 1.3E+00	69 1.3E+00	70 1.3E+00	71 1.3E+00	72 1.3E+00
	73 1.3E+00	74 1.3E+00	75 1.3E+00	76 1.3E+00	77 1.3E+00
	78 1.3E+00	79 1.3E+00	80 1.3E+00	81 1.3E+00	82 1.3E+00
	83 1.3E+00	84 1.3E+00	85 1.3E+00	86 1.3E+00	87 1.3E+00
	88 1.3E+00	89 1.3E+00	90 1.3E+00	91 1.3E+00	92 1.3E+00
	93 1.3E+00	94 1.3E+00	95 1.3E+00	96 1.3E+00	97 1.3E+00
	98 1.3E+00	99 1.3E+00	100 1.3E+00	101 1.0E-01	
TC99	33 6.2E+00	34 7.9E+00	35 7.9E+00	36 7.9E+00	37 7.9E+00
	38 7.9E+00	39 7.9E+00	40 7.9E+00	41 7.9E+00	42 7.9E+00
	43 7.9E+00	44 7.9E+00	45 7.9E+00	46 7.9E+00	47 7.9E+00
	48 7.9E+00	49 7.9E+00	50 7.9E+00	51 7.9E+00	52 7.9E+00
	53 7.9E+00	54 7.9E+00	55 7.9E+00	56 7.9E+00	57 7.9E+00
	58 7.9E+00	59 7.9E+00	60 7.9E+00	61 7.9E+00	62 7.9E+00
	63 7.9E+00	64 7.9E+00	65 7.9E+00	66 7.9E+00	67 7.9E+00
	68 7.9E+00	69 7.9E+00	70 7.9E+00	71 7.9E+00	72 7.9E+00
	73 7.9E+00	74 7.9E+00	75 7.9E+00	76 7.9E+00	77 7.9E+00
	78 7.9E+00	79 7.9E+00	80 7.9E+00	81 7.9E+00	82 7.9E+00
	83 7.9E+00	84 7.9E+00	85 7.9E+00	86 7.9E+00	87 7.9E+00
	88 7.9E+00	89 7.9E+00	90 7.9E+00	91 7.9E+00	92 7.9E+00
	93 7.9E+00	94 7.9E+00	95 7.9E+00	96 7.9E+00	97 7.9E+00
	98 7.9E+00	99 7.9E+00	100 7.9E+00	101 6.2E-01	
I 129	33 5.5E-03	34 7.0E-03	35 7.0E-03	36 7.0E-03	37 7.0E-03
	38 7.0E-03	39 7.0E-03	40 7.0E-03	41 7.0E-03	42 7.0E-03

43 7.0E-03 44 7.0E-03 45 7.0E-03 46 7.0E-03 47 7.0E-03
48 7.0E-03 49 7.0E-03 50 7.0E-03 51 7.0E-03 52 7.0E-03
53 7.0E-03 54 7.0E-03 55 7.0E-03 56 7.0E-03 57 7.0E-03
58 7.0E-03 59 7.0E-03 60 7.0E-03 61 7.0E-03 62 7.0E-03
63 7.0E-03 64 7.0E-03 65 7.0E-03 66 7.0E-03 67 7.0E-03
68 7.0E-03 69 7.0E-03 70 7.0E-03 71 7.0E-03 72 7.0E-03
73 7.0E-03 74 7.0E-03 75 7.0E-03 76 7.0E-03 77 7.0E-03
78 7.0E-03 79 7.0E-03 80 7.0E-03 81 7.0E-03 82 7.0E-03
83 7.0E-03 84 7.0E-03 85 7.0E-03 86 7.0E-03 87 7.0E-03
88 7.0E-03 89 7.0E-03 90 7.0E-03 91 7.0E-03 92 7.0E-03
93 7.0E-03 94 7.0E-03 95 7.0E-03 96 7.0E-03 97 7.0E-03
98 7.0E-03 99 7.0E-03 100 7.0E-03 101 5.5E-04
U 238 33 3.6E-01 34 4.5E-01 35 4.5E-01 36 4.5E-01 37 4.5E-01
38 4.5E-01 39 4.5E-01 40 4.5E-01 41 4.5E-01 42 4.5E-01
43 4.5E-01 44 4.5E-01 45 4.5E-01 46 4.5E-01 47 4.5E-01
48 4.5E-01 49 4.5E-01 50 4.5E-01 51 4.5E-01 52 4.5E-01
53 4.5E-01 54 4.5E-01 55 4.5E-01 56 4.5E-01 57 4.5E-01
58 4.5E-01 59 4.5E-01 60 4.5E-01 61 4.5E-01 62 4.5E-01
63 4.5E-01 64 4.5E-01 65 4.5E-01 66 4.5E-01 67 4.5E-01
68 4.5E-01 69 4.5E-01 70 4.5E-01 71 4.5E-01 72 4.5E-01
73 4.5E-01 74 4.5E-01 75 4.5E-01 76 4.5E-01 77 4.5E-01
78 4.5E-01 79 4.5E-01 80 4.5E-01 81 4.5E-01 82 4.5E-01
83 4.5E-01 84 4.5E-01 85 4.5E-01 86 4.5E-01 87 4.5E-01
88 4.5E-01 89 4.5E-01 90 4.5E-01 91 4.5E-01 92 4.5E-01
93 4.5E-01 94 4.5E-01 95 4.5E-01 96 4.5E-01 97 4.5E-01
98 4.5E-01 99 4.5E-01 100 4.5E-01 101 3.5E-02
NP237 33 1.3E-02 34 1.6E-02 35 1.6E-02 36 1.6E-02 37 1.6E-02
38 1.6E-02 39 1.6E-02 40 1.6E-02 41 1.6E-02 42 1.6E-02
43 1.6E-02 44 1.6E-02 45 1.6E-02 46 1.6E-02 47 1.6E-02
48 1.6E-02 49 1.6E-02 50 1.6E-02 51 1.6E-02 52 1.6E-02
53 1.6E-02 54 1.6E-02 55 1.6E-02 56 1.6E-02 57 1.6E-02
58 1.6E-02 59 1.6E-02 60 1.6E-02 61 1.6E-02 62 1.6E-02
63 1.6E-02 64 1.6E-02 65 1.6E-02 66 1.6E-02 67 1.6E-02
68 1.6E-02 69 1.6E-02 70 1.6E-02 71 1.6E-02 72 1.6E-02
73 1.6E-02 74 1.6E-02 75 1.6E-02 76 1.6E-02 77 1.6E-02
78 1.6E-02 79 1.6E-02 80 1.6E-02 81 1.6E-02 82 1.6E-02
83 1.6E-02 84 1.6E-02 85 1.6E-02 86 1.6E-02 87 1.6E-02
88 1.6E-02 89 1.6E-02 90 1.6E-02 91 1.6E-02 92 1.6E-02
93 1.6E-02 94 1.6E-02 95 1.6E-02 96 1.6E-02 97 1.6E-02
98 1.6E-02 99 1.6E-02 100 1.6E-02 101 1.3E-03

---- POPULATION DATA ----

Population for Chronic Waterborne Release at the following Times A.D.:

Time	Population
1990.	2.9E+05
2100.	3.9E+05
2200.	4.3E+05
2300.	4.7E+05
2990.	1.3E+06
11900.	4.9E+06

Lifetime Effective Cumulative Dose Equivalent as a Function of Time

Period	Year	Dose
until	until	
34	4300.	6.80E+00
35	4370.	1.55E+01
36	4440.	2.44E+01
37	4510.	3.34E+01
38	4580.	4.25E+01
39	4650.	5.18E+01
40	4720.	6.12E+01
41	4790.	7.07E+01
42	4860.	8.04E+01
43	4930.	9.02E+01
44	5000.	1.00E+02
45	5070.	1.10E+02
46	5140.	1.20E+02
47	5210.	1.31E+02
48	5280.	1.41E+02
49	5350.	1.52E+02
50	5420.	1.63E+02
51	5490.	1.74E+02
52	5560.	1.85E+02
53	5630.	1.96E+02
54	5700.	2.07E+02
55	5770.	2.19E+02
56	5840.	2.30E+02
57	5910.	2.42E+02
58	5980.	2.54E+02
59	6050.	2.66E+02
60	6120.	2.78E+02
61	6190.	2.90E+02
62	6260.	3.03E+02

63	6330.	3.15E+02
64	6400.	3.28E+02
65	6470.	3.41E+02
66	6540.	3.54E+02
67	6610.	3.67E+02
68	6680.	3.80E+02
69	6750.	3.94E+02
70	6820.	4.07E+02
71	6890.	4.21E+02
72	6960.	4.35E+02
73	7030.	4.48E+02
74	7100.	4.63E+02
75	7170.	4.77E+02

Lifetime Effective Cumulative Dose Equivalent as a Function of Time

Period	Year	Dose
76	7240.	4.91E+02
77	7310.	5.06E+02
78	7380.	5.20E+02
79	7450.	5.35E+02
80	7520.	5.50E+02
81	7590.	5.65E+02
82	7660.	5.80E+02
83	7730.	5.95E+02
84	7800.	6.11E+02
85	7870.	6.26E+02
86	7940.	6.42E+02
87	8010.	6.58E+02
88	8080.	6.74E+02
89	8150.	6.90E+02
90	8220.	7.06E+02
91	8290.	7.23E+02
92	8360.	7.39E+02
93	8430.	7.56E+02
94	8500.	7.73E+02
95	8570.	7.90E+02
96	8640.	8.07E+02
97	8710.	8.24E+02
98	8780.	8.41E+02
99	8850.	8.59E+02
100	8920.	8.77E+02
101	8990.	8.94E+02
102	9060.	8.96E+02
until	until	
144	12000.	8.96E+02

Dose in units of person-rem;
that is the cumulative population dose received by the local population over 10,000 years with an assumed 70-yr individual lifetime.

Cumulative Population Dose Equivalent by Radionuclide

Radio-nuclide	Effective Dose Equivalent	Annual External Dose	Effective Dose Equivalent	Percent Of Total Dose
C 14	4.5E+01	2.1E-03	4.5E+01	5
TC 99	5.0E+02	3.1E-04	5.0E+02	55
I 129	1.0E+01	3.2E-05	1.0E+01	1
U 238	1.5E+02	3.2E-05	1.5E+02	17
TH 234	1.6E-02	2.1E-02	3.7E-02	0
PA 234	5.4E-05	3.3E-03	3.3E-03	0
NP 237	2.0E+02	9.8E-04	2.0E+02	21
PA 233	2.0E-03	2.3E-02	2.5E-02	0

Dose in units of person-rem;
that is the cumulative population dose received by the local population
with an assumed 70-yr individual lifetime.

Maximum Dose Increment Received By Population
In Year 9060 (70-yr Time Period Number No: 101)

Organ	Cumulative Dose Equivalent	Weighting Factors	Weighted Cumulative Dose Equivalent
Gonads	2.7E+00	2.5E-01	6.7E-01
Breast	2.1E+00	1.5E-01	3.1E-01
R Marrow	1.2E+01	1.2E-01	1.5E+00
Lung	2.1E+00	1.2E-01	2.5E-01
Thyroid	3.3E+01	3.0E-02	1.0E+00
Bone Sur	1.3E+02	3.0E-02	3.9E+00
Stomach	1.1E+02	6.0E-02	6.8E+00
LL Int.	2.2E+01	6.0E-02	1.3E+00
Kidneys	2.0E+01	6.0E-02	1.2E+00
UL Int.	8.6E+00	6.0E-02	5.1E-01
Liver	5.2E+00	6.0E-02	3.1E-01

Cumulative Effective Dose Equivalent 1.8E+01
External Dose 1.0E-03

Lifetime Effective Cumulative
Dose Equivalent 1.8E+01

Dose in units of person-rem;
that is the cumulative population dose received by the local population
with an assumed 70-yr individual lifetime.

Maximum Dose Increment Received By Individual (rem)
In Year 9060 (70-yr Time Period Number No: 101)

Radio-nuclide	Effective Dose Equivalent	Annual External Dose	Effective Dose Equivalent	Percent Of Total Dose
C 14	2.4E-07	1.1E-11	2.4E-07	5
TC 99	2.7E-06	1.6E-12	2.7E-06	55
I 129	5.4E-08	1.7E-13	5.4E-08	1
U 238	8.2E-07	1.7E-13	8.2E-07	17
TH 234	8.6E-11	1.1E-10	2.0E-10	0
PA 234	2.9E-13	1.8E-11	1.8E-11	0
NP 237	1.0E-06	5.2E-12	1.0E-06	21
PA 233	1.0E-11	1.2E-10	1.3E-10	0

4.814 E-6

Population Internal Dose To Organ by Radionuclide
In Year 9060 (70-yr Time Period Number No: 101)

Radionuclide	Lung	Stomach S Int.	UL Int.	LL Int.	Bone Su	R Marro	Testes
C 14	9.2E-01	9.2E-01	9.2E-01	9.2E-01	9.2E-01	1.1E+00	1.1E+00	9.2E-01
TC 99	1.0E+00	1.1E+02	2.0E+00	6.8E+00	1.8E+01	1.2E+00	1.2E+00	1.0E+00
I 129	4.5E-04	6.2E-04	3.9E-04	3.9E-04	3.9E-04	5.3E-04	5.8E-04	3.6E-04
U 238	1.2E-01	1.6E-01	2.3E-01	8.0E-01	2.3E+00	4.1E+01	2.8E+00	1.1E-01
TH 234	2.4E-06	8.8E-05	2.1E-04	1.3E-03	3.8E-03	1.8E-06	1.5E-06	2.0E-07
PA 234	2.8E-08	1.4E-06	2.8E-06	5.8E-06	4.8E-06	5.0E-08	1.4E-07	4.3E-08
NP 237	5.4E-04	5.0E-03	1.2E-02	6.6E-02	2.0E-01	8.8E+01	7.1E+00	6.0E-01
PA 233	1.7E-07	1.1E-05	3.2E-05	1.4E-04	4.1E-04	4.0E-06	2.8E-06	8.5E-07
Total internal	2.1E+00	1.1E+02	3.2E+00	8.6E+00	2.2E+01	1.3E+02	1.2E+01	2.7E+00

Radionuclide	Ovaries	Muscle	Thyroid	Kidneys	Liver
C 14	9.2E-01	9.2E-01	9.2E-01	0.0E+00	0.0E+00
TC 99	1.0E+00	1.0E+00	2.6E+01	0.0E+00	1.4E+00
I 129	3.9E-04	9.4E-04	6.7E+00	0.0E+00	0.0E+00
U 238	1.2E-01	1.1E-01	1.2E-01	2.0E+01	0.0E+00
TH 234	2.5E-06	2.9E-07	2.6E-08	0.0E+00	3.5E-07
PA 234	6.0E-07	9.1E-08	3.3E-09	1.5E-07	1.1E-07
NP 237	6.0E-01	4.8E-04	3.6E-04	0.0E+00	3.8E+00
PA 233	1.0E-05	1.1E-06	2.0E-08	1.4E-06	9.6E-07
Total internal	2.7E+00	2.1E+00	3.3E+01	2.0E+01	5.2E+00

Population Air Submersion and External Incremental Dose by Radionuclide
In Year 9060 (70-yr Time Period Number No: 101)

Radionuclide	Air Submer-sion	External
C 14	5.2E-11	4.1E-05
TC 99	5.0E-12	6.1E-06
I 129	1.0E-12	6.3E-07
U 238	1.0E-12	6.3E-07
TH 234	1.7E-10	4.2E-04
PA 234	2.4E-11	6.5E-05
NP 237	3.8E-12	1.9E-05
PA 233	6.1E-11	4.6E-04
Total external	3.1E-10	1.0E-03

Dose in units of person-rem;
that is the cumulative population dose received by the local population with an assumed 70-yr individual lifetime.

Population Internal Dose To Organ by Exposure Pathway

In Year 9060 (70-yr Time Period Number No: 101)

Pathway	Lung	Stomach	S Int.	UL Int.	LL Int.	Bone	Su R	Marro	Testes
Inhalation	8.3E-03	2.1E-05	1.8E-05	1.8E-05	2.0E-05	3.6E-03	3.0E-04	4.4E-05	
Ingestion (Terr)	1.4E+00	1.1E+02	2.4E+00	7.5E+00	2.0E+01	6.6E+01	6.4E+00	1.7E+00	
Ingestion (Aqua)	5.7E-01	6.3E-01	5.7E-01	6.1E-01	7.0E-01	3.7E+01	3.6E+00	8.1E-01	
Drinking Water	9.9E-02	2.2E+00	1.6E-01	4.6E-01	1.2E+00	2.9E+01	2.2E+00	2.0E-01	
Total internal	2.1E+00	1.1E+02	3.2E+00	8.6E+00	2.2E+01	1.3E+02	1.2E+01	2.7E+00	

Pathway	Ovaries	Muscle	Thyroid	Kidneys	Liver
Inhalation	4.4E-05	1.8E-05	1.9E-05	1.4E-05	1.6E-04
Ingestion (Terr)	1.7E+00	1.4E+00	3.2E+01	1.3E+01	3.0E+00
Ingestion (Aqua)	8.1E-01	5.7E-01	5.9E-01	3.5E-01	1.6E+00
Drinking Water	2.0E-01	9.9E-02	1.2E+00	7.1E+00	6.6E-01
Total internal	2.7E+00	2.1E+00	3.3E+01	2.0E+01	5.2E+00

Dose in units of person-rem;
that is the cumulative population dose received by the local population
with an assumed 70-yr individual lifetime.

```
DITTY Long-Term Surface Water Release TWRS-EIS (Ex Situ Inter. Sepa.)
  5
C 14
I 129
NP237
TC99
U 238
 &INPUT IWAT=1, IPATH=2, LUW=1, IPOPL=2,
  CFLO=120000.,
  RM=1.0, TZ=1990., TZR=0.,
  PL1(1)=294830.,391538.,431210.,469891.,1273208.,4932964.,
  TL(1)=1990., 2100.,2200.,2300.,2990.,11900.,
  NTL=6,
  USAGE(1)=0.3,0.,0.,0.,438.,17.,17.,
  CONSUM(1)=15.,276.,20.,230.,40.,30.,8.5,
  EXTIM=2920.,MOPYR=6, RIRR=150.,
  GRWP(1)=90.,90.,90.,30.,3*90.,
  YELD(1)=1.5,4.,0.84,1.3,3*0.84,
 &END
  5
C 14       5
1990.   0.0
4244.   0.0
4245.   0.0183
8995.   0.0183
8996.   0.0
I 129      5
1990.   0.0
4244.   0.0
4245.   0.0001
8995.   0.0001
8996.   0.0
NP237      5
1990.   0.0
4244.   0.0
4245.   0.00023
8995.   0.00023
8996.   0.0
TC99       5
1990.   0.0
4244.   0.0
4245.   0.1126
8995.   0.1126
8996.   0.0
U 238      5
```

1990.	0.0
4244.	0.0
4245.	0.0064
8995.	0.0064
8996.	0.0

DITTY Dose Calculation Program
(GENII Version 1.485 3-Dec-90)

Integrated population dose calculated for chronic liquid release
Release from time 1990. A.D. onward for 10,000 years
Case title: DITTY Long-Term Surface Water Release TWRS-EIS (Ex Situ Inter. Sepa.)
Executed on: 06/21/96 at 07:02:01.6 Page 1

---- DATA LIBRARIES USED ----------(File)-----

Master Radionuclide Data: (2)
Radionuclide Master Library - Long Times (23-July-93 PDR)
Food Concentration Ratios: (8)
PNL Food Transfer Factor Library (by Z, Changed NP&U LF 6/18/96 AMN)
Fresh Water Bioaccumulation Factors: (9)
Bioaccumulation Factor Library - (30-Aug-88) RAP
External Exposure D.F.'s: (10)
External Dose Factors for GENII in person Sv/yr per Bq/X (8-May-90 RAP)
Inhalation/Ingestion D.F.'s: (30)
Worst-Case Solubilities, DITTY Internal Dose Factors (Sv/Bq) (23-Jul-93 PDR)
Waterborne Release Data: (31)
DITTY.IN

---- MASTER RADIONUCLIDE CONTROL LIST ----------
C 14 TC99 I 129 U 238 TH234 PA234 NP237
PA233

---- TERRESTRIAL/AQUATIC PATHWAY DATA FOR AN AVERAGE INDIVIDUAL

Pathway	Growing Period (days)	Yield (kg/m2)	Consumption (kg/yr)	Pathway	Usage (kg or hr/yr)
LEAFY VEG	9.0E+01	1.5E+00	1.5E+01	FISH	3.0E-01
OTHER VEG	9.0E+01	4.0E+00	2.8E+02	CRUSTACEA	0.0E+00
EGGS	9.0E+01	8.4E-01	2.0E+01	MOLLUSES	0.0E+00
MILK	3.0E+01	1.3E+00	2.3E+02	PLANTS	0.0E+00
BEEF	9.0E+01	8.4E-01	4.0E+01	DRINKING WATER	4.4E+02
PORK	9.0E+01	8.4E-01	3.0E+01	SEDIMENT EXPOSU	1.7E+01
POULTRY	9.0E+01	8.4E-01	8.5E+00	SWIMMING TIME	1.7E+01

External Exposure Time: 2.92E+03 hr/yr

----- LIQUID RELEASE PARAMETERS ----------

River Flow Rate, (ft3/sec) : 1.2E+05 Months/Year Irrigated : 6.0E+00
Reconcentration Ratio : 1.0E+00 Irrigation Rate
Mixing Ratio : 1.0E+00 (liters/m2/month) : 1.5E+02

Input Prepared By: _____ Date: _____

Input Checked By: _____ Date: _____

DITTY Dose Calculation Program
(GENII Version 1.485 3-Dec-90)

Integrated population dose calculated for chronic liquid release
Release from time 1990. A.D. onward for 10,000 years
Case title: DITTY Long-Term Surface Water Release TWRS-EIS (Ex Situ Inter. Sepa.)
Executed on: 06/21/96 at 07:02:01.6

---- WATER RELEASE OF EACH RADIONCLIDE PER 70-YR PERIOD (Ci) ----------

Radio-nuclide	Period/ Activity	Period/ Activity	Period/ Activity	Period/ Activity	Period/ Activity
C 14	33 1.0E+00	34 1.3E+00	35 1.3E+00	36 1.3E+00	37 1.3E+00
	38 1.3E+00	39 1.3E+00	40 1.3E+00	41 1.3E+00	42 1.3E+00
	43 1.3E+00	44 1.3E+00	45 1.3E+00	46 1.3E+00	47 1.3E+00
	48 1.3E+00	49 1.3E+00	50 1.3E+00	51 1.3E+00	52 1.3E+00
	53 1.3E+00	54 1.3E+00	55 1.3E+00	56 1.3E+00	57 1.3E+00
	58 1.3E+00	59 1.3E+00	60 1.3E+00	61 1.3E+00	62 1.3E+00
	63 1.3E+00	64 1.3E+00	65 1.3E+00	66 1.3E+00	67 1.3E+00
	68 1.3E+00	69 1.3E+00	70 1.3E+00	71 1.3E+00	72 1.3E+00
	73 1.3E+00	74 1.3E+00	75 1.3E+00	76 1.3E+00	77 1.3E+00
	78 1.3E+00	79 1.3E+00	80 1.3E+00	81 1.3E+00	82 1.3E+00
	83 1.3E+00	84 1.3E+00	85 1.3E+00	86 1.3E+00	87 1.3E+00
	88 1.3E+00	89 1.3E+00	90 1.3E+00	91 1.3E+00	92 1.3E+00
	93 1.3E+00	94 1.3E+00	95 1.3E+00	96 1.3E+00	97 1.3E+00
	98 1.3E+00	99 1.3E+00	100 1.3E+00	101 1.0E-01	
TC99	33 6.2E+00	34 7.9E+00	35 7.9E+00	36 7.9E+00	37 7.9E+00
	38 7.9E+00	39 7.9E+00	40 7.9E+00	41 7.9E+00	42 7.9E+00
	43 7.9E+00	44 7.9E+00	45 7.9E+00	46 7.9E+00	47 7.9E+00
	48 7.9E+00	49 7.9E+00	50 7.9E+00	51 7.9E+00	52 7.9E+00
	53 7.9E+00	54 7.9E+00	55 7.9E+00	56 7.9E+00	57 7.9E+00
	58 7.9E+00	59 7.9E+00	60 7.9E+00	61 7.9E+00	62 7.9E+00
	63 7.9E+00	64 7.9E+00	65 7.9E+00	66 7.9E+00	67 7.9E+00
	68 7.9E+00	69 7.9E+00	70 7.9E+00	71 7.9E+00	72 7.9E+00
	73 7.9E+00	74 7.9E+00	75 7.9E+00	76 7.9E+00	77 7.9E+00
	78 7.9E+00	79 7.9E+00	80 7.9E+00	81 7.9E+00	82 7.9E+00
	83 7.9E+00	84 7.9E+00	85 7.9E+00	86 7.9E+00	87 7.9E+00
	88 7.9E+00	89 7.9E+00	90 7.9E+00	91 7.9E+00	92 7.9E+00
	93 7.9E+00	94 7.9E+00	95 7.9E+00	96 7.9E+00	97 7.9E+00
	98 7.9E+00	99 7.9E+00	100 7.9E+00	101 6.2E-01	
I 129	33 5.5E-03	34 7.0E-03	35 7.0E-03	36 7.0E-03	37 7.0E-03
	38 7.0E-03	39 7.0E-03	40 7.0E-03	41 7.0E-03	42 7.0E-03

43 7.0E-03 44 7.0E-03 45 7.0E-03 46 7.0E-03 47 7.0E-03
48 7.0E-03 49 7.0E-03 50 7.0E-03 51 7.0E-03 52 7.0E-03
53 7.0E-03 54 7.0E-03 55 7.0E-03 56 7.0E-03 57 7.0E-03
58 7.0E-03 59 7.0E-03 60 7.0E-03 61 7.0E-03 62 7.0E-03
63 7.0E-03 64 7.0E-03 65 7.0E-03 66 7.0E-03 67 7.0E-03
68 7.0E-03 69 7.0E-03 70 7.0E-03 71 7.0E-03 72 7.0E-03
73 7.0E-03 74 7.0E-03 75 7.0E-03 76 7.0E-03 77 7.0E-03
78 7.0E-03 79 7.0E-03 80 7.0E-03 81 7.0E-03 82 7.0E-03
83 7.0E-03 84 7.0E-03 85 7.0E-03 86 7.0E-03 87 7.0E-03
88 7.0E-03 89 7.0E-03 90 7.0E-03 91 7.0E-03 92 7.0E-03
93 7.0E-03 94 7.0E-03 95 7.0E-03 96 7.0E-03 97 7.0E-03
98 7.0E-03 99 7.0E-03 100 7.0E-03 101 5.5E-04

U 238 33 3.6E-01 34 4.5E-01 35 4.5E-01 36 4.5E-01 37 4.5E-01
38 4.5E-01 39 4.5E-01 40 4.5E-01 41 4.5E-01 42 4.5E-01
43 4.5E-01 44 4.5E-01 45 4.5E-01 46 4.5E-01 47 4.5E-01
48 4.5E-01 49 4.5E-01 50 4.5E-01 51 4.5E-01 52 4.5E-01
53 4.5E-01 54 4.5E-01 55 4.5E-01 56 4.5E-01 57 4.5E-01
58 4.5E-01 59 4.5E-01 60 4.5E-01 61 4.5E-01 62 4.5E-01
63 4.5E-01 64 4.5E-01 65 4.5E-01 66 4.5E-01 67 4.5E-01
68 4.5E-01 69 4.5E-01 70 4.5E-01 71 4.5E-01 72 4.5E-01
73 4.5E-01 74 4.5E-01 75 4.5E-01 76 4.5E-01 77 4.5E-01
78 4.5E-01 79 4.5E-01 80 4.5E-01 81 4.5E-01 82 4.5E-01
83 4.5E-01 84 4.5E-01 85 4.5E-01 86 4.5E-01 87 4.5E-01
88 4.5E-01 89 4.5E-01 90 4.5E-01 91 4.5E-01 92 4.5E-01
93 4.5E-01 94 4.5E-01 95 4.5E-01 96 4.5E-01 97 4.5E-01
98 4.5E-01 99 4.5E-01 100 4.5E-01 101 3.5E-02

NP237 33 1.3E-02 34 1.6E-02 35 1.6E-02 36 1.6E-02 37 1.6E-02
38 1.6E-02 39 1.6E-02 40 1.6E-02 41 1.6E-02 42 1.6E-02
43 1.6E-02 44 1.6E-02 45 1.6E-02 46 1.6E-02 47 1.6E-02
48 1.6E-02 49 1.6E-02 50 1.6E-02 51 1.6E-02 52 1.6E-02
53 1.6E-02 54 1.6E-02 55 1.6E-02 56 1.6E-02 57 1.6E-02
58 1.6E-02 59 1.6E-02 60 1.6E-02 61 1.6E-02 62 1.6E-02
63 1.6E-02 64 1.6E-02 65 1.6E-02 66 1.6E-02 67 1.6E-02
68 1.6E-02 69 1.6E-02 70 1.6E-02 71 1.6E-02 72 1.6E-02
73 1.6E-02 74 1.6E-02 75 1.6E-02 76 1.6E-02 77 1.6E-02
78 1.6E-02 79 1.6E-02 80 1.6E-02 81 1.6E-02 82 1.6E-02
83 1.6E-02 84 1.6E-02 85 1.6E-02 86 1.6E-02 87 1.6E-02
88 1.6E-02 89 1.6E-02 90 1.6E-02 91 1.6E-02 92 1.6E-02
93 1.6E-02 94 1.6E-02 95 1.6E-02 96 1.6E-02 97 1.6E-02
98 1.6E-02 99 1.6E-02 100 1.6E-02 101 1.3E-03

DITTY Dose Calculation Program
(GENII Version 1.485 3-Dec-90)

Integrated population dose calculated for chronic liquid release
Release from time 1990. A.D. onward for 10,000 years
Case title: DITTY Long-Term Surface Water Release TWRS-EIS (Ex Situ Inter. Sepa.)
Executed on: 06/21/96 at 07:02:01.6 Page 3

---- POPULATION DATA ----------

Population for Chronic Waterborne Release at the following Times A.D.:

Time	Population
1990.	2.9E+05
2100.	3.9E+05
2200.	4.3E+05
2300.	4.7E+05
2990.	1.3E+06
11900.	4.9E+06

Lifetime Effective Cumulative Dose Equivalent as a Function of Time

Period	Year	Dose
until	until	
34	4300.	6.80E+00
35	4370.	1.55E+01
36	4440.	2.44E+01
37	4510.	3.34E+01
38	4580.	4.25E+01
39	4650.	5.18E+01
40	4720.	6.12E+01
41	4790.	7.07E+01
42	4860.	8.04E+01
43	4930.	9.02E+01
44	5000.	1.00E+02
45	5070.	1.10E+02
46	5140.	1.20E+02
47	5210.	1.31E+02
48	5280.	1.41E+02
49	5350.	1.52E+02
50	5420.	1.63E+02
51	5490.	1.74E+02
52	5560.	1.85E+02
53	5630.	1.96E+02
54	5700.	2.07E+02
55	5770.	2.19E+02
56	5840.	2.30E+02
57	5910.	2.42E+02
58	5980.	2.54E+02
59	6050.	2.66E+02
60	6120.	2.78E+02
61	6190.	2.90E+02
62	6260.	3.03E+02

63	6330.	3.15E+02
64	6400.	3.28E+02
65	6470.	3.41E+02
66	6540.	3.54E+02
67	6610.	3.67E+02
68	6680.	3.80E+02
69	6750.	3.94E+02
70	6820.	4.07E+02
71	6890.	4.21E+02
72	6960.	4.35E+02
73	7030.	4.48E+02
74	7100.	4.63E+02
75	7170.	4.77E+02
---	---	---

Lifetime Effective Cumulative Dose Equivalent as a Function of Time

Period	Year	Dose
76	7240.	4.91E+02
77	7310.	5.06E+02
78	7380.	5.20E+02
79	7450.	5.35E+02
80	7520.	5.50E+02
81	7590.	5.65E+02
82	7660.	5.80E+02
83	7730.	5.95E+02
84	7800.	6.11E+02
85	7870.	6.26E+02
86	7940.	6.42E+02
87	8010.	6.58E+02
88	8080.	6.74E+02
89	8150.	6.90E+02
90	8220.	7.06E+02
91	8290.	7.23E+02
92	8360.	7.39E+02
93	8430.	7.56E+02
94	8500.	7.73E+02
95	8570.	7.90E+02
96	8640.	8.07E+02
97	8710.	8.24E+02
98	8780.	8.41E+02
99	8850.	8.59E+02
100	8920.	8.77E+02
101	8990.	8.94E+02
102	9060.	8.96E+02
until	until	
144	12000.	8.96E+02

Dose in units of person-rem;
that is the cumulative population dose received by the local population over 10,000 years with an assumed 70-yr individual lifetime.

Cumulative Population Dose Equivalent by Radionuclide

Radio-nuclide	Effective Dose Equivalent	Annual External Dose	Effective Dose Equivalent	Percent Of Total Dose
C 14	4.5E+01	2.1E-03	4.5E+01	5
TC 99	5.0E+02	3.1E-04	5.0E+02	55
I 129	1.0E+01	3.2E-05	1.0E+01	1
U 238	1.5E+02	3.2E-05	1.5E+02	17
TH 234	1.6E-02	2.1E-02	3.7E-02	0
PA 234	5.4E-05	3.3E-03	3.3E-03	0
NP 237	2.0E+02	9.8E-04	2.0E+02	21
PA 233	2.0E-03	2.3E-02	2.5E-02	0

Dose in units of person-rem;
that is the cumulative population dose received by the local population
with an assumed 70-yr individual lifetime.

Maximum Dose Increment Received By Population
In Year 9060 (70-yr Time Period Number No: 101)

Organ	Cumulative Dose Equivalent	Weighting Factors	Weighted Cumulative Dose Equivalent
Gonads	2.7E+00	2.5E-01	6.7E-01
Breast	2.1E+00	1.5E-01	3.1E-01
R Marrow	1.2E+01	1.2E-01	1.5E+00
Lung	2.1E+00	1.2E-01	2.5E-01
Thyroid	3.3E+01	3.0E-02	1.0E+00
Bone Sur	1.3E+02	3.0E-02	3.9E+00
Stomach	1.1E+02	6.0E-02	6.8E+00
LL Int.	2.2E+01	6.0E-02	1.3E+00
Kidneys	2.0E+01	6.0E-02	1.2E+00
UL Int.	8.6E+00	6.0E-02	5.1E-01
Liver	5.2E+00	6.0E-02	3.1E-01

Cumulative Effective Dose Equivalent 1.8E+01
External Dose 1.0E-03

Lifetime Effective Cumulative
Dose Equivalent 1.8E+01

Dose in units of person-rem;
that is the cumulative population dose received by the local population
with an assumed 70-yr individual lifetime.

Maximum Dose Increment Received By Individual (rem)
In Year 9060 (70-yr Time Period Number No: 101)

Radio-nuclide	Effective Dose Equivalent	Annual External Dose	Effective Dose Equivalent	Percent Of Total Dose
C 14	2.4E-07	1.1E-11	2.4E-07	5
TC 99	2.7E-06	1.6E-12	2.7E-06	55
I 129	5.4E-08	1.7E-13	5.4E-08	1
U 238	8.2E-07	1.7E-13	8.2E-07	17
TH 234	8.6E-11	1.1E-10	2.0E-10	0
PA 234	2.9E-13	1.8E-11	1.8E-11	0
NP 237	1.0E-06	5.2E-12	1.0E-06	21
PA 233	1.0E-11	1.2E-10	1.3E-10	0

4.814×10^{-6}

Population Internal Dose To Organ by Radionuclide
In Year 9060 (70-yr Time Period Number No: 101)

Radionuclide	Lung	Stomach S Int.	UL Int.	LL Int.	Bone Su	R Marro	Testes	
C 14	9.2E-01	9.2E-01	9.2E-01	9.2E-01	9.2E-01	1.1E+00	1.1E+00	9.2E-01
TC 99	1.0E+00	1.1E+02	2.0E+00	6.8E+00	1.8E+01	1.2E+00	1.2E+00	1.0E+00
I 129	4.5E-04	6.2E-04	3.9E-04	3.9E-04	3.9E-04	5.3E-04	5.8E-04	3.6E-04
U 238	1.2E-01	1.6E-01	2.3E-01	8.0E-01	2.3E+00	4.1E+01	2.8E+00	1.1E-01
TH 234	2.4E-06	8.8E-05	2.1E-04	1.3E-03	3.8E-03	1.8E-06	1.5E-06	2.0E-07
PA 234	2.8E-08	1.4E-06	2.8E-06	5.8E-06	4.8E-06	5.0E-08	1.4E-07	4.3E-08
NP 237	5.4E-04	5.0E-03	1.2E-02	6.6E-02	2.0E-01	8.8E+01	7.1E+00	6.0E-01
PA 233	1.7E-07	1.1E-05	3.2E-05	1.4E-04	4.1E-04	4.0E-06	2.8E-06	8.5E-07
Total internal	2.1E+00	1.1E+02	3.2E+00	8.6E+00	2.2E+01	1.3E+02	1.2E+01	2.7E+00

Radionuclide	Ovaries	Muscle	Thyroid	Kidneys	Liver
C 14	9.2E-01	9.2E-01	9.2E-01	0.0E+00	0.0E+00
TC 99	1.0E+00	1.0E+00	2.6E+01	0.0E+00	1.4E+00
I 129	3.9E-04	9.4E-04	6.7E+00	0.0E+00	0.0E+00
U 238	1.2E-01	1.1E-01	1.2E-01	2.0E+01	0.0E+00
TH 234	2.5E-06	2.9E-07	2.6E-08	0.0E+00	3.5E-07
PA 234	6.0E-07	9.1E-08	3.3E-09	1.5E-07	1.1E-07
NP 237	6.0E-01	4.8E-04	3.6E-04	0.0E+00	3.8E+00
PA 233	1.0E-05	1.1E-06	2.0E-08	1.4E-06	9.6E-07
Total internal	2.7E+00	2.1E+00	3.3E+01	2.0E+01	5.2E+00

opulation Air Submersion and External Incremental Dose by Radionuclide
In Year 9060 (70-yr Time Period Number No: 101)

Radionuclide	Air Submer-sion	External
C 14	5.2E-11	4.1E-05
TC 99	5.0E-12	6.1E-06
I 129	1.0E-12	6.3E-07
U 238	1.0E-12	6.3E-07
TH 234	1.7E-10	4.2E-04
PA 234	2.4E-11	6.5E-05
NP 237	3.8E-12	1.9E-05
PA 233	6.1E-11	4.6E-04
Total external	3.1E-10	1.0E-03

Dose in units of person-rem;
that is the cumulative population dose received by the local population with an assumed 70-yr individual lifetime.

DITTY Dose Calculation Program
(GENII Version 1.485 3-Dec-90)

Integrated population dose calculated for chronic liquid release
Release from time 1990. A.D. onward for 10,000 years
Case title: DITTY Long-Term Surface Water Release TWRS-EIS (Ex Situ Inter. Sepa.)
Executed on: 06/21/96 at 07:02:01.6 Page 10

Population Internal Dose To Organ by Exposure Pathway

In Year 9060 (70-yr Time Period Number No: 101)

Pathway	Lung	Stomach	S Int.	UL Int.	LL Int.	Bone	Su R	Marro	Testes
Inhalation	8.3E-03	2.1E-05	1.8E-05	1.8E-05	2.0E-05	3.6E-03	3.0E-04	4.4E-05	
Ingestion (Terr)	1.4E+00	1.1E+02	2.4E+00	7.5E+00	2.0E+01	6.6E+01	6.4E+00	1.7E+00	
Ingestion (Aqua)	5.7E-01	6.3E-01	5.7E-01	6.1E-01	7.0E-01	3.7E+01	3.6E+00	8.1E-01	
Drinking Water	9.9E-02	2.2E+00	1.6E-01	4.6E-01	1.2E+00	2.9E+01	2.2E+00	2.0E-01	
Total internal	2.1E+00	1.1E+02	3.2E+00	8.6E+00	2.2E+01	1.3E+02	1.2E+01	2.7E+00	

Pathway	Ovaries	Muscle	Thyroid	Kidneys	Liver
Inhalation	4.4E-05	1.8E-05	1.9E-05	1.4E-05	1.6E-04
Ingestion (Terr)	1.7E+00	1.4E+00	3.2E+01	1.3E+01	3.0E+00
Ingestion (Aqua)	8.1E-01	5.7E-01	5.9E-01	3.5E-01	1.6E+00
Drinking Water	2.0E-01	9.9E-02	1.2E+00	7.1E+00	6.6E-01
Total internal	2.7E+00	2.1E+00	3.3E+01	2.0E+01	5.2E+00

Dose in units of person-rem;
that is the cumulative population dose received by the local population
with an assumed 70-yr individual lifetime.

```
DITTY Long-Term Surface Water Release TWRS-EIS (Ex Situ No Sepa.)
   5
C 14
I 129
NP237
TC99
U 238
 &INPUT IWAT=1, IPATH=2, LUW=1, IPOPL=2,
  CFLO=120000.,
  RM=1.0, TZ=1990., TZR=0.,
  PL1(1)=294830.,391538.,431210.,469891.,1273208.,4932964.,
  TL(1)=1990., 2100.,2200.,2300.,2990.,11900.,
  NTL=6,
  USAGE(1)=0.3,0.,0.,0.,438.,17.,17.,
  CONSUM(1)=15.,276.,20.,230.,40.,30.,8.5,
  EXTIM=2920.,MOPYR=6, RIRR=150.,
  GRWP(1)=90.,90.,90.,30.,3*90.,
  YELD(1)=1.5,4.,0.84,1.3,3*0.84,
 &END
   5
C 14        5
1990.   0.0
4244.   0.0
4245.   0.0183
8995.   0.0183
8996.   0.0
I 129       5
1990.   0.0
4244.   0.0
4245.   0.0001
8995.   0.0001
8996.   0.0
NP237       5
1990.   0.0
4244.   0.0
4245.   0.00023
8995.   0.00023
8996.   0.0
TC99        5
1990.   0.0
4244.   0.0
4245.   0.1126
8995.   0.1126
8996.   0.0
U 238       5
```

1990.	0.0
4244.	0.0
4245.	0.0064
8995.	0.0064
8996.	0.0

DITTY Dose Calculation Program
(GENII Version 1.485 3-Dec-90)

Integrated population dose calculated for chronic liquid release
Release from time 1990. A.D. onward for 10,000 years
Case title: DITTY Long-Term Surface Water Release TWRS-EIS (Ex Situ No Sepa.)
Executed on: 06/21/96 at 07:03:13.0 Page 1

---- DATA LIBRARIES USED ----------(File)-----

Master Radionuclide Data: (2)
Radionuclide Master Library - Long Times (23-July-93 PDR)
Food Concentration Ratios: (8)
PNL Food Transfer Factor Library (by Z, Changed NP&U LF 6/18/96 AMN)
Fresh Water Bioaccumulation Factors: (9)
Bioaccumulation Factor Library - (30-Aug-88) RAP
External Exposure D.F.'s: (10)
External Dose Factors for GENII in person Sv/yr per Bq/X (8-May-90 RAP)
Inhalation/Ingestion D.F.'s: (30)
Worst-Case Solubilities, DITTY Internal Dose Factors (Sv/Bq) (23-Jul-93 PDR)
Waterborne Release Data: (31)
DITTY.IN

---- MASTER RADIONUCLIDE CONTROL LIST ----------
C 14 TC99 I 129 U 238 TH234 PA234 NP237
PA233

---- TERRESTRIAL/AQUATIC PATHWAY DATA FOR AN AVERAGE INDIVIDUAL

Pathway	Growing Period (days)	Yield (kg/m2)	Consumption (kg/yr)	Pathway	Usage (kg or hr/yr)
LEAFY VEG	9.0E+01	1.5E+00	1.5E+01	FISH	3.0E-01
OTHER VEG	9.0E+01	4.0E+00	2.8E+02	CRUSTACEA	0.0E+00
EGGS	9.0E+01	8.4E-01	2.0E+01	MOLLUSES	0.0E+00
MILK	3.0E+01	1.3E+00	2.3E+02	PLANTS	0.0E+00
BEEF	9.0E+01	8.4E-01	4.0E+01	DRINKING WATER	4.4E+02
PORK	9.0E+01	8.4E-01	3.0E+01	SEDIMENT EXPOSU	1.7E+01
POULTRY	9.0E+01	8.4E-01	8.5E+00	SWIMMING TIME	1.7E+01

External Exposure Time: 2.92E+03 hr/yr

---- LIQUID RELEASE PARAMETERS ----------

River Flow Rate, (ft3/sec) : 1.2E+05 Months/Year Irrigated : 6.0E+00
Reconcentration Ratio : 1.0E+00 Irrigation Rate
Mixing Ratio : 1.0E+00 (liters/m2/month) : 1.5E+02

Input Prepared By: _____ Date: _____

Input Checked By: _____ Date: _____

DITTY Dose Calculation Program
(GENII Version 1.485 3-Dec-90)

Integrated population dose calculated for chronic liquid release
Release from time 1990. A.D. onward for 10,000 years
Case title: DITTY Long-Term Surface Water Release TWRS-EIS (Ex Situ No Sepa.)
Executed on: 06/21/96 at 07:03:13.0 Page 2

---- WATER RELEASE OF EACH RADIONCLIDE PER 70-YR PERIOD (Ci) ----------

Radio-nuclide	Period/ Activity	Period/ Activity	Period/ Activity	Period/ Activity	Period/ Activity
C 14	33 1.0E+00	34 1.3E+00	35 1.3E+00	36 1.3E+00	37 1.3E+00
	38 1.3E+00	39 1.3E+00	40 1.3E+00	41 1.3E+00	42 1.3E+00
	43 1.3E+00	44 1.3E+00	45 1.3E+00	46 1.3E+00	47 1.3E+00
	48 1.3E+00	49 1.3E+00	50 1.3E+00	51 1.3E+00	52 1.3E+00
	53 1.3E+00	54 1.3E+00	55 1.3E+00	56 1.3E+00	57 1.3E+00
	58 1.3E+00	59 1.3E+00	60 1.3E+00	61 1.3E+00	62 1.3E+00
	63 1.3E+00	64 1.3E+00	65 1.3E+00	66 1.3E+00	67 1.3E+00
	68 1.3E+00	69 1.3E+00	70 1.3E+00	71 1.3E+00	72 1.3E+00
	73 1.3E+00	74 1.3E+00	75 1.3E+00	76 1.3E+00	77 1.3E+00
	78 1.3E+00	79 1.3E+00	80 1.3E+00	81 1.3E+00	82 1.3E+00
	83 1.3E+00	84 1.3E+00	85 1.3E+00	86 1.3E+00	87 1.3E+00
	88 1.3E+00	89 1.3E+00	90 1.3E+00	91 1.3E+00	92 1.3E+00
	93 1.3E+00	94 1.3E+00	95 1.3E+00	96 1.3E+00	97 1.3E+00
	98 1.3E+00	99 1.3E+00	100 1.3E+00	101 1.0E-01	
TC99	33 6.2E+00	34 7.9E+00	35 7.9E+00	36 7.9E+00	37 7.9E+00
	38 7.9E+00	39 7.9E+00	40 7.9E+00	41 7.9E+00	42 7.9E+00
	43 7.9E+00	44 7.9E+00	45 7.9E+00	46 7.9E+00	47 7.9E+00
	48 7.9E+00	49 7.9E+00	50 7.9E+00	51 7.9E+00	52 7.9E+00
	53 7.9E+00	54 7.9E+00	55 7.9E+00	56 7.9E+00	57 7.9E+00
	58 7.9E+00	59 7.9E+00	60 7.9E+00	61 7.9E+00	62 7.9E+00
	63 7.9E+00	64 7.9E+00	65 7.9E+00	66 7.9E+00	67 7.9E+00
	68 7.9E+00	69 7.9E+00	70 7.9E+00	71 7.9E+00	72 7.9E+00
	73 7.9E+00	74 7.9E+00	75 7.9E+00	76 7.9E+00	77 7.9E+00
	78 7.9E+00	79 7.9E+00	80 7.9E+00	81 7.9E+00	82 7.9E+00
	83 7.9E+00	84 7.9E+00	85 7.9E+00	86 7.9E+00	87 7.9E+00
	88 7.9E+00	89 7.9E+00	90 7.9E+00	91 7.9E+00	92 7.9E+00
	93 7.9E+00	94 7.9E+00	95 7.9E+00	96 7.9E+00	97 7.9E+00
	98 7.9E+00	99 7.9E+00	100 7.9E+00	101 6.2E-01	
I 129	33 5.5E-03	34 7.0E-03	35 7.0E-03	36 7.0E-03	37 7.0E-03
	38 7.0E-03	39 7.0E-03	40 7.0E-03	41 7.0E-03	42 7.0E-03

43 7.0E-03 44 7.0E-03 45 7.0E-03 46 7.0E-03 47 7.0E-03
48 7.0E-03 49 7.0E-03 50 7.0E-03 51 7.0E-03 52 7.0E-03
53 7.0E-03 54 7.0E-03 55 7.0E-03 56 7.0E-03 57 7.0E-03
58 7.0E-03 59 7.0E-03 60 7.0E-03 61 7.0E-03 62 7.0E-03
63 7.0E-03 64 7.0E-03 65 7.0E-03 66 7.0E-03 67 7.0E-03
68 7.0E-03 69 7.0E-03 70 7.0E-03 71 7.0E-03 72 7.0E-03
73 7.0E-03 74 7.0E-03 75 7.0E-03 76 7.0E-03 77 7.0E-03
78 7.0E-03 79 7.0E-03 80 7.0E-03 81 7.0E-03 82 7.0E-03
83 7.0E-03 84 7.0E-03 85 7.0E-03 86 7.0E-03 87 7.0E-03
88 7.0E-03 89 7.0E-03 90 7.0E-03 91 7.0E-03 92 7.0E-03
93 7.0E-03 94 7.0E-03 95 7.0E-03 96 7.0E-03 97 7.0E-03
98 7.0E-03 99 7.0E-03 100 7.0E-03 101 5.5E-04

U 238 33 3.6E-01 34 4.5E-01 35 4.5E-01 36 4.5E-01 37 4.5E-01
38 4.5E-01 39 4.5E-01 40 4.5E-01 41 4.5E-01 42 4.5E-01
43 4.5E-01 44 4.5E-01 45 4.5E-01 46 4.5E-01 47 4.5E-01
48 4.5E-01 49 4.5E-01 50 4.5E-01 51 4.5E-01 52 4.5E-01
53 4.5E-01 54 4.5E-01 55 4.5E-01 56 4.5E-01 57 4.5E-01
58 4.5E-01 59 4.5E-01 60 4.5E-01 61 4.5E-01 62 4.5E-01
63 4.5E-01 64 4.5E-01 65 4.5E-01 66 4.5E-01 67 4.5E-01
68 4.5E-01 69 4.5E-01 70 4.5E-01 71 4.5E-01 72 4.5E-01
73 4.5E-01 74 4.5E-01 75 4.5E-01 76 4.5E-01 77 4.5E-01
78 4.5E-01 79 4.5E-01 80 4.5E-01 81 4.5E-01 82 4.5E-01
83 4.5E-01 84 4.5E-01 85 4.5E-01 86 4.5E-01 87 4.5E-01
88 4.5E-01 89 4.5E-01 90 4.5E-01 91 4.5E-01 92 4.5E-01
93 4.5E-01 94 4.5E-01 95 4.5E-01 96 4.5E-01 97 4.5E-01
98 4.5E-01 99 4.5E-01 100 4.5E-01 101 3.5E-02

NP237 33 1.3E-02 34 1.6E-02 35 1.6E-02 36 1.6E-02 37 1.6E-02
38 1.6E-02 39 1.6E-02 40 1.6E-02 41 1.6E-02 42 1.6E-02
43 1.6E-02 44 1.6E-02 45 1.6E-02 46 1.6E-02 47 1.6E-02
48 1.6E-02 49 1.6E-02 50 1.6E-02 51 1.6E-02 52 1.6E-02
53 1.6E-02 54 1.6E-02 55 1.6E-02 56 1.6E-02 57 1.6E-02
58 1.6E-02 59 1.6E-02 60 1.6E-02 61 1.6E-02 62 1.6E-02
63 1.6E-02 64 1.6E-02 65 1.6E-02 66 1.6E-02 67 1.6E-02
68 1.6E-02 69 1.6E-02 70 1.6E-02 71 1.6E-02 72 1.6E-02
73 1.6E-02 74 1.6E-02 75 1.6E-02 76 1.6E-02 77 1.6E-02
78 1.6E-02 79 1.6E-02 80 1.6E-02 81 1.6E-02 82 1.6E-02
83 1.6E-02 84 1.6E-02 85 1.6E-02 86 1.6E-02 87 1.6E-02
88 1.6E-02 89 1.6E-02 90 1.6E-02 91 1.6E-02 92 1.6E-02
93 1.6E-02 94 1.6E-02 95 1.6E-02 96 1.6E-02 97 1.6E-02
98 1.6E-02 99 1.6E-02 100 1.6E-02 101 1.3E-03

DITTY Dose Calculation Program
(GENII Version 1.485 3-Dec-90)

Integrated population dose calculated for chronic liquid release
Release from time 1990. A.D. onward for 10,000 years
Case title: DITTY Long-Term Surface Water Release TWRS-EIS (Ex Situ No Sepa.)
Executed on: 06/21/96 at 07:03:13.0 Page 3

---- POPULATION DATA ----------

Population for Chronic Waterborne Release at the following Times A.D.:

Time	Population
1990.	2.9E+05
2100.	3.9E+05
2200.	4.3E+05
2300.	4.7E+05
2990.	1.3E+06
11900.	4.9E+06

Lifetime Effective Cumulative Dose Equivalent as a Function of Time

Period	Year	Dose
until	until	
34	4300.	6.80E+00
35	4370.	1.55E+01
36	4440.	2.44E+01
37	4510.	3.34E+01
38	4580.	4.25E+01
39	4650.	5.18E+01
40	4720.	6.12E+01
41	4790.	7.07E+01
42	4860.	8.04E+01
43	4930.	9.02E+01
44	5000.	1.00E+02
45	5070.	1.10E+02
46	5140.	1.20E+02
47	5210.	1.31E+02
48	5280.	1.41E+02
49	5350.	1.52E+02
50	5420.	1.63E+02
51	5490.	1.74E+02
52	5560.	1.85E+02
53	5630.	1.96E+02
54	5700.	2.07E+02
55	5770.	2.19E+02
56	5840.	2.30E+02
57	5910.	2.42E+02
58	5980.	2.54E+02
59	6050.	2.66E+02
60	6120.	2.78E+02
61	6190.	2.90E+02
62	6260.	3.03E+02

63	6330.	3.15E+02
64	6400.	3.28E+02
65	6470.	3.41E+02
66	6540.	3.54E+02
67	6610.	3.67E+02
68	6680.	3.80E+02
69	6750.	3.94E+02
70	6820.	4.07E+02
71	6890.	4.21E+02
72	6960.	4.35E+02
73	7030.	4.48E+02
74	7100.	4.63E+02
75	7170.	4.77E+02

Lifetime Effective Cumulative Dose Equivalent as a Function of Time

Period	Year	Dose
76	7240.	4.91E+02
77	7310.	5.06E+02
78	7380.	5.20E+02
79	7450.	5.35E+02
80	7520.	5.50E+02
81	7590.	5.65E+02
82	7660.	5.80E+02
83	7730.	5.95E+02
84	7800.	6.11E+02
85	7870.	6.26E+02
86	7940.	6.42E+02
87	8010.	6.58E+02
88	8080.	6.74E+02
89	8150.	6.90E+02
90	8220.	7.06E+02
91	8290.	7.23E+02
92	8360.	7.39E+02
93	8430.	7.56E+02
94	8500.	7.73E+02
95	8570.	7.90E+02
96	8640.	8.07E+02
97	8710.	8.24E+02
98	8780.	8.41E+02
99	8850.	8.59E+02
100	8920.	8.77E+02
101	8990.	8.94E+02
102	9060.	8.96E+02
until	until	
144	12000.	8.96E+02

Dose in units of person-rem;
that is the cumulative population dose received by the local population over 10,000 years with an assumed 70-yr individual lifetime.

Cumulative Population Dose Equivalent by Radionuclide

Radio-nuclide	Effective Dose Equivalent	Annual External Dose	Effective Dose Equivalent	Percent Of Total Dose
C 14	4.5E+01	2.1E-03	4.5E+01	5
TC 99	5.0E+02	3.1E-04	5.0E+02	55
I 129	1.0E+01	3.2E-05	1.0E+01	1
U 238	1.5E+02	3.2E-05	1.5E+02	17
TH 234	1.6E-02	2.1E-02	3.7E-02	0
PA 234	5.4E-05	3.3E-03	3.3E-03	0
NP 237	2.0E+02	9.8E-04	2.0E+02	21
PA 233	2.0E-03	2.3E-02	2.5E-02	0

Dose in units of person-rem;
that is the cumulative population dose received by the local population
with an assumed 70-yr individual lifetime.

Maximum Dose Increment Received By Population
In Year 9060 (70-yr Time Period Number No: 101)

Organ	Cumulative Dose Equivalent	Weighting Factors	Weighted Cumulative Dose Equivalent
Gonads	2.7E+00	2.5E-01	6.7E-01
Breast	2.1E+00	1.5E-01	3.1E-01
R Marrow	1.2E+01	1.2E-01	1.5E+00
Lung	2.1E+00	1.2E-01	2.5E-01
Thyroid	3.3E+01	3.0E-02	1.0E+00
Bone Sur	1.3E+02	3.0E-02	3.9E+00
Stomach	1.1E+02	6.0E-02	6.8E+00
LL Int.	2.2E+01	6.0E-02	1.3E+00
Kidneys	2.0E+01	6.0E-02	1.2E+00
UL Int.	8.6E+00	6.0E-02	5.1E-01
Liver	5.2E+00	6.0E-02	3.1E-01

Cumulative Effective Dose Equivalent 1.8E+01
External Dose 1.0E-03

Lifetime Effective Cumulative
Dose Equivalent 1.8E+01

Dose in units of person-rem;
that is the cumulative population dose received by the local population
with an assumed 70-yr individual lifetime.

Maximum Dose Increment Received By Individual (rem)
In Year 9060 (70-yr Time Period Number No: 101)

Radio-nuclide	Effective Dose Equivalent	Annual External Dose	Effective Dose Equivalent	Percent Of Total Dose
C 14	2.4E-07	1.1E-11	2.4E-07	5
TC 99	2.7E-06	1.6E-12	2.7E-06	55
I 129	5.4E-08	1.7E-13	5.4E-08	1
U 238	8.2E-07	1.7E-13	8.2E-07	17
TH 234	8.6E-11	1.1E-10	2.0E-10	0
PA 234	2.9E-13	1.8E-11	1.8E-11	0
NP 237	1.0E-06	5.2E-12	1.0E-06	21
PA 233	1.0E-11	1.2E-10	1.3E-10	0

4.84×10^{-6}

Population Internal Dose To Organ by Radionuclide
In Year 9060 (70-yr Time Period Number No: 101)

Radionuclide	Lung	Stomach S Int.	UL Int.	LL Int.	Bone Su	R Marro	Testes
C 14	9.2E-01	9.2E-01	9.2E-01	9.2E-01	9.2E-01	1.1E+00	1.1E+00	9.2E-01
TC 99	1.0E+00	1.1E+02	2.0E+00	6.8E+00	1.8E+01	1.2E+00	1.2E+00	1.0E+00
I 129	4.5E-04	6.2E-04	3.9E-04	3.9E-04	3.9E-04	5.3E-04	5.8E-04	3.6E-04
U 238	1.2E-01	1.6E-01	2.3E-01	8.0E-01	2.3E+00	4.1E+01	2.8E+00	1.1E-01
TH 234	2.4E-06	8.8E-05	2.1E-04	1.3E-03	3.8E-03	1.8E-06	1.5E-06	2.0E-07
PA 234	2.8E-08	1.4E-06	2.8E-06	5.8E-06	4.8E-06	5.0E-08	1.4E-07	4.3E-08
NP 237	5.4E-04	5.0E-03	1.2E-02	6.6E-02	2.0E-01	8.8E+01	7.1E+00	6.0E-01
PA 233	1.7E-07	1.1E-05	3.2E-05	1.4E-04	4.1E-04	4.0E-06	2.8E-06	8.5E-07
Total internal	2.1E+00	1.1E+02	3.2E+00	8.6E+00	2.2E+01	1.3E+02	1.2E+01	2.7E+00

Radionuclide	Ovaries	Muscle	Thyroid	Kidneys	Liver
C 14	9.2E-01	9.2E-01	9.2E-01	0.0E+00	0.0E+00
TC 99	1.0E+00	1.0E+00	2.6E+01	0.0E+00	1.4E+00
I 129	3.9E-04	9.4E-04	6.7E+00	0.0E+00	0.0E+00
U 238	1.2E-01	1.1E-01	1.2E-01	2.0E+01	0.0E+00
TH 234	2.5E-06	2.9E-07	2.6E-08	0.0E+00	3.5E-07
PA 234	6.0E-07	9.1E-08	3.3E-09	1.5E-07	1.1E-07
NP 237	6.0E-01	4.8E-04	3.6E-04	0.0E+00	3.8E+00
PA 233	1.0E-05	1.1E-06	2.0E-08	1.4E-06	9.6E-07
Total internal	2.7E+00	2.1E+00	3.3E+01	2.0E+01	5.2E+00

Population Air Submersion and External Incremental Dose by Radionuclide
In Year 9060 (70-yr Time Period Number No: 101)

Radionuclide	Air Submer-sion	External
C 14	5.2E-11	4.1E-05
TC 99	5.0E-12	6.1E-06
I 129	1.0E-12	6.3E-07
U 238	1.0E-12	6.3E-07
TH 234	1.7E-10	4.2E-04
PA 234	2.4E-11	6.5E-05
NP 237	3.8E-12	1.9E-05
PA 233	6.1E-11	4.6E-04
Total external	3.1E-10	1.0E-03

Dose in units of person-rem;
that is the cumulative population dose received by the local population with an assumed 70-yr individual lifetime.

Population Internal Dose To Organ by Exposure Pathway

In Year 9060 (70-yr Time Period Number No: 101)

Pathway	Lung	Stomach	S Int.	UL Int.	LL Int.	Bone	Su R	Marro	Testes
Inhalation	8.3E-03	2.1E-05	1.8E-05	1.8E-05	2.0E-05	3.6E-03	3.0E-04	4.4E-05	
Ingestion (Terr)	1.4E+00	1.1E+02	2.4E+00	7.5E+00	2.0E+01	6.6E+01	6.4E+00	1.7E+00	
Ingestion (Aqua)	5.7E-01	6.3E-01	5.7E-01	6.1E-01	7.0E-01	3.7E+01	3.6E+00	8.1E-01	
Drinking Water	9.9E-02	2.2E+00	1.6E-01	4.6E-01	1.2E+00	2.9E+01	2.2E+00	2.0E-01	
Total internal	2.1E+00	1.1E+02	3.2E+00	8.6E+00	2.2E+01	1.3E+02	1.2E+01	2.7E+00	

Pathway	Ovaries	Muscle	Thyroid	Kidneys	Liver
Inhalation	4.4E-05	1.8E-05	1.9E-05	1.4E-05	1.6E-04
Ingestion (Terr)	1.7E+00	1.4E+00	3.2E+01	1.3E+01	3.0E+00
Ingestion (Aqua)	8.1E-01	5.7E-01	5.9E-01	3.5E-01	1.6E+00
Drinking Water	2.0E-01	9.9E-02	1.2E+00	7.1E+00	6.6E-01
Total internal	2.7E+00	2.1E+00	3.3E+01	2.0E+01	5.2E+00

Dose in units of person-rem;
that is the cumulative population dose received by the local population
with an assumed 70-yr individual lifetime.

TWRS EIS
CALCULATION COVER SHEET

DISCIPLINE & TITLE Engineering – Combo Low Law Vaults – Flux for Groundwater Modeling FEIS

ORIGINATOR Colin Henderson DATE 6/11/96

REVISION NO. 0

OBJECTIVE Estimate the Concentration of Radionuclides Released from the LAW Vaults for the Ex Situ/In Situ Combination 2 Alternative, in Support of the Final EIS.

METHODOLOGY Same methodology as followed for the Ex Situ Intermediate Separations (Calc. Attached)

ASSUMPTIONS Assumptions From Intermediate Separations Calculation are Valid. LAW Vault Inventory and isotopic distribution developed from inventory selected for retrieval. LAW inventory based on same HLW-LAW split as Intermediate Separations (see attached combo low spreadsheet).

(Continue on another sheet if necessary)

Colin Henderson 6/11/96
SIGNATURE/DATE

David J Murray 6/11/96
CHECKED/DATE

CALCULATION & RESULTS
ATTACHED

Combo Low Release Concentrations from LAW vaults

Combo Low		Estimated Vaults Release Concentrations, g/L					
0.00044	factor						
Glass	Metric	Conc.	Conc.	Ionic	Metal	Metal	Oxygen
Component	Tons	g/L	g/meter^3	Form	Subscript	At Wt	Subscript
Ag2O	1.04E-01	4.26E-05	4.26E-02	Ag+1	2	108	1
Al2O3	1.17E+04	2.73E+00	2.73E+03	Al+3	2	27	3
Am2O3	2.03E-03	8.13E-07	8.13E-04	Am+3	2	243	3
As2O5	9.66E-01	2.77E-04	2.77E-01	As+5	2	75	5
B2O3	4.47E-01	1.76E-04	1.76E-01	B+3	2	209	3
BaO	6.57E-01	2.59E-04	2.59E-01	Ba+2	1	137	1
BeO	1.68E-01	2.66E-05	2.66E-02	Be+2	1	9	1
Bi2O3	5.85E+00	2.31E-03	2.31E+00	Bi+3	2	209	3
CaO	2.63E+04	8.27E+00	8.27E+03	Ca+2	1	40	1
CdO	1.46E+00	5.62E-04	5.62E-01	Cd+2	1	112	1
Ce2O3	1.03E+00	3.87E-04	3.87E-01	Ce+3	2	140	3
Cm2O3	NS	0.00E+00	0.00E+00	Cm+3	2	247	3
Co2O3	NS	0.00E+00	0.00E+00	Co+3	2	59	3
Cr2O3	3.97E+01	1.20E-02	1.20E+01	Cr+3	2	52	3
Cs2O	3.46E-03	1.44E-06	1.44E-03	Cs+1	2	133	1
CuO	1.39E-01	4.89E-05	4.89E-02	Cu+2	1	64	1
Fe2O3	5.58E+00	1.72E-03	1.72E+00	Fe+3	2	56	3
K2O	4.49E+00	1.64E-03	1.64E+00	K+1	2	39	1
La2O3	2.35E-01	8.82E-05	8.82E-02	La+3	2	139	3
Li2O	2.17E-04	4.46E-08	4.46E-05	Li+1	2	7	1
MgO	5.57E-01	1.47E-04	1.47E-01	Mg+2	1	24	1
MnO2	1.09E+01	3.03E-03	3.03E+00	Mn+4	1	55	2
MoO3	6.55E+00	1.92E-03	1.92E+00	Mo+6	1	96	3
Na2O	3.44E+04	1.12E+01	1.12E+04	Na+1	2	23	1
Ni2O3	4.00E+01	1.25E-02	1.25E+01	Ni+3	2	59	3
NiO	ns	0.00E+00	0.00E+00	Ni+2	1	59	1
NpO2	1.34E-02	5.19E-06	5.19E-03	Np+4	1	237	2
P2O5	8.23E+02	1.58E-01	1.58E+02	PO4-3	2	31	5
PbO2	2.07E+00	7.89E-04	7.89E-01	Pb+4	1	207	2
PuO2	9.44E-04	3.67E-07	3.67E-04	Pu+4	1	242	2
Rb2O	ns	0.00E+00	0.00E+00	Rb+1	2	85	1
Re2O7	ns\	0.00E+00	0.00E+00	Re+7	2	186	7
Rh2O3	ns	0.00E+00	0.00E+00	Rh+3	2	103	3
Ru2O3	ns	0.00E+00	0.00E+00	Ru+3	2	101	3
Sb2O5	NA	0.00E+00	0.00E+00	Sb+5	2	122	5
SeO3	NA	0.00E+00	0.00E+00	Se+6	1	79	3
SiO2	1.56E+05	3.20E+01	3.20E+04	Si+4	1	28	2
Sm2O3	NA	0.00E+00	0.00E+00	Sm+3	2	150	3
SnO2	NA	0.00E+00	0.00E+00	Sn+4	1	119	2
SrO	4.07E-03	1.52E-06	1.52E-03	Sr+2	1	88	1
Tc2O7	2.07E+00	5.82E-04	5.82E-01	TcO4-1	2	99	7
TeO3	NA	0.00E+00	0.00E+00	Te+6	1	128	3
ThO2	NA	0.00E+00	0.00E+00	Th+4	1	232	2
TiO2	NA	0.00E+00	0.00E+00	Ti+4	1	48	2
Tl2O3	NA	0.00E+00	0.00E+00	Tl+3	2	204	3
UO3	4.44E+01	1.63E-02	1.63E+01	UO2+2	1	238	3
V2O5	ns	0.00E+00	0.00E+00	V+5	2	51	5
WO2	ns	0.00E+00	0.00E+00	WO4-2	1	184	2
WO3	2.50E+00	8.72E-04	8.72E-01	WO4-2	1	184	3
ZnO	3.20E+00	1.13E-03	1.13E+00	Zn+2	1	65	1
ZrO2	3.45E-02	1.12E-05	1.12E-02	ZrO+2	1	91	2

Combo Low isotopic breakdown

Am-241	99.54%
Am-242	0.00%
Am-242m	0.02%
Am-243	0.44%
Cs-135	14.63%
Cs-137	85.37%
Np-237	100.00%
Np-238	0.00%
Np-239	0.00%
Pu-238	0.01%
Pu-239	93.50%
Pu-240	6.35%
Pu-241	0.14%
Pu-242	0.00%
U-233	0.00%
U-234	0.00%
U-235	0.65%
U-236	0.00%
U-237	0.00%
U-238	99.35%

Table in grams							Decay Dat	Inventory in Tanks Selected for Retrieval				Grand
35064	Tanks Selected for Retrieval					-	35064					Total
Radionucli	1WSS	2WSS	1ESS	2ESS	4ESS	total	Radionucli	3WDS	3EDS	5EDS		
Ac-225	1.2E-11	7.9E-12	4.8E-11	7.7E-12	0	7.6E-11						7.6E-11
Ac-227	4.2E-05	3E-05	6.5E-05	1.4E-05	0	0.00015						0.00015
Ac-228							Curies					
Am-241	418.314	874.617	1407.44	2205.53	0	4905.91	Am-241	149.368	17116.3	40.6464		22212.2
Am-242	0.00027	0.00081	0.00139	0.00191	0	0.00437						0.00437
Am-242m	0.22207	0.67562	1.15451	1.58655	0	3.63875						3.63875
Am-243	4.25182	16.3129	27.8839	50.0293	0	98.478						98.478
At-217	4.3E-19	2.9E-19	1.7E-18	2.8E-19	0	2.7E-18						2.7E-18
Ba-135m	0	0	0	0	0	0						0
Ba-137m	0.003	0.00973	0.01162	0.00041	0	0.02475	Ba-137m	0.00671	0.04014	0.00357		0.07516
Bi-210	3.7E-14	1.9E-14	4.3E-14	2.5E-14	0	1.2E-13						1.2E-13
Bi-211	7.2E-12	5.1E-12	1.1E-11	2.4E-12	0	2.6E-11						2.6E-11
Bi-212	0	0	0	0	0	0						0
Bi-213	5E-11	3.3E-11	2E-10	3.2E-11	0	3.2E-10						3.2E-10
Bi-214	4.3E-16	2.2E-16	4.8E-16	2.5E-16	0	1.4E-15						1.4E-15
C-14	56.9782	76.3917	278.401	20.7296	0	432.5	C-14	0	522.586	0.73069		955.817
Cm-242	0.00054	0.00164	0.0028	0.00385	0	0.00884						0.00884
Cm-244	0.02447	0.15991	0.30034	0.65999	0	1.14471						1.14471
Cm-245	0.00077	0.00549	0.01031	0.02377	0	0.04035						0.04035
Cs-135	9572.72	26121.3	26790.9	758.904	0	63243.8						63243.8
Cs-137	6752.73	21898.3	26154.6	918.376	0	55724.1	Cs-137	41711	249460	22171.9		369067
Eu-154							Eu-154	0	277.929	0		277.929
Fr-221	3.9E-15	2.6E-15	1.6E-14	2.5E-15	0	2.5E-14						2.5E-14
Fr-223	1.1E-12	7.6E-13	1.7E-12	3.5E-13	0	3.9E-12						3.9E-12
I-129	5765.84	14786.3	34046.5	3696.33	0	58295						58295
Nb-93m	0.16745	0.2296	0.64644	1.01436	0	2.05785						2.05785
Ni-59	0	0	0	0	0	0						0
Ni-63	64.3577	44.5162	553.862	612.618	0	1275.35						1275.35
Np-237	6335.33	7782.41	40077.3	130.131	0	54325.1	Np-237	0	63988.4	0		118313
Np-238	4E-08	1.2E-07	2.1E-07	2.8E-07	0	6.5E-07						6.5E-07
Np-239	3.6E-06	1.4E-05	2.4E-05	4.3E-05	0	8.4E-05						8.4E-05
Pa-231	0.1213	0.07625	0.17296	0.04001	0	0.41053						0.41053
Pa-233	0.00022	0.00026	0.00136	4.4E-06	0	0.00185						0.00185
Pa-234	8.9E-06	2.2E-06	7.1E-06	1.1E-06	0	1.9E-05						1.9E-05
Pa-234m	1.6E-07	4E-08	1.3E-07	2.1E-08	0	3.5E-07						3.5E-07
Pb-209	1.5E-11	1E-11	6.1E-11	9.7E-12	0	9.6E-11						9.6E-11
Pb-210	6.1E-11	3E-11	7E-11	4.1E-11	0	2E-10						2E-10
Pb-211	1.2E-10	8.7E-11	1.9E-10	4E-11	0	4.4E-10						4.4E-10
Pb-212	0	0	0	0	0	0						0
Pb-214	5.8E-16	3E-16	6.5E-16	3.4E-16	0	1.9E-15						1.9E-15
Pd-107	9228.32	23734.6	55953	6852.66	0	95768.6						95768.6
Po-210	1E-12	5.2E-13	1.2E-12	7E-13	0	3.4E-12						3.4E-12
Po-211	7.9E-17	5.6E-17	1.2E-16	2.6E-17	0	2.8E-16						2.8E-16
Po-212	0	0	0	0	0	0						0
Po-213	5.3E-23	3.6E-23	2.2E-22	3.4E-23	0	3.4E-22						3.4E-22
Po-214	5.9E-23	3E-23	6.6E-23	3.4E-23	0	1.9E-22						1.9E-22
Po-215	1E-16	7.2E-17	1.6E-16	3.4E-17	0	3.7E-16						3.7E-16
Po-216	0	0	0	0	0	0						0
Po-218	6.7E-17	3.4E-17	7.5E-17	3.9E-17	0	2.2E-16						2.2E-16
Pu-236												
Pu-238	1.36533	2.09709	2.40055	3.07132	0	8.93429	Pu-238	0	9.97701	0		18.9113
Pu-239	14877.2	2992.02	3474.87	20524.5	0	41868.6	Pu-239	944.128	79843.1	883.874		123540
Pu-240	960.354	156.218	189.689	1359.22	0	2665.49	Pu-240	64.3827	5599.85	60.2738		8390
Pu-241	29.1449	1.97041	2.62799	23.5181	0	57.2614	Pu-241	0.31208	125.959	0.29217		183.824
Pu-242	0.0027	0.00823	0.01406	0.01932	0	0.04431						0.04431
Ra-223	5.9E-08	4.2E-08	9.2E-08	1.9E-08	0	2.1E-07						2.1E-07
Ra-224	0	0	0	0	0	0						0

Ra-225	1.8E-11	1.2E-11	7.2E-11	1.1E-11	0	1.1E-10						1.1E-10
Ra-226	1.9E-08	9.8E-09	2.2E-08	1.1E-08	0	6.2E-08						6.2E-08
Ra-228	0	0	0	0	0	0						0
Rh-106	1.6E-14	5E-15	1.1E-13	1.5E-11	0	1.5E-11						1.5E-11
Rn-219	2.3E-13	1.6E-13	3.6E-13	7.6E-14	0	8.3E-13						8.3E-13
Rn-220	0	0	0	0	0	0						0
Rn-222	1.2E-13	6.3E-14	1.4E-13	7.2E-14	0	4E-13						4E-13
Ru-106	1.7E-08	5.3E-09	1.2E-07	1.6E-05	0	1.6E-05						1.6E-05
Sb-126	8.4E-05	1.6E-05	2.2E-05	0.00011	0	0.00023						0.00023
Sb-126m	6.4E-07	1.2E-07	1.7E-07	8.2E-07	0	1.8E-06						1.8E-06
Se-79	729.505	1878.85	4307.65	442.053	0	7358.06						7358.06
Sm-151	1895.9	383.617	575.741	2426.65	0	5281.9						5281.9
Sn-126	1779.73	340.225	462.79	2271.53	0	4854.28						4854.28
Sr-90	5547.32	14640.5	34950.2	16781.8	0	71919.8	Sr-90	255.941	78947.1	68.9182		151192
Tc-99	41437.7	106258	243481	25249.2	0	416426	Tc-99	216565	930348	57515.5		1620854
Th-227	9.6E-08	6.9E-08	1.5E-07	3.2E-08	0	3.5E-07						3.5E-07
Th-228	0	0	0	0	0	0						0
Th-229	3.2E-06	2.2E-06	1.3E-05	2.1E-06	0	2.1E-05						2.1E-05
Th-230	0.00014	6.9E-05	0.00015	5.9E-05	0	0.00041						0.00041
Th-231	0.00087	0.00022	0.0007	0.00011	0	0.00191						0.00191
Th-232	0	0	0	0	0	0						0
Th-233												
Th-234	0.00478	0.00119	0.00383	0.00061	0	0.01041						0.01041
Tl-207	1.6E-11	1.1E-11	2.5E-11	5.2E-12	0	5.7E-11						5.7E-11
Tl-208	0	0	0	0	0	0						0
Tl-209	3.6E-17	2.4E-17	1.5E-16	2.3E-17	0	2.3E-16						2.3E-16
U-232												
U-233	0.05751	0.05937	0.3362	0.01586	0	0.46894						0.46894
U-234	2.53751	1.30759	2.63698	1.30647	0	7.78854						7.78854
U-235	2138051	539449	1713209	274902	0	4665610						4665610
U-236	1.75725	0.28576	0.34693	2.48677	0	4.87672						4.87672
U-237	9E-07	6.1E-08	8.1E-08	7.3E-07	0	1.8E-06						1.8E-06
U-238	3.3E+08	8.2E+07	2.6E+08	4.2E+07	0	7.2E+08						7.2E+08
Y-90	148.024	390.664	932.606	447.803	0	1919.1	Y-90	6.92136	2134.95	1.86374		4062.83
Zr-93	1751.3	7362.9	15697.3	142299	0	167110						167110
						0						
No. Tanks	3	3	6	1		13						
Table 15 End												

6/23

		isotopic	Oxide	mt		Total Inventory					
total	total grams	%				-		% of total			% of total
						Radionuclide		retrieved			retrieved
						Ac-225	2.3E-10	0.32728			
						Ac-227	0.00026	0.57072			
						Ac-228					
		0.9954235				Am-241	30353.7	0.73178			
		1.96E-07				Am-242	0.00782	0.55948			
		0.0001631				Am-242m	6.50378	0.55948			
Am	22314.34579	0.0044132	Am2O3	0.02452		Am-243	162.169	0.60725	Am	30522.4	0.73108
						At-217	8.4E-18	0.32728			
						Ba-135m	0				
						Ba-137m	0.10052	0.74775			
						Bi-210	3.8E-13	0.32951			
						Bi-211	4.5E-11	0.57072			
						Bi-212	0				
						Bi-213	9.8E-10	0.32728			
						Bi-214	4.6E-15	0.30026			
						C-14	1198.19	0.79772			
						Cm-242	0.0158	0.55948			
						Cm-244	1.64957	0.69395			
						Cm-245	0.05895	0.68442			
		0.1462925				Cs-135	123304	0.51291			
Cs	432310.706	0.8537075	Cs2O	0.45831		Cs-137	443391	0.83237	Cs	566696	0.76286
						Eu-154	281.925	0.98583			
						Fr-221	7.6E-14	0.32728			
						Fr-223	6.8E-12	0.57072			
						I-129	90909.1	0.64124			
						Nb-93m	11.8792	0.17323			
						Ni-59	62360.9	0			
						Ni-63	4621.59	0.27596			
		1				Np-237	149244	0.79275			
		5.488E-12				Np-238	1.2E-06	0.55948			
Np	118313.4779	7.14E-10	NpO2	0.13429		Np-239	0.00014	0.60725	Np	149244	0.79275
						Pa-231	0.7287	0.56337			
						Pa-233	0.00287	0.64279			
						Pa-234	3.8E-05	0.50623			
						Pa-234m	6.9E-07	0.50623			
						Pb-209	2.9E-10	0.32728			
						Pb-210	6.1E-10	0.32951			
						Pb-211	7.7E-10	0.57072			
						Pb-212	0				
						Pb-214	6.2E-15	0.30026			
						Pd-107	147066	0.65119			
						Po-210	1E-11	0.32951			
						Po-211	5E-16	0.57072			
						Po-212	0				
						Po-213	1E-21	0.32728			
						Po-214	6.3E-22	0.30026			
						Po-215	6.4E-16	0.57072			
						Po-216	0				
						Po-218	7.2E-16	0.30026			
						Pu-236					
		0.0001431				Pu-238	148.077	0.12771			
		0.9349685				Pu-239	425864	0.29009			
		0.0634969				Pu-240	29494.3	0.28446			
		0.0013912				Pu-241	874.525	0.2102			
Pu	132132.4636	3.353E-07	PuO2	0.1496		Pu-242	0.0792	0.55948	Pu	456381	0.28952
						Ra-223	3.7E-07	0.57072			
						Ra-224	0				

7/23

						Ra-225	3.4E-10	0.32728			
						Ra-226	2.1E-07	0.30026			
						Ra-228	0				
						Rh-106	1.7E-10	0.08765			
						Rn-219	1.5E-12	0.57072			
						Rn-220	0				
						Rn-222	1.3E-12	0.30026			
						Ru-106	0.00018	0.08765			
						Sb-126	0.00106	0.21714			
						Sb-126m	8.1E-06	0.21714			
						Se-79	11480.2	0.64093			
						Sm-151	24714.8	0.21371			
						Sn-126	22355.1	0.21714			
						Sr-90	425249	0.35554			
			Tc2O7	2.5377		Tc-99	1899425	0.85334			
						Th-227	6.1E-07	0.57072			
						Th-228	0				
						Th-229	6.3E-05	0.32728			
						Th-230	0.00152	0.26956			
						Th-231	0.00384	0.49606			
						Th-232	0				
						Th-233					
						Th-234	0.02056	0.50623			
						Tl-207	9.9E-11	0.57072			
						Tl-208	0	#DIV/0!			
						Tl-209	7.1E-16	0.32728			
						U-232					
		6.512E-10				U-233	0.98589	0.47566			
		1.082E-08				U-234	31.103	0.25041			
		0.0064787				U-235	9405289	0.49606			
		6.772E-09				U-236	34.6607	0.1407			
		2.462E-15				U-237	1.3E-05	0.13938			
U	720147586.9	0.9935213	UO3	865.387		U-238	1.4E+09	0.50623	U	1.4E+09	0.50616
						Y-90	11359.5	0.35766			
						Zr-93	1566636	0.10667			

8/23

Assumptions:									
1. HLW glass waste oxide loading basis to be 20 wt% waste oxides (excluding Na2O and SiO2)									
2. Using the WHC engineering data package material balance calculate the waste oxide loading									
and adjust mass of the glass produced to achieve a 20 wt % waste oxide loading									
3. LAW glass sodium oxide loading basis is to be 15 wt%									
	Input Stream	Input		LAW			HLW		HLW fraction
	STREAM 1	converted to		407	437		314	344	
		oxides		FRIT	GLASS		FRIT	GLASS	
Volume kilo-liters									
Specific Gravity									
Cs and Ba, (MCi)	63.774				9.37E+00			5.44E+01	0.85311
Sr and Y, (MCi)	43.032				2.73E+00			4.03E+01	0.9365
Tc, (MCi)	0.0274				2.23E-02			5.09E-03	0.185790632
Am, (MCi)	0.0763				6.32E-03			7.00E-02	0.917148362
Np, (MCi)	0.0001				9.98E-06			9.00E-05	0.900193798
Pu-239, (MCi)	0.0076				4.81E-04			7.12E-03	0.936670459
Pu-240, (MCi)	0.0019				1.18E-04			1.78E-03	0.93815357
Pu-241,(MCi)	0.0189				3.74E-04			1.85E-02	0.980235043
Total TRU, (MCi)	0.1053				6.05E-03			9.92E-02	0.942507069
Total MCi	115.095				1.59E+00			1.14E+02	0.986148321
Total Mass Flow (MT)				1.91E+05			6.88E+03		
Total Cr, (MT)									0.215686275
Total Na, (MT)									0.031431269
Total Si, (MT)									
Total P, (MT)									0.167694205
Total NO2-, (MT)									
Total NO3-, (MT)									
AG+	5.05E-01								
AG2O		5.43E-01			1.04E-01			4.39E-01	0.807860262
AL+3	4.33E+02								
AL2O3		3.51E+03		8.98E+03	1.17E+04			7.66E+02	0.21815889
AL(OH)4-	5.02E+03								
AM+3									
AM2O3	0.02452	2.45E-02			2.03E-03			2.25E-02	0.917017438
AS+5	1.04E+00								
AS2O5		1.59E+00			9.66E-01			6.27E-01	0.393627955
B+3	9.68E-01								
B2O3		3.12E+00			4.47E-01		8.85E+02	8.88E+02	0.856898029
BA+2	2.89E+00								
BAO		3.23E+00			6.57E-01			2.57E+00	0.796582775
BE+2	6.61E-02								
BEO		1.84E-01			1.68E-01			1.60E-02	0.086886565
BI+3	2.05E+01								
BI2O3		2.29E+01			5.85E+00			1.70E+01	0.74439157
C14									
CA+2	3.21E+01								
CANCRINITE									
CAO		4.49E+01		2.63E+04	2.63E+04			4.05E+01	0.9018
CD+2	6.14E+00								
CDO		7.01E+00			1.46E+00			5.55E+00	0.791958042
CE+3	8.75E+01								
CE2O3		1.02E+02			1.03E+00			1.01E+02	0.989992467
CL-	2.62E+02								
CL2									
CO									
CO2									
CO3-2	1.88E+03								
CR+3	3.31E+01								
CR2O3		5.05E+01			3.97E+01			1.09E+01	0.215321681
CR(OH)4-	9.93E+01								
CS+									
CS2O		4.88E-01			3.46E-03			4.85E-01	0.992921033
CU+2	5.82E-01								
CUO		7.28E-01			1.39E-01			5.89E-01	0.808658009
CUSO4									
F-	1.22E+02								
F2									
FE+3	2.33E+02								

9/23

FE2O3		3.33E+02			5.58E+00			3.28E+02	0.983260198
H2									
H20									
H2S									
HG									
HG+2	1.35E-01								
I-									
I2									
K+	3.63E+02								
K2O		4.33E+02			4.49E+00			4.29E+02	0.989634266
KEROSENE									
LA+3	1.93E+01								
LA2O3		2.27E+01			2.35E-01			2.24E+01	0.989621048
LI+	2.46E-02								
LI2O		5.27E-02			2.17E-04		2.53E+02	2.53E+02	0.995883681
MG+2	9.33E+00								
MGO		7.10E+00			5.57E-01			6.54E+00	0.921568627
MNO2	7.37E+01	1.17E+02			1.09E+01			1.06E+02	0.90633131
MO+6	5.10E+00								
MOO3		7.64E+00			6.55E+00			1.10E+00	0.143360752
N2									
NA+	2.63E+04								
NA2O		3.55E+04			3.44E+04			1.12E+03	0.031418851
NH3									
NI+3	5.91E+01								
NI2FECN6	8.62E+01								
NI2O3		1.05E+02			4.00E+01			6.49E+01	0.618412275
NIO									0.999933925
NO									
NO2									
NO2-	4.57E+03								
NO3-	3.99E+04								
NP+4									
NPO2		1.34E-01			1.34E-02			1.21E-01	0.900360144
O2									
OH-	2.25E+03								
PB+4	4.79E+00								
PBO2		5.53E+00			2.07E+00			3.46E+00	0.626446281
PO4-3	1.32E+03								
P2O5		9.89E+02			8.23E+02			1.66E+02	0.167564655
P2O5:24W									
PU+4									
PUO2		1.50E-01			9.44E-03			1.40E-01	0.936895083
S									
SI+4									
SIO2	4.59E+02	4.59E+02		1.56E+05	1.56E+05		5.72E+03	6.18E+03	1
SO2									
SO4-2	1.06E+03								
SR+2	3.73E-01								
SRO		4.41E-01			4.07E-03			4.37E-01	0.990762125
TCO2									
TCO4-									
TC2O7		2.54E+00			2.07E+00			4.71E-01	0.185689949
TOC	1.10E+03								
UO2+2	1.69E+00								
UO3		8.67E+02			4.44E+01			8.23E+02	0.948755823
V+5									
V2O5									0.751121076
W+6	1.99E+00								
WO2									0.999934018
WO3		2.50E+00			2.50E+00			5.47E-03	0.002186697
ZN+2	3.26E+00								
ZNO		4.06E+00			3.20E+00			8.54E-01	0.210619469
ZR+4	2.72E+01								
ZRO2		3.67E+01			3.45E-02			3.67E+01	0.999060304
ZRO2:2H2									
Waste Oxides Total (MT)					3.81E+04			4.51E+03	
Waste Oxides Less Na & Si								2.94E+03	

10/23

HLW								
20 wt. % waste oxide loading								
Blending factor			1	**1.2**	1.5	2	3.5	
Mass of glass required			1.27E+04	**1.52E+04**	1.90E+04	2.53E+04	4.43E+04	
frit required MT			8.15E+03	**1.07E+04**	1.45E+04	2.08E+04	3.98E+04	
WOL (- Na2O, - SiO2)			23%	**20%**	15%	12%	7%	
WOL (with all tank wastes)			36%	**30%**	24%	18%	10%	
Glass Formers Required								
B2O3 (MT)			1.05E+03	**1.37E+03**	1.86E+03	2.68E+03	5.12E+03	
Li2O (MT)			3.00E+02	**3.93E+02**	5.33E+02	7.66E+02	1.46E+03	
SiO2 (MT)			6.77E+03	**8.87E+03**	1.20E+04	1.73E+04	3.31E+04	
glass density (MT/m^3)	2.63							
cullet packing fraction	0.7	(LAW only)						
Waste volume (m^3)			~~4.81E+03~~	**5.78E+03**	~~7.22E+03~~	~~9.63E+03~~	~~1.68E+04~~	
Canister Volume (m^3)	1.17							
Number of Canisters (2x)			~~4.11E+03~~	**4.94E+03**	~~6.17E+03~~	~~8.23E+03~~	~~1.44E+04~~	
Nu. of Canisters /HMPC	4							
Number of HMPCs			~~1.03E+03~~	**1.23E+03**	~~1.54E+03~~	~~2.06E+03~~	~~3.60E+03~~	
Number of trips @ 10 HMPCs /trip			~~103~~	**123**	~~154~~	~~206~~	~~360~~	
HLW Facility Sizing								
Schedule	14 yrs							
Capacity MT/day	3							
Overall efficiency, %			~~53%~~	~~70%~~	~~94%~~	~~136%~~	~~260%~~	
Required capacity MT/day (assuming 14 yrs ops, 60% OE)			~~2.66~~	~~3.48~~	~~4.72~~	~~6.79~~	~~12.98~~	
Required operating duration yrs (assuming 3 MT/day, 60% OE)			~~12.00~~	**16**	~~22.00~~	~~32.00~~	~~61.00~~	
Required Operating duration, yrs (including 2 yrs start up)				**18**				
LAW								
15 wt. % sodium oxide loading								
Blending factor			**1**	1.25	1.5	2	3.5	
Mass of glass required to achieve 15% wo loading, MT			**2.29E+05**	2.87E+05	3.44E+05	4.59E+05	8.03E+05	
total glass formers required, MT			**1.91E+05**	2.48E+05	3.06E+05	4.20E+05	7.64E+05	
glass density (MT/m^3)	2.63							
cullet packing fraction	0.7							
Glass formers (MT)								
Al2O3			**8.98E+03**	1.17E+04	1.44E+04	1.98E+04	3.59E+04	
CaO			**2.63E+04**	3.42E+04	4.21E+04	5.79E+04	1.05E+05	
SiO2			**1.56E+05**	2.02E+05	2.49E+05	3.43E+05	6.23E+05	
Waste volume (m^3)			**1.25E+05**	1.56E+05	1.87E+05	2.49E+05	4.36E+05	
Number of 5300 m^3 vaults			**24**	29	35	47	82	
LAW facility sizing								
Schedule, years	14							
Capacity MT/day	200							
Overall efficiency, %			~~22%~~	~~28%~~	~~34%~~	~~45%~~	~~79%~~	
Required capacity MT/day (assuming 15 yrs ops, 60% OE)			**70**	~~87~~	~~105~~	~~140~~	~~244~~	
Required operating duration yrs (assuming 70 MT/day, 60% OE)			**15**	~~18.70~~	~~22.44~~	~~29.92~~	~~52.35~~	
Operating duration (including 2 yrs start up)			**17**					

REVISED FACTOR

$$2.29E5\ MT \times \left\{ \frac{5.88\times10^{-6}\ yr^{-1} \times \frac{10^6 g}{MT}}{555\ L/yr \cdot vault \times 24\ vaults} \right\}$$

$$= 2.29\times10^5\ MT \times \underbrace{4.4E-4\ g/L \cdot MT}$$

$$= 100\ g/L$$

factor revised from attached calc ~~B~~ 6/11 Step 13. to account for fewer vaults.

12/23 1/11

Sheet 12 (isotopic mass fraction a
CH 8/16/95

TWRS EIS
CALCULATION COVER SHEET

DISCIPLINE & TITLE Engineering - Flux From TPA LLW Vaults

ORIGINATOR D. Murray DATE 2/1/95

REVISION NO. 1

OBJECTIVE Estimate the concentration of radionuclides released from the LLW vaults. and time required for release

METHODOLOGY See p1

ASSUMPTIONS 1. Cullet/sulfur waste form is stored in vaults similar to grout vaults
2. All concrete structures fail after 500 yrs
3 Hanford Barrier fails after 1000 yrs
4 Recharge rate is 0.05 cm/yr until barrier fails. it then becomes 0.1 cm/yr

(Continue on another sheet if necessary) (cont. p13)

David J Murray
SIGNATURE

CALCULATION & RESULTS ATTACHED

JACOBS\FORMS\CALCVR.SHT

Methodology

A Calculate time for water/leach solution to reach vaults.

B Calculate release time of radionuclides

C Calculate feed rate of liquid into vaults

D Calculate number of vaults required

E Calculate amount leached per year, and total mass dissolved. Compare with solubility tables

F Calculate concentrations of ions in solution

Assumptions (cont)

5. Vitrified waste is uniform spheres, 1cm in dia. Packing fraction is 0.7
6. Glass will have composition shown in TPA Eng. Data Pkg
7. Matrix is 95% sulfur + 5% organic binders
8. The vaults are 15m below the surface of the barrier
9. Leaching commences when the recharge reaches the vaults
10. Leach products form in the same proportion as in the glass
11. Release time is approximated by $\left(\frac{\text{Particle Radius}}{\text{Corrosion Rate}}\right)$ (Ref 1)
12. Corrosion rate is 3×10^{-6} cm/yr
13. Glass density = 2.6 g/cm^3
14. Vaults are 37m × 15m × 10m deep
15. Soln resulting from dissolution of glass will contain the ions shown in the ASPEN tables in the TPA Eng Data Pkg
16. Radioactive decay is not taken into account

References

1 R.A. Kornesky, et al. Impacts of Disposal System Design Options on Low Level Glass Waste Disposal System Performance (Working Draft) July 29, 1994.
2 John A Dean, ed., Lange's Handbook of Chemistry McGraw-Hill, 11th Edition

Calculation

① How far will recharge penetrate in the 1st thousand years?

$$.05 \frac{cm}{yr} \times 1{,}000\ yrs = 50\ cm = 0.5\ m.$$

② How long will it take for recharge to reach vaults?

$$t = d/r = \frac{14.5\ m}{0.1\ cm/yr} = \frac{1450\ cm}{0.1\ cm/yr} = 14{,}500\ yrs.$$

③ What is the release time?

$$t \equiv \frac{0.5\ cm}{3 \times 10^{-6}} = 1.7 \times 10^5\ yrs\ (\text{Assumption } 11)$$

④ What is liquid feed rate on top of one vault?

$$Q = VA = \frac{.1\ cm}{yr} \times (15 \times 37)\ m^2 \times \frac{10^4\ cm^2}{m^2}$$

$$= 555{,}000 \frac{cm^3}{yr} \times \frac{1\ liter}{1000\ cm^3} = 555 \frac{liters}{yr}$$

⑤ What is the vol of LLW spheres in one vault?

$$V = 0.7LWH = 0.7(37 \times 15 \times 10) = 3{,}885\ m^3$$

JACOBS ENGINEERING GROUP INC.

DATE 2/1/95 SUBJECT Flux from TPA LLW Vaults SHEET NO. 5/11 (16/23)

BY [illegible] CHKD. _____ JOB NO. 01K47101

(6) How many vaults are required?

$V = LWH = 5{,}550\ m^3$ = vol of one vault

From data pkg. p10-3, vol of LLW mix $= 2.27 \times 10^5\ m^3$

$$\text{Vaults} = 2.27 \times 10^5\ m^3 \times \frac{\text{vault}}{5{,}550\ m^3} = 40.9 \text{ vaults}$$

(7) From data pkg, p A-114, total mass of cullet = ~~4.00×10^5~~ 3.87×10^5 MT

$$\cancel{4 \times 10^5}\ 3.87 \times 10^5\ MT \times \frac{m^3}{2.6\ MT} = \cancel{154{,}000}\ 148{,}800\ m^3 \text{ cullet}$$

(8) Vol of cullet/sulfur mix $= \frac{\cancel{154{,}000}\ 148{,}800}{.7} = \cancel{220{,}000}\ 213{,}000\ m^3$ mix

Checks with $227{,}000\ m^3$ mix from step (6)

(9) Wt of LLW spheres in one vault

$= \cancel{4.4 \times 10^5}\ 3.87 \times 10^5\ MT / 40.9 = \cancel{9779.9}\ 9462$ Cell, t ~~9780~~ 9460 MT

Total solution flow $= 555 \frac{L}{yr \cdot vault} \times 40.9 \text{ vaults} = 22{,}700\ L/yr$

(10) Amount leached in a yr (from one vault) $= \frac{\cancel{9780}\ 9460\ MT}{170{,}000\ yrs}$

$= \cancel{.0575}\ .0556\ MT/yr$

$= \cancel{57{,}500}\ 55{,}600\ g/yr$

FORM 91-005-1 (4/81)

(11) Dissolved concentration = $\frac{55{,}600 \text{ g/yr}}{555 \text{ liters/yr}}$

= ~~101~~ 100 g/L total

From p10-107 of Lange, this doesn't exceed the solubility of sodium silicate (Ref 2)

(12) From all vaults (total inventory) what fraction is leached every year?

$$\frac{1}{170{,}000} = 5.88 \times 10^{-6} \text{ yr}^{-1}$$

(13) Multiplying the glass components by this fraction will give the metric tons per year of each component, which when divided by total flow will give the concentration in the leach product.

For total mass, for example

$$\cancel{4 \times 10^{5}}\ 3.87 \times 10^{5} \text{ MT} \times \left\{ \frac{5.88 \times \cancel{10^{-6}}\ \cancel{\text{yr}^{-1}} \times \frac{\cancel{10^{6}}\ \text{g}}{\cancel{\text{MT}}}}{\frac{555\ \text{L}}{\cancel{\text{yr}} \cdot \cancel{\text{vault}}} \times 40.9\ \cancel{\text{vaults}}} \right\} \rightarrow 2.59 \times 10^{-4} \text{ Combined Factor}$$

$$= \frac{\cancel{101}}{100} \frac{\text{g}}{\text{L}} \text{ total solids}$$

(14) To get the concentrations of ions in soln, the metric tons of oxides must be converted to metric tons of the element.

For Sm as an example. table shows 3.98×10^{-4} MT Sm_2O_3

$$\text{Then } 3.98\times10^{-4}\ MT\ Sm_2O_3 \times \frac{2\times150}{(2\times150)+(3\times16)}\ \frac{MT\ Sm}{MT\ Sm_2O_3}$$

Subscript of Sm

At wt of SM

Subscript of O

At of O

$= 3.43 \times 10^{-4}$ MT Sm

(15) Now multiply by conversion fraction from step (13)

$$(3.43\times10^{-4})(2.59\times10^{-4}) = 8.89\times10^{-8}\ \frac{g}{L}\ Sm^{+3}$$

Results

At 14,500 yrs after a barrier is emplaced, the leach vaults begin to release solution to the vadose zone.

This continues for 170,000 yrs until all of the LL glass is leached.

The total flow of leachate is 22,700 L/yr.

The concentrations of elements in the leachate are shown in the following table in the column titled "Conc. g/L".

19/23
2/11

Estimated Vaults Release Concentrations, g/L						
Glass Component	Metric Tons	Conc. g/L	Ionic Form	Metal Subscript	Metal At Wt	Oxygen Subscript
Ag2O	3.52E-01	8.49E-05	Ag+1	2	108	1
Al2O3	1.94E+04	2.66E+00	Al+3	2	27	3
Am2O3	2.76E-03	6.51E-07	Am+3	2	243	3
As2O5	1.18E+00	1.99E-04	As+5	2	75	5
B2O3	1.67E+00	3.88E-04	B+3	2	209	3
BaO	8.81E-01	2.04E-04	Ba+2	1	137	1
BeO	2.27E-01	2.12E-05	Be+2	1	9	1
Bi2O3	7.52E+01	1.75E-02	Bi+3	2	209	3
CaO	3.87E+04	7.16E+00	Ca+2	1	40	1
CdO	2.83E+00	6.41E-04	Cd+2	1	112	1
Ce2O3	2.79E+00	6.17E-04	Ce+3	2	140	3
Cm2O3	NS	0.00E+00	Cm+3	2	247	3
Co2O3	NS	0.00E+00	Co+3	2	59	3
Cr2O3	2.11E+02	3.74E-02	Cr+3	2	52	3
Cs2O	6.83E-03	1.67E-06	Cs+1	2	133	1
CuO	2.21E-01	4.58E-05	Cu+2	1	64	1
Fe2O3	2.06E+01	3.73E-03	Fe+3	2	56	3
K2O	2.65E-01	5.70E-05	K+1	2	39	1
La2O3	2.58E-01	5.70E-05	La+3	2	139	3
Li2O	1.24E-02	1.50E-06	Li+1	2	7	1
MgO	1.60E+00	2.49E-04	Mg+2	1	24	1
MnO2	2.16E+01	3.54E-03	Mn+4	1	55	2
MoO3	7.29E+00	1.26E-03	Mo+6	1	96	3
Na2O	9.86E+04	1.89E+01	Na+1	2	23	1
Ni2O3	5.72E+00	1.05E-03	Ni+3	2	59	3
NiO	1.50E-02	3.06E-06	Ni+3	1	59	1
NpO2	1.66E-02	3.79E-06	Np+4	1	237	2
P2O5	3.09E+03	5.35E-01	PO4-3	2	31	5
PbO2	2.26E+00	5.07E-04	Pb+4	1	207	2
PuO2	3.26E-02	7.46E-06	Pu+4	1	242	2
RbO2	NA	0.00E+00	Rb+4	1	85	2
Re2O7	NA	0.00E+00	Re+7	2	186	7
Rh2O3	NA	0.00E+00	Rh+3	2	103	3
Ru2O3	NA	0.00E+00	Ru+3	2	101	3
Sb2O5	NA	0.00E+00	Sb+5	2	122	5
SeO3	NA	0.00E+00	Se+6	1	79	3
SiO2	2.29E+05	2.77E+01	Si+4	1	28	2
Sm2O3	NA	0.00E+00	Sm+3	2	150	3
SnO2	NA	0.00E+00	Sn+4	1	119	2
SrO	4.00E-01	8.77E-05	Sr+2	1	88	1
Tc2O7	2.39E+00	3.25E-04	TcO4-1	2	99	7
TeO3	NA	0.00E+00	Te+6	1	128	3
ThO2	NA	0.00E+00	Th+4	1	232	2
TiO2	NA	0.00E+00	Ti+4	1	48	2
Tl2O3	NA	0.00E+00	Tl+3	2	204	3
UO3	9.02E+01	2.21E-02	UO2+2	1	238	3
V2O5	1.11E-01	1.61E-05	V+5	2	51	5
WO2	2.91E-05	8.65E-09	WO4-2	1	184	2
WO3	9.40E-01	2.60E-04	WO4-2	1	184	3
ZnO	4.46E+00	9.27E-04	Zn+2	1	65	1
ZrO2	6.49E-01	1.46E-04	ZrO+2	1	91	2
VAULTCON.WKS		Rev. B				

20/23 4/11

Stream Name / Solid Component	435	436	437	438	439	440	441	442	443	444
Cs and Ba, (MCi)	4.93E-06	4.93E-06	4.93E-01	4.93E-05	4.93E-01	4.93E-01	4.93E-01		4.93E-05	4.93E-05
Sr and Y, (MCi)	1.90E-05	1.90E-05	1.90E+00	1.90E-04	1.90E+00	1.90E+00	1.90E+00		1.90E-04	1.90E-04
Tc, (MCi)	2.59E-07	2.59E-07	2.59E-02	2.59E-06	2.59E-02	2.59E-02	2.59E-02		2.59E-06	2.59E-06
Am, (MCi)	8.60E-08	8.60E-08	8.60E-03	8.60E-07	8.60E-03	8.60E-03	8.60E-03		8.60E-07	8.60E-07
Np, (MCi)	1.03E-10	1.03E-10	1.03E-05	1.03E-09	1.03E-05	1.03E-05	1.03E-05		1.03E-09	1.03E-09
Pu-239, (MCi)	1.67E-08	1.67E-08	1.67E-03	1.67E-07	1.67E-03	1.67E-03	1.67E-03		1.67E-07	1.67E-07
Pu-240, (MCi)	4.13E-09	4.13E-09	4.14E-04	4.14E-08	4.14E-04	4.14E-04	4.14E-04		4.14E-08	4.14E-08
Pu-241, (MCi)	1.48E-08	1.48E-08	1.48E-03	1.48E-07	1.48E-03	1.48E-03	1.48E-03		1.48E-07	1.48E-07
Total TRU, (MCi)	1.22E-07	1.22E-07	1.22E-02	1.22E-06	1.22E-02	1.22E-02	1.22E-02		1.22E-06	1.22E-06
Total MCi	2.43E-05	2.43E-05	2.43E+00	2.43E-04	2.43E+00	2.43E+00	2.43E+00		2.43E-04	2.43E-04
Total Mass Flow, (MT)	3.87E+00	3.87E+00	3.87E+05	3.87E+01	3.87E+05	3.87E+05	5.15E+05		3.87E+01	3.87E+01
Total Cr, (MT)	1.44E-03	1.44E-03	1.44E+02	1.44E-02	1.44E+02	1.44E+02	1.44E+02		1.44E-02	1.44E-02
Total Na, (MT)	7.18E-01	7.18E-01	7.18E+04	7.18E+00	7.18E+04	7.18E+04	7.18E+04		7.18E+00	7.18E+00
Total Si, (MT)	1.07E+00	1.07E+00	1.07E+05	1.07E+01	1.07E+05	1.07E+05	1.07E+05		1.07E+01	1.07E+01
Total P, (MT)	1.35E-02	1.35E-02	1.35E+03	1.35E-01	1.35E+03	1.35E+03	1.35E+03		1.35E-01	1.35E-01
Total NO2-, (MT)										
Total NO3-, (MT)										
AG+										
AG2O	3.52E-06	3.52E-06	3.52E-01	3.52E-05	3.52E-01	3.52E-01	3.52E-01		3.52E-05	3.52E-05
AL+3										
AL2O3	1.94E-01	1.94E-01	1.94E+04	1.94E+00	1.94E+04	1.94E+04	1.94E+04		1.94E+00	1.94E+00
AM+3										
AM2O3	2.75E-08	2.75E-08	2.76E-03	2.76E-07	2.76E-03	2.76E-03	2.76E-03		2.76E-07	2.76E-07
AS+5										
AS2O5	1.18E-05	1.18E-05	1.18E+00	1.18E-04	1.18E+00	1.18E+00	1.18E+00		1.18E-04	1.18E-04
B+3										
B2O3	1.67E-05	1.67E-05	1.67E+00	1.67E-04	1.67E+00	1.67E+00	1.67E+00		1.67E-04	1.67E-04
BA+2										
BAO	8.81E-06	8.81E-06	8.81E-01	8.82E-05	8.82E-01	8.82E-01	8.81E-01		8.82E-05	8.82E-05
BE+2										
BEO	2.27E-06	2.27E-06	2.27E-01	2.27E-05	2.27E-01	2.27E-01	2.27E-01		2.27E-05	2.27E-05
BI+3										
BI2O3	7.52E-04	7.52E-04	7.52E+01	7.52E-03	7.52E+01	7.52E+01	7.52E+01		7.52E-03	7.52E-03
C14										
CA+2										
CANCRIN1										
CAO	3.87E-01	3.87E-01	3.87E+04	3.87E+00	3.87E+04	3.87E+04	3.87E+04		3.87E+00	3.87E+00
CD+2										
CDO	2.38E-05	2.38E-05	2.38E+00	2.38E-04	2.38E+00	2.38E+00	2.38E+00		2.38E-04	2.38E-04
CE+3										
CE2O3	2.79E-05	2.79E-05	2.79E+00	2.79E-04	2.79E+00	2.79E+00	2.79E+00		2.79E-04	2.79E-04
CL-										
CO3-2										
CR+3										
CR2O3	2.10E-03	2.10E-03	2.11E+02	2.11E-02	2.11E+02	2.11E+02	2.11E+02		2.11E-02	2.11E-02
CS+										

21/23 19/11

Stream Name / Solid Component	435	436	437	438	439	440	441	442	443	444
CS2O	6.82E-08	6.82E-08	6.83E-03	6.83E-07	6.83E-03	6.83E-03	6.83E-03		6.83E-07	6.83E-07
CU										
CU+2										
CUO	2.21E-06	2.21E-06	2.21E-01	2.21E-05	2.21E-01	2.21E-01	2.21E-01		2.21E-05	2.21E-05
CUSO4										
F-										
FE+3										
FE2O3	2.06E-04	2.06E-04	2.06E+01	2.06E-03	2.06E+01	2.06E+01	2.06E+01		2.06E-03	2.06E-03
HG+2										
I-										
K+										
K2O	2.65E-06	2.65E-06	2.65E-01	2.65E-05	2.65E-01	2.65E-01	2.65E-01		2.65E-05	2.65E-05
LA+3										
LA2O3	2.58E-06	2.58E-06	2.58E-01	2.58E-05	2.58E-01	2.58E-01	2.58E-01		2.58E-05	2.58E-05
LI+										
LI2O	1.24E-07	1.24E-07	1.24E-02	1.24E-06	1.24E-02	1.24E-02	1.24E-02		1.24E-06	1.24E-06
MG+2										
MGO	1.60E-05	1.60E-05	1.60E+00	1.60E-04	1.60E+00	1.60E+00	1.60E+00		1.60E-04	1.60E-04
MNO2	2.16E-04	2.16E-04	2.16E+01	2.16E-03	2.16E+01	2.16E+01	2.16E+01		2.16E-03	2.16E-03
MO+6										
MOO3	7.29E-05	7.29E-05	7.29E+00	7.29E-04	7.29E+00	7.29E+00	7.29E+00		7.29E-04	7.29E-04
NA+										
NA2O	9.68E-01	9.68E-01	9.68E+04	9.68E+00	9.68E+04	9.68E+04	9.68E+04		9.68E+00	9.68E+00
NI+3										
NI2FECN6										
NI2O3	5.72E-05	5.72E-05	5.72E+00	5.72E-04	5.72E+00	5.72E+00	5.72E+00		5.72E-04	5.72E-04
NIO	1.50E-07	1.50E-07	1.50E-02	1.50E-06	1.50E-02	1.50E-02	1.50E-02		1.50E-06	1.50E-06
NO2-										
NO3-										
NP+4										
NPO2	1.66E-07	1.66E-07	1.66E-02	1.66E-06	1.66E-02	1.66E-02	1.66E-02		1.66E-06	1.66E-06
OH-										
P2O5	3.09E-02	3.09E-02	3.09E+03	3.09E-01	3.09E+03	3.09E+03	3.09E+03		3.09E-01	3.09E-01
P2O5:24W										
PB+4										
PBO2	2.26E-05	2.26E-05	2.26E+00	2.26E-04	2.26E+00	2.26E+00	2.26E+00		2.26E-04	2.26E-04
PO4-3										
POLY										
PU+4										
PUO2	3.26E-07	3.26E-07	3.26E-02	3.26E-06	3.26E-02	3.26E-02	3.26E-02		3.26E-06	3.26E-06
S							1.28E+05			
SI+4										
SIO2	2.29E+00	2.29E+00	2.29E+05	2.29E+01	2.29E+05	2.29E+05	2.29E+05		2.29E+01	2.29E+01
SO4-2										
SR+2										
SRO	4.00E-06	4.00E-06	4.00E-01	4.00E-05	4.00E-01	4.00E-01	4.00E-01		4.00E-05	4.00E-05

Stream Name Solid Components	435	436	437	438	439	440	441	442	443	444
TC2O7	2.39E-05	2.39E-05	2.39E+00	2.39E-04	2.39E+00	2.39E+00	2.39E+00		2.39E-04	2.39E-04
TCO4-										
TOC										
UO2+2										
UO3	9.01E-04	9.01E-04	9.02E+01	9.02E-03	9.02E+01	9.02E+01	9.02E+01		9.02E-03	9.02E-03
V+5										
V2O5	1.10E-06	1.10E-06	1.11E-01	1.11E-05	1.11E-01	1.11E-01	1.11E-01		1.11E-05	1.11E-05
WO2	2.91E-10	2.91E-10	2.91E-05	2.91E-09	2.91E-05	2.91E-05	2.91E-05		2.91E-09	2.91E-09
WO3	9.40E-06	9.40E-06	9.40E-01	9.40E-05	9.40E-01	9.40E-01	9.40E-01		9.40E-05	9.40E-05
ZN+2										
ZNO	4.46E-05	4.46E-05	4.46E+00	4.46E-04	4.46E+00	4.46E+00	4.46E+00		4.46E-04	4.46E-04
ZR+4										
ZRO2	6.49E-06	6.49E-06	6.49E-01	6.49E-05	6.49E-01	6.49E-01	6.49E-01		6.49E-05	6.49E-05
ZRO2:2H2										

Comparison of LLW glass from TPA material balance Rev A versus Rev B

LLW glass is material balance Stream 437

Consitutents of Concern

		stream 437 Inventory Rev A MT	sream 437 Inventory Rev B MT		stream 437 inventory in grams
	Tc2O7	2.81	2.39	Tc	1526516
	UO3	9.74E+01	9.02E+01	U	75061538
	PuO2	9.46E-03	3.26E-02	Pu	28820.29
	NpO2	5.35E-03	1.66E-02	Np	14625.28

Inventory in LLW glass based on mass fraction in feed	grams	metric tons
Tc99	1526516	1.526516
Pu238	9.346429	9.35E-06
Pu239	26896.57	0.026897
Pu240	1863.687	0.001864
Pu241	50.68281	5.07E-05
Pu242	0.005495	5.49E-09
U233	0.058661	5.87E-08
U234	1.61748	1.62E-06
U235	496835.2	0.496835
U236	1.832832	1.83E-06
U237	6.73E-07	6.73E-13
U238	74564700	74.5647
Np237	14625.28	0.014625
Np238	1.14E-07	1.14E-13
Np239	1.28E-05	1.28E-11

FROM THE INVENTORY DATA

MASS OF RADIONUCLIDES (grams)

from inventory by tank grouping

	SSTs	DSTs	TOTAL	Fraction
Pu238	65.1	82.88	147.98	0.000324
Pu239	290791.6	135056	425847.6	0.933251
Pu240	18960.35	10547	29507.35	0.064666
Pu241	417.5	384.95	802.45	0.001759
Pu242	0.087		0.087	1.91E-07
total Pu			456305.5	
U233	1.125		1.125	7.82E-10
U234	31.02		31.02	2.15E-08
U235	9528294		9528294	0.006619
U236	35.15		35.15	2.44E-08
U237	1.29E-05		1.29E-05	8.96E-15
U238	1.43E+09		1.43E+09	0.993381
total Np			1.44E+09	
Np237	98913	64729	163642	1
Np238	1.28E-06		1.28E-06	7.82E-12
Np239	1.43E-04		0.000143	8.74E-10
total Np			163642	

The material balance is based on WHC inventory which is 12/31/99

The breakdown by isotope using tank by tank grouping data is decayed to 12/31/95\

23/23

TWRS EIS
CALCULATION COVER SHEET

DISCIPLINE & TITLE ENGINEERING - NOMINAL CASE RETRIEVAL LEAKAGE AND RESIDUAL INVENTORY - FEIS

ORIGINATOR Colin Henderson DATE 6/10/96

REVISION NO. ~~0~~ 1 6/24/96 CH.

OBJECTIVE ESTIMATE Nominal Case leakage estimates and residual inventories for use in Calculating the nominal or "best estimate" risk.

METHODOLOGY See ATTACHED.

ASSUMPTIONS See Attached.

(Continue on another sheet if necessary)

REV1. REVISED Metodology
Removed Np, Tc 99 solubility revised
Revised uranium inventory (nominal case) to equal base case. See pg 23

Col. Henderson 6/10/96.
SIGNATURE/DATE

Naresh Murthy 6/11/96
CHECKED/DATE

CALCULATION & RESULTS
ATTACHED

Approach to Nominal Case Tank Residuals and Retrieval Leakage

Tank Leakage During Retrieval

Background

Recent discussions with the DOE and other contractor staff indicate that the volume of leakage assumed for the Draft EIS is a reasonable nominal assumption. The assumption used in the Draft EIS of full solution strength for the assumed leakage volume is conservative.

The WHC Engineering data packages were developed assuming that the wastes would require dilution by approximately 2:1 on an overall basis during retrieval. Based on a 2:1 dilution one could expect that retrieval leakage concentrations could be reduced to 1/3 of the original estimated concentration. Since tank liquids would be recirculated from the retrieval annexes to the sluicing system during retrieval, reduction of the release concentrations by a factor of 1/3 would be a more conservative nominal case "best estimate".

Proposed

For the nominal case maintain the same estimate for leakage volume (e.g., 4,000 gallons for each SST) and reduce the estimated concentration of the leaks by 1/3 (e.g., to 2/3 of their original value).

Tank Residuals

Background

The Draft EIS is based on the assumption that during retrieval 99% of the current inventory would be recovered by the retrieval function, leaving 1% of the constituents behind as a residual. This is conservative because it does not account for recovery of the more soluble constituents during hydraulic retrieval operations.

Proposed

For the SSTs and DSTs, using the current residual inventory as a basis, reduce the inventory of mobile constituents of concern using sludge wash factors taken from WHC-EP-0616 (Tech. Options Report) modified as follows:

a. To account for conditions where the scale and hardened sludges do not see the sluicing liquid during retrieval the assumed % soluble in water is limited to a maximum of 90%.

b. Tc-99 as TcO4- is assigned a solubility of 90%.

c. The isotopes C-14, Tc-99, and I-129 are addressed in the nominal case analysis.

d. Solubility factors for Np are not included in this calculation because the nominal case analysis methodology includes revising the Kd value for Np from 0 to 1. Previous analysis has shown that constituents with a Kd value of 1 or greater do not reach the groundwater during the time frame analyzed.

e. The solubility of uranium during the retrieval operations would be expected to solubilize approximately 5% of the inventory. However, in order to simplify the

groundwater modeling analysis the nominal case inventory of uranium would be the same as the base case inventory (e.g., 1% of the original uranium inventory).

Assumptions:
1. Tank leakage during retrieval remains at 4,000 gallons/SST.
2. Assumed the following constituents relevant to the nominal case analysis based on previous results from the Ex Situ Intermediate Separations tank sources:
   C-14, I-129, Tc-99, U, nitrate,and nitrite.
3. Assumed that the leachate from the tank residuals would be constrained to solubilities that were no greater than the solubilities estimated for the base case which had 1% of the overall inventory in the residual. In other words, removal of the soluble constituents during the retrieval process would not increase the solubility of the remaining constituents. If this constraint were not applied the predicted solubility, using the nitrate congruent dissolution model, would be one order of magnitude higher than previously predicted because the nominal case nitrate residual is 10% of the base case.

Results:
See attached tables. Tables titled "Base Case" correspond to the original ex situ data based on 1% tank residuals. Tables titled "Nominal Case" correspond to the residual inventory that has been modified to account for removal of soluble constituents from the tank residuals. Nominal case tables report values only for constituents that were modified for the nominal case.

Table G1-1. Sludge Wash Factors, Assumed Percent Soluble in Water.

	CC	NCAW	NCRW	PFP	SST		CC	NCAW	NCRW	PFP	SST
Ag+	0%	9%	0%	0%	0%	Ni2Fe(CN)6	0%	0%	0%	0%	0%
Al+3	95%	48%	9%	2%	25%	NO2-	99%	97%	81%	99%	99%
Am+3	95%	2%	0%	0%	10%	NO3-	99%	99%	64%	99%	99%
As+5	0%	36%	0%	0%	0%	Np+4	0%	15%	0%	0%	10%
B+3	95%	27%	0%	0%	0%	OH-	93%	64%	18%	1%	78%
Ba+2	90%	3%	0%	0%	0%	Pb+4	0%	7%	0%	0%	0%
Be+2	0%	7%	0%	0%	0%	PO4-3	99%	92%	0%	60%	50%
Bi+3	0%	0%	0%	0%	25%	P2O5:24WO2:44H2O	0%	0%	0%	0%	0%
Cancrinite					0%	Pu+4	95%	4%	0%	0%	2%
^{14}C	0%	95%	20%	82%	99%	Rb+	0%	96%	0%	0%	0%
Ca+2	90%	3%	2%	15%	5%	Re+7	0%	11%	0%	0%	0%
Cd+2	0%	0%	0%	0%	50%	Rh+3	0%	14%	0%	0%	0%
Ce+3	0%	6%	0%	0%	1%	Ru+3	0%	9%	0%	0%	0%
Cl-	99%	96%	97%	95%	95%	Sb+5	0%	3%	0%	0%	0%
Cm+3	0%	2%	0%	0%	1%	Se+6	0%	39%	0%	0%	0%
Co+3	0%	6%	0%	0%	0%	Si+4	0%	43%	20%	3%	0%
CO3-2	99%	83%	80%	83%	90%	Sm+3	0%	1%	0%	0%	1%
Cr+3	95%	91%	2%	48%	10%	Sn+4	0%	0%	0%	0%	25%
Cs+	99%	97%	50%	95%	75%	SO4-2	99%	99%	44%	31%	98%
Cu+2	0%	5%	0%	0%	0%	Sr+2	95%	1%	0%	0%	1%
F-	99%	97%	93%	91%	95%	TcO4-	0%	81%	57%	99%	50%
Fe+3	95%	0%	0%	0%	1%	Te+6	0%	8%	0%	0%	0%
Hg+2	0%	0%	0%	0%	99%	Th+4	0%	5%	0%	0%	1%
I-	0%	47%	20%	99%	99%	Ti+4	0%	3%	0%	0%	0%
K+	99%	93%	78%	99%	0%	Tl+3	0%	6%	0%	0%	0%
La+3	90%	1%	0%	0%	1%	UO2+2	95%	61%	0%	52%	5%
Li+	0%	8%	0%	65%	0%	V+5	0%	36%	0%	0%	0%
Mg+2	90%	2%	0%	0%	0%	W+6	0%	0%	0%	0%	0%
MnO2	95%	0%	0%	0%	5%	Zn+2	90%	21%	0%	0%	0%
Mo+6	95%	94%	0%	0%	0%	Zr+4	0%	0%	0%	0%	0%
Na+	99%	97%	72%	91%	99%	ZrO2:2H2O	90%	0%	0%	0%	5%
Nb+5	0%	0%	0%	0%	0%						
Ni+3	95%	0%	0%	0%	0%						

Table 1. Base Case					
Radionuclide	**tank contents in grams**				
# of Tanks	40	43	40	16	10
Grams	1WSS	2WSS	1ESS	2ESS	4ESS
Ac-225	2.97E-11	4.96E-11	1.04E-10	3.87E-11	4.89E-11
Ac-227	7.16E-05	5.89E-05	1.22E-04	2.15E-05	3.83E-06
Am-241	4.96E+02	2.76E+03	2.18E+03	2.83E+03	1.35E+03
Am-242	3.33E-04	2.41E-03	2.34E-03	2.48E-03	1.08E-03
Am-242m	2.77E-01	2.00E+00	1.95E+00	2.07E+00	8.97E-01
Am-243	5.10E+00	3.93E+01	4.81E+01	5.85E+01	1.57E+01
At-217	1.07E-18	1.79E-18	3.75E-18	1.39E-18	1.76E-18
Ba-137m	1.57E-03	7.03E-03	6.59E-03	2.35E-04	2.54E-04
Bi-210	1.21E-13	9.36E-14	1.08E-13	5.67E-14	2.27E-14
Bi-211	1.24E-11	1.02E-11	2.12E-11	3.71E-12	6.62E-13
Bi-213	1.25E-10	2.08E-10	4.37E-10	1.63E-10	2.06E-10
Bi-214	1.38E-15	1.14E-15	1.18E-15	6.76E-16	3.58E-16
C-14	6.38E+01	1.10E+02	4.11E+02	4.83E+01	4.09E+01
Cm-242	6.73E-04	4.87E-03	4.73E-03	5.02E-03	2.18E-03
Cm-244	3.98E-02	2.96E-01	6.20E-01	6.61E-01	8.91E-02
Cm-245	1.21E-03	1.01E-02	2.22E-02	2.38E-02	3.21E-03
Cs-135	1.80E+04	5.90E+04	4.58E+04	1.40E+03	1.85E+03
Cs-137	1.03E+04	4.62E+04	4.33E+04	1.54E+03	1.67E+03
Fr-221	9.75E-15	1.63E-14	3.41E-14	1.27E-14	1.60E-14
Fr-223	1.85E-12	1.52E-12	3.16E-12	5.55E-13	9.90E-14
I-129	9.66E+03	2.49E+04	5.19E+04	3.39E+03	9.72E+02
Nb-93m	3.25E-01	2.57E+00	1.41E+00	1.54E+00	5.72E+00
Ni-59	0.00E+00	2.12E+04	4.12E+04	0.00E+00	0.00E+00
Ni-63	1.16E+02	8.27E+02	9.02E+02	9.99E+02	1.85E+03
Np-237	1.17E+04	1.56E+04	7.04E+04	4.78E+02	6.37E+02
Np-238	4.94E-08	3.58E-07	3.48E-07	3.69E-07	1.60E-07
Np-239	4.38E-06	3.37E-05	4.12E-05	5.02E-05	1.35E-05
Pa-231	2.04E-01	1.55E-01	3.23E-01	7.16E-02	1.35E-02
Pa-233	3.99E-04	5.31E-04	2.40E-03	1.63E-05	2.17E-05
Pa-234	1.38E-05	5.20E-06	1.31E-05	5.19E-06	1.33E-06
Pa-234m	2.51E-07	9.43E-08	2.38E-07	9.41E-08	2.40E-08
Pb-209	3.76E-11	6.27E-11	1.31E-10	4.89E-11	6.19E-11
Pb-210	1.97E-10	1.52E-10	1.75E-10	9.20E-11	3.68E-11
Pb-211	2.10E-10	1.72E-10	3.58E-10	6.28E-11	1.12E-11
Pb-214	1.85E-15	1.53E-15	1.59E-15	9.09E-16	4.81E-16
Pd-107	1.76E+04	4.53E+04	9.64E+04	7.13E+03	1.90E+03
Po-210	3.34E-12	2.58E-12	2.98E-12	1.57E-12	6.27E-13
Po-211	1.36E-16	1.12E-16	2.32E-16	4.07E-17	7.27E-18
Po-213	1.34E-22	2.23E-22	4.68E-22	1.74E-22	2.20E-22
Po-214	1.89E-22	1.56E-22	1.62E-22	9.26E-23	4.90E-23
Po-215	1.76E-16	1.44E-16	3.00E-16	5.26E-17	9.39E-18
Po-218	2.15E-16	1.78E-16	1.84E-16	1.05E-16	5.57E-17

Pu-238	1.23E+01	1.73E+01	1.08E+01	1.16E+01	1.31E+01
Pu-239	3.36E+04	5.80E+04	4.68E+04	7.82E+04	7.42E+04
Pu-240	1.80E+03	3.48E+03	3.06E+03	5.46E+03	5.15E+03
Pu-241	3.80E+01	6.17E+01	8.21E+01	1.28E+02	1.08E+02
Pu-242	3.37E-03	2.44E-02	2.37E-02	2.52E-02	1.09E-02
Ra-223	1.01E-07	8.32E-08	1.73E-07	3.03E-08	5.41E-09
Ra-225	4.40E-11	7.34E-11	1.54E-10	5.73E-11	7.24E-11
Ra-226	6.15E-08	5.09E-08	5.27E-08	3.02E-08	1.60E-08
Rh-106	1.72E-14	4.78E-12	2.32E-11	2.74E-11	1.12E-10
Rn-219	3.98E-13	3.28E-13	6.80E-13	1.19E-13	2.13E-14
Rn-222	3.95E-13	3.26E-13	3.38E-13	1.94E-13	1.02E-13
Ru-106	1.83E-08	5.08E-06	2.47E-05	2.91E-05	1.19E-04
Sb-126	9.50E-05	2.79E-04	8.04E-05	1.67E-04	4.31E-04
Sb-126m	7.22E-07	2.12E-06	6.11E-07	1.27E-06	3.27E-06
Se-79	1.39E+03	3.61E+03	7.49E+03	4.64E+02	1.37E+02
Sm-151	2.37E+03	7.00E+03	2.08E+03	3.84E+03	9.43E+03
Sn-126	2.00E+03	5.88E+03	1.69E+03	3.52E+03	9.07E+03
Sr-90	1.08E+04	1.03E+05	5.99E+04	3.53E+04	1.37E+05
Tc-99	6.92E+04	1.79E+05	3.72E+05	2.33E+04	6.80E+03
Th-227	1.66E-07	1.37E-07	2.84E-07	4.99E-08	8.89E-09
Th-229	8.14E-06	1.36E-05	2.84E-05	1.06E-05	1.34E-05
Th-230	4.45E-04	3.89E-04	3.72E-04	2.23E-04	1.54E-04
Th-231	1.36E-03	5.55E-04	1.31E-03	5.31E-04	1.32E-04
Th-234	7.44E-03	2.80E-03	7.06E-03	2.79E-03	7.14E-04
Tl-207	2.72E-11	2.24E-11	4.64E-11	8.15E-12	1.45E-12
Tl-209	9.11E-17	1.52E-16	3.18E-16	1.19E-16	1.50E-16
U-233	1.24E-01	1.82E-01	6.13E-01	8.37E-02	1.22E-01
U-234	7.86E+00	7.36E+00	6.91E+00	4.87E+00	4.04E+00
U-235	3.34E+06	1.36E+06	3.20E+06	1.30E+06	3.23E+05
U-236	3.35E+00	6.47E+00	5.67E+00	1.01E+01	9.55E+00
U-237	1.18E-06	1.91E-06	2.54E-06	3.96E-06	3.33E-06
U-238	5.12E+08	1.93E+08	4.85E+08	1.92E+08	4.91E+07
Y-90	2.80E+02	2.68E+03	1.55E+03	9.15E+02	3.54E+03
Zr-93	1.81E+04	3.19E+05	9.63E+04	2.24E+05	9.11E+05
End Table 1. Base Case					

Table 2. Base Case

	release concentration grams/cubic meter				
	1WSS	2WSS	1ESS	2ESS	4ESS
Ac-225	4.07E-16	3.92E-16	1.98E-15	5.40E-14	3.60E-15
Ac-227	9.80E-10	4.66E-10	2.33E-09	3.00E-08	2.82E-10
Am-241	6.78E-03	2.19E-02	4.16E-02	3.95E+00	9.92E-02
Am-242	4.56E-09	1.91E-08	4.46E-08	3.47E-06	7.94E-08
Am-242m	3.79E-06	1.59E-05	3.71E-05	2.88E-03	6.60E-05
Am-243	6.99E-05	3.11E-04	9.16E-04	8.16E-02	1.16E-03
At-217	1.47E-23	1.41E-23	7.13E-23	1.95E-21	1.30E-22
Ba-137m	2.15E-08	5.56E-08	1.26E-07	3.28E-07	1.87E-08
Bi-210	1.66E-18	7.40E-19	2.06E-18	7.91E-17	1.67E-18
Bi-211	1.70E-16	8.06E-17	4.03E-16	5.18E-15	4.88E-17
Bi-213	1.71E-15	1.65E-15	8.32E-15	2.27E-13	1.51E-14
Bi-214	1.89E-20	9.02E-21	2.25E-20	9.43E-19	2.63E-20
C-14	8.74E-04	8.71E-04	7.83E-03	6.74E-02	3.01E-03
Cm-242	9.21E-09	3.85E-08	9.01E-08	7.01E-06	1.60E-07
Cm-244	5.45E-07	2.34E-06	1.18E-05	9.23E-04	6.56E-06
Cm-245	1.65E-08	8.02E-08	4.24E-07	3.32E-05	2.36E-07
Cs-135	2.46E-01	4.67E-01	8.73E-01	1.96E+00	1.36E-01
Cs-137	1.41E-01	3.65E-01	8.25E-01	2.15E+00	1.23E-01
Fr-221	1.33E-19	1.29E-19	6.49E-19	1.77E-17	1.18E-18
Fr-223	2.53E-17	1.20E-17	6.02E-17	7.74E-16	7.29E-18
I-129	1.32E-01	1.97E-01	9.89E-01	4.73E+00	7.15E-02
Nb-93m	4.44E-06	2.03E-05	2.69E-05	2.15E-03	4.21E-04
Ni-59	0.00E+00	1.67E-01	7.85E-01	0.00E+00	0.00E+00
Ni-63	1.59E-03	6.54E-03	1.72E-02	1.39E+00	1.37E-01
Np-237	1.61E-01	1.24E-01	1.34E+00	6.68E-01	4.69E-02
Np-238	6.76E-13	2.83E-12	6.62E-12	5.15E-10	1.18E-11
Np-239	5.99E-11	2.67E-10	7.86E-10	7.00E-08	9.91E-10
Pa-231	2.79E-06	1.23E-06	6.16E-06	9.98E-05	9.94E-07
Pa-233	5.46E-09	4.20E-09	4.56E-08	2.27E-08	1.59E-09
Pa-234	1.89E-10	4.11E-11	2.50E-10	7.24E-09	9.77E-11
Pa-234m	3.43E-12	7.46E-13	4.53E-12	1.31E-10	1.77E-12
Pb-209	5.14E-16	4.96E-16	2.50E-15	6.83E-14	4.55E-15
Pb-210	2.69E-15	1.20E-15	3.34E-15	1.28E-13	2.71E-15
Pb-211	2.87E-15	1.36E-15	6.82E-15	8.77E-14	8.25E-16
Pb-214	2.54E-20	1.21E-20	3.02E-20	1.27E-18	3.54E-20
Pd-107	2.41E-01	3.58E-01	1.84E+00	9.95E+00	1.40E-01
Po-210	4.58E-17	2.04E-17	5.68E-17	2.18E-15	4.61E-17
Po-211	1.86E-21	8.84E-22	4.42E-21	5.69E-20	5.35E-22
Po-213	1.83E-27	1.77E-27	8.92E-27	2.43E-25	1.62E-26
Po-214	2.58E-27	1.23E-27	3.08E-27	1.29E-25	3.61E-27
Po-215	2.40E-21	1.14E-21	5.71E-21	7.34E-20	6.91E-22
Po-218	2.94E-21	1.40E-21	3.50E-21	1.47E-19	4.10E-21

Pu-238	1.68E-04	1.37E-04	2.06E-04	1.62E-02	9.63E-04
Pu-239	4.60E-01	4.59E-01	8.92E-01	1.09E+02	5.46E+00
Pu-240	2.47E-02	2.76E-02	5.82E-02	7.62E+00	3.79E-01
Pu-241	5.21E-04	4.88E-04	1.56E-03	1.79E-01	7.92E-03
Pu-242	4.62E-08	1.93E-07	4.52E-07	3.51E-05	8.04E-07
Ra-223	1.38E-12	6.58E-13	3.29E-12	4.23E-11	3.98E-13
Ra-225	6.02E-16	5.81E-16	2.93E-15	7.99E-14	5.33E-15
Ra-226	8.42E-13	4.02E-13	1.00E-12	4.21E-11	1.18E-12
Rh-106	2.36E-19	3.78E-17	4.43E-16	3.82E-14	8.23E-15
Rn-219	5.45E-18	2.59E-18	1.30E-17	1.67E-16	1.57E-18
Rn-222	5.40E-18	2.58E-18	6.44E-18	2.70E-16	7.54E-18
Ru-106	2.51E-13	4.02E-11	4.70E-10	4.06E-08	8.75E-09
Sb-126	1.30E-09	2.21E-09	1.53E-09	2.33E-07	3.17E-08
Sb-126m	9.88E-12	1.68E-11	1.16E-11	1.77E-09	2.41E-10
Se-79	1.91E-02	2.85E-02	1.43E-01	6.47E-01	1.01E-02
Sm-151	3.25E-02	5.54E-02	3.96E-02	5.36E+00	6.94E-01
Sn-126	2.74E-02	4.65E-02	3.23E-02	4.91E+00	6.68E-01
Sr-90	1.48E-01	8.14E-01	1.14E+00	4.92E+01	1.01E+01
Tc-99	9.48E-01	1.42E+00	7.09E+00	3.24E+01	5.01E-01
Th-227	2.28E-12	1.08E-12	5.41E-12	6.96E-11	6.55E-13
Th-229	1.11E-10	1.07E-10	5.42E-10	1.48E-08	9.86E-10
Th-230	6.10E-09	3.08E-09	7.08E-09	3.12E-07	1.13E-08
Th-231	1.87E-08	4.39E-09	2.49E-08	7.41E-07	9.71E-09
Th-234	1.02E-07	2.22E-08	1.34E-07	3.90E-06	5.26E-08
Tl-207	3.72E-16	1.77E-16	8.84E-16	1.14E-14	1.07E-16
Tl-209	1.25E-21	1.20E-21	6.07E-21	1.65E-19	1.10E-20
U-233	1.70E-06	1.44E-06	1.17E-05	1.17E-04	9.00E-06
U-234	1.08E-04	5.82E-05	1.32E-04	6.79E-03	2.97E-04
U-235	4.57E+01	1.07E+01	6.10E+01	1.81E+03	2.38E+01
U-236	4.58E-05	5.12E-05	1.08E-04	1.41E-02	7.03E-04
U-237	1.61E-11	1.51E-11	4.84E-11	5.53E-09	2.45E-10
U-238	7.00E+03	1.52E+03	9.24E+03	2.68E+05	3.61E+03
Y-90	3.83E-03	2.12E-02	2.96E-02	1.28E+00	2.61E-01
Zr-93	2.47E-01	2.52E+00	1.83E+00	3.13E+02	6.71E+01
End Table 2. Base Case					

9/23

Table 1. Nominal Case						
NOMINAL CASE						
Radionuclide Tank Residual Inventory (modified for solubility based on sludge wash factors)						
# of Tanks	40	43	40	16	10	
grams	1WSS	2WSS	1ESS	2ESS	4ESS	
C-14	**6.38E-02**	**1.10E-01**	**4.11E-01**	**4.83E-02**	**4.09E-02**	
I-129	**9.66E+00**	**2.49E+01**	**5.19E+01**	**3.39E+00**	**9.72E-01**	

10/23

Tc-99	6.92E+01	1.79E+02	3.72E+02	2.33E+01	6.80E+00	
U-233	1.24E-03	1.82E-03	6.13E-03	8.37E-04	1.22E-03	
U-234	7.86E-02	7.36E-02	6.91E-02	4.87E-02	4.04E-02	
U-235	3.34E+04	1.36E+04	3.20E+04	1.30E+04	3.23E+03	
U-236	3.35E-02	6.47E-02	5.67E-02	1.01E-01	9.55E-02	
U-237	1.18E-08	1.91E-08	2.54E-08	3.96E-08	3.33E-08	
U-238	5.12E+06	1.93E+06	4.85E+06	1.92E+06	4.91E+05	

End Table 1. Nominal Case

11/23

Table 2.Nominal Case						
Radionuclide Tank Residual Inventory Solubility (modified						
for solubility based on sludge wash factors), GRAMS/M^3						
# of Tanks	40	43	40	16	10	
	1WSS	2WSS	1ESS	2ESS	4ESS	
C-14	8.74E-04	8.71E-04	7.82E-03	6.72E-02	3.01E-03	
I-129	1.32E-01	1.97E-01	9.88E-01	4.71E+00	7.15E-02	

12/23

Tc-99	9.48E-01	1.42E+00	7.08E+00	3.23E+01	5.01E-01	
U-233	1.70E-06	1.44E-06	1.17E-05	1.17E-04	9.00E-06	
U-234	1.08E-04	5.82E-05	1.32E-04	6.79E-03	2.97E-04	
U-235	4.57E+01	1.07E+01	6.10E+01	1.81E+03	2.38E+01	
U-236	4.58E-05	5.12E-05	1.08E-04	1.41E-02	7.03E-04	
U-237	1.61E-11	1.51E-11	4.84E-11	5.53E-09	2.45E-10	
U-238	7.00E+03	1.52E+03	9.24E+03	2.68E+05	3.61E+03	
End Table 2.Nominal Case						

Table 3. Base Case						
SST CHEM INVENTORY (METRIC TONS)						
Chemical	1WSS	2WSS	1ESS	2ESS	4ESS	Total
Al(OH)4-	~~4.54E+02~~	~~1.07E+03~~	~~7.19E+02~~	~~7.58E+01~~	~~1.81E+01~~	~~2.34E+03~~
Ba+2	~~3.58E-02~~	~~1.70E-01~~	~~1.02E-01~~	~~1.09E-01~~	~~1.90E-01~~	~~6.07E-01~~
Bi+3	1.66E+02	2.80E-01	9.43E+01	5.95E-01	0.00E+00	2.61E+02
CO3-2	7.07E+02	1.60E+02	6.40E+02	6.20E+01	3.80E+01	1.61E+03
Ca+2	1.98E-01	5.82E+00	5.47E+01	6.59E+01	1.54E+00	1.28E+02
Cd+2	8.63E-01	1.02E+00	1.16E+00	6.11E-01	1.78E-01	3.84E+00
Ce+3	1.16E+02	3.16E+01	8.82E+01	2.64E-01	1.75E+00	2.38E+02
Cl-	2.19E+01	5.41E+00	1.26E+01	4.01E-02	6.03E-02	4.00E+01
Cr+3	1.26E+00	8.33E+01	7.25E-01	1.65E-01	8.24E-01	8.63E+01
CrO4-2	3.12E-01	2.07E+01	1.80E-01	4.10E-02	2.04E-01	2.14E+01
F-	1.44E+02	3.00E+01	2.32E+02	4.00E+02	3.08E-01	8.06E+02
Fe+3	1.70E+02	8.18E+01	1.42E+02	5.55E+01	1.78E+02	6.27E+02
Fe(CN)6-4	2.19E+00	1.37E+00	2.48E+02	7.00E+01	5.30E-02	3.22E+02
Hg+	2.02E-01	2.40E-01	2.73E-01	1.43E-01	4.17E-02	9.00E-01
Mn+4	2.10E+01	1.13E+01	1.31E+01	5.12E+01	2.35E+01	1.20E+02
Na+	1.45E+04	2.11E+04	1.16E+04	2.10E+03	3.78E+03	5.31E+04
Ni+2	5.02E+00	3.33E+00	1.25E+02	4.40E+01	9.93E-01	1.78E+02
NO2-	1.76E+03	8.01E+02	2.06E+03	4.74E-01	2.32E+02	4.85E+03
NO3-	2.63E+04	4.55E+04	1.89E+04	2.59E+02	4.89E+03	9.59E+04
OH-	4.53E+02	2.30E+03	1.04E+03	1.42E+03	1.74E+02	5.39E+03
PO4-3	2.67E+03	1.10E+02	1.81E+03	2.98E+01	8.61E-01	4.62E+03
Pb	~~2.35E+00~~	~~3.86E+00~~	~~4.23E+02~~	~~6.82E+00~~	~~1.03E-01~~	~~4.36E+02~~
SiO3-	5.60E+02	2.40E+02	4.04E+02	7.07E-01	2.09E+00	1.21E+03
SO4-2	6.34E+02	2.48E+02	5.53E+02	1.34E+02	8.35E+01	1.65E+03
Sr+2	9.38E-04	6.98E-02	3.59E+01	2.53E-02	5.78E-02	3.60E+01
W+4	3.24E+00	3.84E+00	4.38E+00	2.30E+00	6.68E-01	1.44E+01
Zr+4	1.40E+01	2.31E+01	6.50E+00	2.03E+02	1.28E-01	2.46E+02

Table 4. Base Case, SST Release Solubility grams/meter^3					
(Based on congruent release model where					
solubility=(mass constituent/mass nitrate)*360,000 g/m^3					
	SOLUBILITY GRAMS/CU METER				
Chemical	1WSS	2WSS	1ESS	2ESS	4ESS
Al(OH)4-	~~6.23E+03~~	~~8.47E+03~~	~~1.37E+04~~	~~1.05E+05~~	~~1.34E+03~~
Ba+2	~~4.91E-01~~	~~1.34E+00~~	~~1.95E+00~~	~~1.52E+02~~	~~1.40E+01~~
Bi+3	2.28E+03	2.21E+00	1.79E+03	8.27E+02	0.00E+00
CO3-2	9.68E+03	1.27E+03	1.22E+04	8.62E+04	2.80E+03
Ca+2	2.72E+00	4.60E+01	1.04E+03	9.16E+04	1.13E+02
Cd+2	1.18E+01	8.07E+00	2.21E+01	8.49E+02	1.31E+01
Ce+3	1.59E+03	2.50E+02	1.68E+03	3.67E+02	1.29E+02
Cl-	3.00E+02	4.28E+01	2.40E+02	5.58E+01	4.44E+00
Cr+3	1.73E+01	6.59E+02	1.38E+01	2.30E+02	6.07E+01
CrO4-2	4.28E+00	1.63E+02	3.42E+00	5.69E+01	1.50E+01
F-	1.97E+03	2.38E+02	4.42E+03	5.56E+05	2.27E+01
Fe+3	2.33E+03	6.47E+02	2.70E+03	7.72E+04	1.31E+04
Fe(CN)6-4	3.00E+01	1.08E+01	4.72E+03	9.73E+04	3.90E+00
Hg+	2.77E+00	1.90E+00	5.19E+00	1.99E+02	3.07E+00
Mn+4	2.87E+02	8.92E+01	2.49E+02	7.12E+04	1.73E+03
Na+	1.99E+05	1.67E+05	2.20E+05	2.92E+06	2.78E+05
Ni+2	6.88E+01	2.64E+01	2.37E+03	6.12E+04	7.31E+01
NO2-	2.41E+04	6.33E+03	3.92E+04	6.59E+02	1.71E+04
NO3-	3.60E+05	3.60E+05	3.60E+05	3.60E+05	3.60E+05
OH-	6.20E+03	1.82E+04	1.98E+04	1.97E+06	1.28E+04
PO4-3	3.66E+04	8.70E+02	3.44E+04	4.14E+04	6.34E+01
Pb	3.22E+01	3.06E+01	8.04E+03	9.48E+03	7.60E+00
SiO3-	7.67E+03	1.90E+03	7.68E+03	9.83E+02	1.54E+02
SO4-2	8.68E+03	1.96E+03	1.05E+04	1.86E+05	6.15E+03
Sr+2	1.28E-02	5.52E-01	6.82E+02	3.52E+01	4.25E+00
W+4	4.44E+01	3.04E+01	8.33E+01	3.20E+03	4.92E+01
Zr+4	1.92E+02	1.83E+02	1.24E+02	2.82E+05	9.41E+00
NOTE: values with strike through are not reported on the WHC inventory					
data package.					

Table 3. Nominal Case					
NOMINAL CASE					
SST CHEM RESIDUAL INVENTORY (METRIC TONS)					
Chemical	1WSS	2WSS	1ESS	2ESS	4ESS
NO2-	1.76E+00	8.01E-01	2.06E+00	4.74E-04	2.32E-01
NO3-	2.63E+01	4.55E+01	1.89E+01	2.59E-01	4.89E+00

Table 4. Nominal Case					
NOMINAL CASE RESIDUAL SOLUBILITY					
BASED ON CONGRUENT DISSOLUTION (GRAMS/M^3)					
Chemical	1WSS	2WSS	1ESS	2ESS	4ESS
NO2-	**2.41E+04**	**6.33E+03**	**3.92E+04**	**6.59E+02**	**1.71E+04**
NO3-	**3.60E+05**	**3.60E+05**	**3.60E+05**	**3.60E+05**	**3.60E+05**

360,000

Table 5. Base Case, 1% Tank Residuals						
Radionuclides	3WDS		3EDS		5EDS	
(grams)	Soluble	Insoluble	Soluble	Insoluble	Soluble	Insoluble
C-14	0.00E+00	1.81E-03	7.64E-01	4.46E+00	1.18E-02	0.00E+00
Sr-90	1.55E+00	2.84E+00	4.62E+01	7.44E+02	9.66E-01	4.05E+00
Y-90	4.20E-02	7.69E-02	1.25E+00	2.01E+01	2.61E-02	1.09E-01
Tc-99	2.17E+03	0.00E+00	9.14E+03	2.36E+02	9.46E+02	0.00E+00
Cs-137	4.20E+02	4.52E+00	2.47E+03	6.29E+01	4.31E+02	1.92E+01
Ba-137	6.75E-05	7.27E-07	3.97E-04	1.01E-05	6.94E-05	3.09E-06
Eu-154	1.65E-02	1.66E-04	2.71E+00	7.33E-02	2.02E-02	0.00E+00
Np-237	0.00E+00	5.39E+00	9.60E+01	5.44E+02	1.45E+00	5.66E-01
Pu-238	0.00E+00	6.15E-01	9.68E-02	2.99E-03	8.21E-02	3.19E-02
Pu-239	3.27E+00	3.42E+02	1.97E+02	6.01E+02	1.01E+01	1.96E+02
Pu-240	2.23E-01	3.34E+01	1.35E+01	4.25E+01	6.91E-01	1.52E+01
Pu-241	1.11E-03	2.17E+00	8.69E-02	1.17E+00	3.35E-03	1.21E+00
Am-241	4.76E-01	3.42E+01	1.47E+01	1.56E+02	4.29E-01	1.02E+00

17/23

Table 6. Base Case				
SOLUBILITY IN GRAMS/CU M =(MASS NUCLIDE/MASS NO3)*360000				
Decayed to 12/31/1995				
Radionuclide		3WDS	3EDS	5EDS
NO3 (grams)		1.04E+09	2.20E+09	4.45E+09
C-14		6.27E-05	8.56E-02	9.52E-05
Sr-90		1.52E-01	1.29E+01	4.05E-02
Y-90		4.11E-03	3.49E-01	1.10E-03
Tc-99		7.50E+01	1.54E+02	7.66E+00
I-129		4.46E-02	1.52E-01	1.71E-02
Cs-137		1.47E+01	4.14E+01	3.65E+00
Ba-137		2.36E-06	6.66E-06	5.87E-07
Eu-154		5.61E-04	4.45E-02	1.60E-04
Np-237		1.86E-01	1.05E+01	1.63E-02
Pu-238		2.13E-02	1.63E-03	9.22E-04
Pu-239		1.20E+01	1.31E+01	1.67E+00
Pu-240		1.16E+00	9.17E-01	1.28E-01
Pu-241		6.23E-02	1.71E-02	8.12E-03
Am-241		1.20E+00	2.80E+00	1.17E-02

18/25

Table 5. Nominal Case			
Nominal Case			
RESIDUAL Modified based on Solubility			
Radionuclides	3WDS	3EDS	5EDS
(grams)			
C-14	0.0002	0.5227	0.0012
Tc-99	216.56	937.32	94.648
I-129	12.892	92.795	21.076

Table 6. Nominal Case			
Nominal Case Residual Solubility			
RESIDUAL Modified based on Solubility			
Radionuclides	3WDS	3EDS	5EDS
(GRAMS/M^3)			
C-14	6.27E-05	8.56E-02	9.52E-05
Tc-99	7.49E+01	1.54E+02	7.66E+00
I-129	4.46E-02	1.52E-01	1.71E-02

19/23

Table 7.Base Case								
DST CHEM INVENTORY (METRIC TONS)								
Chemical	5EDS		3EDS		3WDS		Total	
	Soluble	Insoluble	Soluble	Insoluble	Soluble	Insoluble	Soluble	Insoluble
Ag+	1.18E-01	1.32E+00	2.10E-01			5.80E-02	3.28E-01	1.38E+00
Al+3		4.29E+01		1.05E+01		1.44E+01		6.78E+01
As+5	7.44E-01	2.97E-01	2.60E-02			2.01E-01	7.70E-01	4.98E-01
B+3	1.01E-01	9.17E-01	6.64E-02		3.52E-01	7.66E-02	5.19E-01	9.94E-01
Ba+2	7.01E-01	2.41E+00	6.16E-02	6.80E-01	2.93E-02	3.26E-03	7.91E-01	3.09E+00
Be+2	5.97E-02	7.47E-03	2.22E-02	1.39E-04			8.19E-02	7.61E-03
Bi+3	1.74E+00		5.21E-01				2.26E+00	
Ca+2	5.19E+00	7.96E+00	6.02E-01	1.79E+00	4.48E+00	1.74E+00	1.03E+01	1.15E+01
Cd+2	9.68E-02	5.77E+00	7.05E-02			2.42E-01	1.67E-01	6.01E+00
Ce+3	2.26E-02	2.78E+00				2.64E-01	2.26E-02	3.04E+00
Cr+3		9.31E+00		7.84E-01		2.40E+01		3.41E+01
Cu+2	7.32E-02	4.05E-01	1.04E-01			3.42E-01	1.77E-01	7.46E-01
Fe+3	3.10E+00	1.32E+02	8.18E-01	1.92E+00	4.17E+00	8.27E+00	8.09E+00	1.42E+02
Hg+	5.75E-02		9.43E-04				5.84E-02	
K+	1.48E+02	1.79E+00	3.60E+02	1.80E+01	3.72E+01	3.76E-01	5.46E+02	2.02E+01
La+	2.19E-01	1.96E+01		1.35E+00		9.89E-02	2.19E-01	2.10E+01
Li+	2.13E-03	2.26E-02			3.64E-03	1.96E-03	5.77E-03	2.46E-02
Mg+2	5.26E-01	9.53E+00	3.92E-01	1.00E+00	4.67E-02	4.62E-01	9.65E-01	1.10E+01
Mn+4	6.11E+00	1.48E+01	1.53E-01	9.50E-01	1.42E+00	2.29E+00	7.69E+00	1.80E+01
Mo+6	3.82E+00	2.09E-01	2.72E-01	5.25E-01	7.85E-01	6.71E-02	4.87E+00	8.01E-01
Na+	6.00E+03	6.51E+01	2.80E+03	1.36E+02	2.13E+03	2.85E+01	1.09E+04	2.30E+02
Ni+2	3.34E+00	5.03E+00	1.81E-01	4.30E-01	5.54E-01	1.11E+00	4.07E+00	6.57E+00
Pb+4	5.63E-01	2.95E+00	1.39E+00			3.34E-01	1.96E+00	3.28E+00
Pd		1.20E+00						1.20E+00
SiO3-	1.03E+01	1.99E+02	5.13E+00	9.32E+00	7.15E-02	6.01E+00	1.55E+01	2.14E+02
UO2+2	2.19E+00	7.91E-01	1.36E+00	2.60E+01			3.54E+00	2.68E+01
V+5	6.20E-02	8.09E-03		1.66E-01		1.37E-02	6.20E-02	1.88E-01
W+6	7.47E-01						7.47E-01	
Zn+2	3.50E-01	4.20E-01	2.14E+00	2.80E-01	1.10E+00	2.45E-01	3.59E+00	9.45E-01
Zr+4	2.30E-01	1.85E+01	2.18E-01	2.58E+02		1.85E-01	4.48E-01	2.77E+02
Al(OH)4-2	2.44E+03		8.34E+02		1.19E+03		4.47E+03	
CO3-2	9.41E+02	5.17E+01	8.43E+02	3.00E+00	8.39E+01	3.61E+00	1.87E+03	5.83E+01
Cl-	1.47E+02	5.75E-01	5.24E+01	3.60E-02	7.41E+01	8.77E-01	2.73E+02	1.49E+00
Cr(OH)4-	4.06E+01		1.14E+01		6.01E+01		1.12E+02	
F-	3.56E+01	6.39E-01	3.02E+02	1.81E+01	8.63E+00	3.63E-01	3.46E+02	1.91E+01
SO4-2	2.77E+02	1.96E+00	7.10E+01	1.25E+00	3.83E+01	3.46E+00	3.86E+02	6.68E+00
NO3-	4.43E+03	2.04E+01	2.19E+03	8.28E+00	1.03E+03	1.04E+01	7.65E+03	3.91E+01
NO2-	1.94E+03	5.06E+00	8.88E+02	8.94E-01	2.44E+02	2.46E+00	3.07E+03	8.42E+00
PO4-3	7.13E+01	1.40E+01	7.44E+01	4.57E-01	6.63E+01	7.16E+00	2.12E+02	2.16E+01
OH-	9.99E+02	2.45E+01	6.97E+02	5.96E+01	2.03E+02	3.87E+01	1.90E+03	1.23E+02
TOC	8.08E+02	6.25E+01	5.48E+01	4.60E+00	1.28E+02	1.29E+00	9.90E+02	6.84E+01

Table 8. Base Case				
CHEMICAL SOLUBILITY GRAMS/CUBIC METER				
Chemical	5EDS	3EDS	3WDS	
Ag+	1.16E+02	3.43E+01	2.01E+01	
Al+3	3.47E+03	1.72E+03	5.00E+03	
As+5	8.42E+01	4.26E+00	6.97E+01	
B+3	8.23E+01	1.09E+01	1.48E+02	
Ba+2	2.52E+02	1.22E+02	1.13E+01	
Be+2	5.43E+00	3.66E+00	0.00E+00	
Bi+3	1.40E+02	8.53E+01	0.00E+00	
Ca+2	1.06E+03	3.92E+02	2.15E+03	
Cd+2	4.75E+02	1.16E+01	8.36E+01	
Ce+3	2.27E+02	0.00E+00	9.12E+01	
Cr+3	7.53E+02	1.28E+02	8.32E+03	
Cu+2	3.86E+01	1.71E+01	1.18E+02	
Fe+3	1.09E+04	4.48E+02	4.31E+03	
Hg+	4.65E+00	1.54E-01	0.00E+00	
K+	1.21E+04	6.19E+04	1.30E+04	
La+	1.60E+03	2.21E+02	3.42E+01	
Li+	2.00E+00	0.00E+00	1.94E+00	
Mg+2	8.13E+02	2.28E+02	1.76E+02	
Mn+4	1.69E+03	1.81E+02	1.28E+03	
Mo+6	3.26E+02	1.31E+02	2.95E+02	
Na+	4.91E+05	4.81E+05	7.48E+05	
Ni+2	6.77E+02	1.00E+02	5.75E+02	
Pb+4	2.84E+02	2.28E+02	1.16E+02	
Pd	9.70E+01	0.00E+00	0.00E+00	
SiO3-	1.69E+04	2.37E+03	2.10E+03	
UO2+2	2.41E+02	4.48E+03	0.00E+00	
V+5	5.67E+00	2.72E+01	4.74E+00	
W+6	6.04E+01	0.00E+00	0.00E+00	
Zn+2	6.23E+01	3.95E+02	4.66E+02	
Zr+4	1.51E+03	4.23E+04	6.39E+01	
Al(OH)4-2	1.97E+05	1.37E+05	4.13E+05	
CO3-2	8.03E+04	1.38E+05	3.03E+04	
Cl-	1.19E+04	8.59E+03	2.59E+04	
Cr(OH)4-	3.28E+03	1.87E+03	2.08E+04	
F-	2.93E+03	5.24E+04	3.11E+03	
SO4-2	2.26E+04	1.18E+04	1.45E+04	
NO3-	3.60E+05	3.60E+05	3.60E+05	
NO2-	1.57E+05	1.46E+05	8.51E+04	
PO4-3	6.91E+03	1.23E+04	2.54E+04	
OH-	8.28E+04	1.24E+05	8.37E+04	
TOC	7.04E+04	9.73E+03	4.46E+04	

Table 7. Nominal Case			
Nominal Case Residual Inventory			
DST CHEM INVENTORY (grams)			
Chemical	5EDS	3EDS	3WDS
UO2+2	2.98E+04	2.15E+04	0.00E+00
NO3-	4.45E+06	2.20E+06	1.04E+06
NO2-	1.95E+06	8.89E+05	2.46E+05

Table 8. Nominal Case			
Nominal Case Residual Solubility			
DST CHEM INVENTORY (GRAMS/M^3)			
Chemical	5EDS	3EDS	3WDS
UO2+2	2.41E+02	4.48E+03	0.00E+00
NO3-	3.60E+05	3.60E+05	3.60E+05
NO2-	1.57E+05	1.46E+05	8.53E+04

REVISIONS:

Rev 1. - Added I-129 Inventory to DSTs.
- Revised Tc-99 as TcO_4^- solubility from 50% to 90%.
- Removed Np isotopes from Nominal Case tables.
- Revised Uranium inventory for residual nominal case so to eliminate the 5% wash factor.

11 pages + Attachment
1/11

TWRS EIS
CALCULATION COVER SHEET

DISCIPLINE & TITLE Engineering - Selective Retrieval based on risk reduction

ORIGINATOR Colin Henderson DATE 6/2/96

REVISION NO. 0

OBJECTIVE Develop a method of selective retrieval based on retrieving the largest inventory of mobile radionuclides from the fewest number of tanks.

METHODOLOGY This calculation is a modification of a previous selective retrieval calculation dated 12/28/95 (attached) and follows the same methodology except includes the isotopes Np-237 and Se-79 in the sorting process.

ASSUMPTIONS See attached

(Continue on another sheet if necessary)

SIGNATURE/DATE

8/21/96

CHECKED/DATE

CALCULATION & RESULTS
ATTACHED

JACOBS\FORMS\CALCVR.SHT

JACOBS ENGINEERING GROUP INC.

DATE _____ SUBJECT _____ SHEET NO. 2/11

BY _____ CHKD. _____ JOB NO. _____

RISK REDUCTION SELECTIVE RETRIEVAL.

SORT BASED ON Np237, Tc99 AND U238.
OVER 25 TANKS PROVIDES

RECOVERY OF:

Tc99	85.3%
Np237	79.3%
C14	79.8%
I-129	64.1%
U238	50.6%
Se79	64.1%
U235	49.6%

SEE ATTACHED SPREAD SHEET TABLE

GIVEN MAX RISK TO RESIDENTIAL FARMER
NO ACTION ALTERNATIVE PROVIDES
THE FOLLOWING ILCI

C14	7E-2
I129	8E-3
Np237	5E-1
Se79	1E-2
Tc99	1E-1
U238	8E-2

Σ_i = 0.768

BASED ON RETRIEVAL of 99% (Volume) of those TANKS Selected for RETRIEVAL. The following RISK VALUES are Calculated:

FORM 91-005-1 (4/81)

JACOBS ENGINEERING GROUP INC.

DATE _____ SUBJECT _____ SHEET NO. 3/11

BY _____ CHKD. _____ JOB NO. _____

C-14 (1 - .798 X .99) X 7 E-2 = 1.5E-2 1.09 E-2
Np237 (1 - .793 x .99) X 5E-1 = 1.1E-1 ✓ 1.07 E-1
I129 (1 - .641 x .99) X 8E-3 = 2.92E-3 ✓
Se79 (1 - .641 x .99) X 1E-2 = 3.7E-3 ✓
Tc99 (1 - .853 x .99) X 1E-1 = 1.6E-2 ✓
U238 (1 - .506 x .99) X 8E-2 = 4.0E-2 ✓

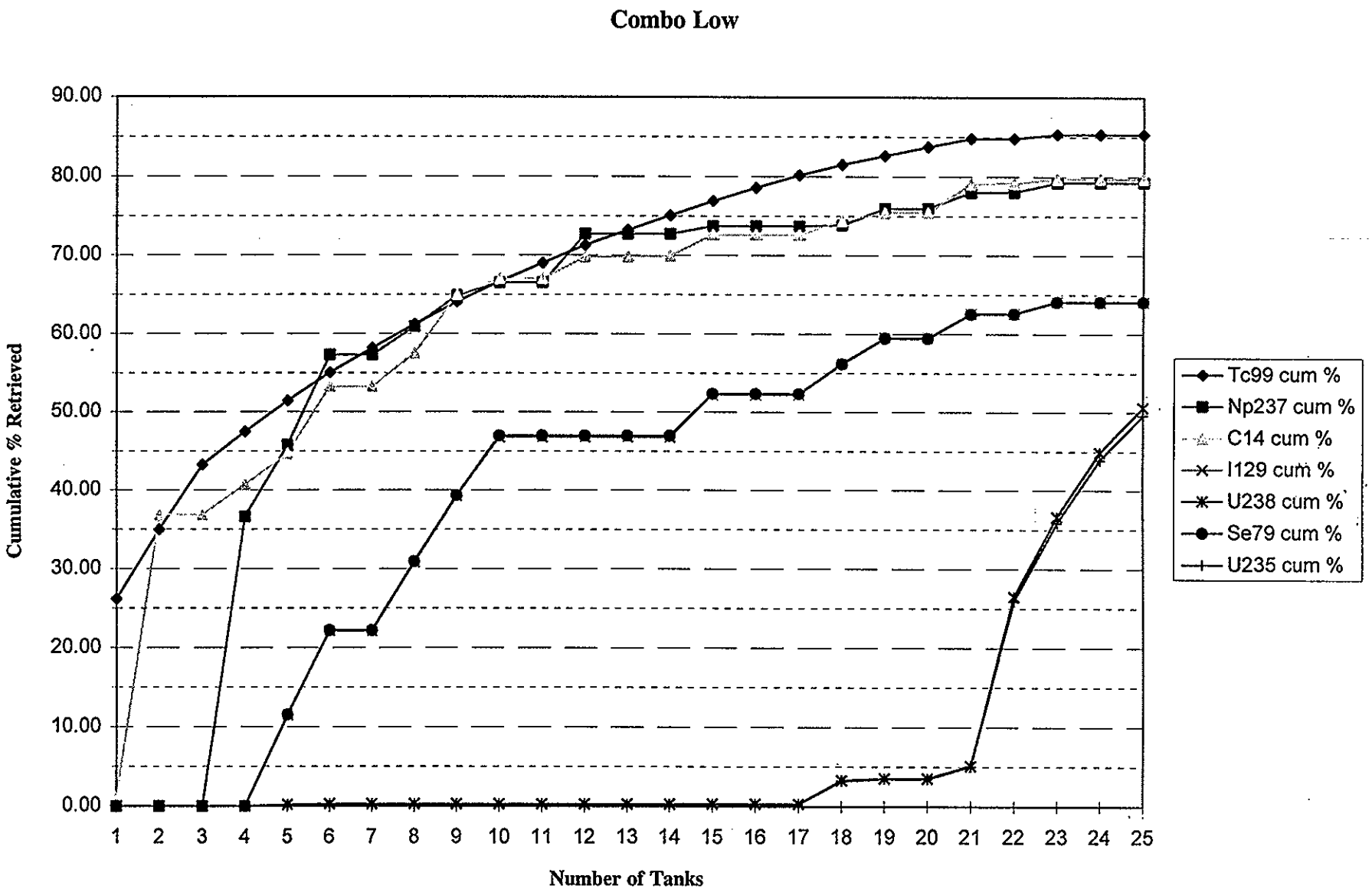
.1876
0.180 ✓

REDUCTION = $\frac{.768 - .1876}{.768} \times 100 = 76\%$ 76.5

OR REMAINING = 24% OF ORIGINAL RISK

TO THE NO ACTION RESIDENTIAL FARMER

FORM 91-005-1 (4/81)


Combo Low
Cumulative % Retrieved
90.00
80.00
70.00
60.00
50.00
40.00
30.00
20.00
10.00
0.00
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25
Number of Tanks
Tc99 cum %
Np237 cum %
C14 cum %
I129 cum %
U238 cum %
Se79 cum %
U235 cum %

4/11

combo low

	1	2	3	4	5	6	7	8	9	10	11	12
Radionuclide	102AN	107AN	103SY	101AZ	BX-104	B-111	101SY		BX-106		105-AN (1)	102AZ
Cumulative % T	26.18%	34.98%	43.24%	47.47%	51.42%	55.05%	58.19%	61.19%	64.06%	66.66%	68.99%	71.30%
Cumulative %	0.00%	0.00%	0.00%	36.64%	45.81%	57.31%	57.31%	60.92%	64.90%	66.50%	66.50%	72.74%
Cumulative %	1.29%	36.91%	36.91%	40.74%	44.72%	53.27%	53.27%	57.57%	64.98%	67.05%	67.05%	69.80%
Cumulative % I	2.46%	4.79%	6.40%	18.30%	23.12%	27.54%	31.71%	35.35%	38.86%	42.01%	46.32%	54.39%
Cumulative %	0.00%	0.00%	0.00%	0.00%	0.18%	0.27%	0.27%	0.27%	0.28%	0.29%	0.29%	0.29%
Se79 cum %	0.00%	0.00%	0.00%	0.00%	11.55%	22.21%	22.21%	30.94%	39.33%	46.96%	46.96%	46.96%
U235 cum %	0.00%	0.00%	0.00%	0.00%	0.17%	0.26%	0.26%	0.26%	0.27%	0.28%	0.28%	0.28%

12 DSTs
13 SSTs

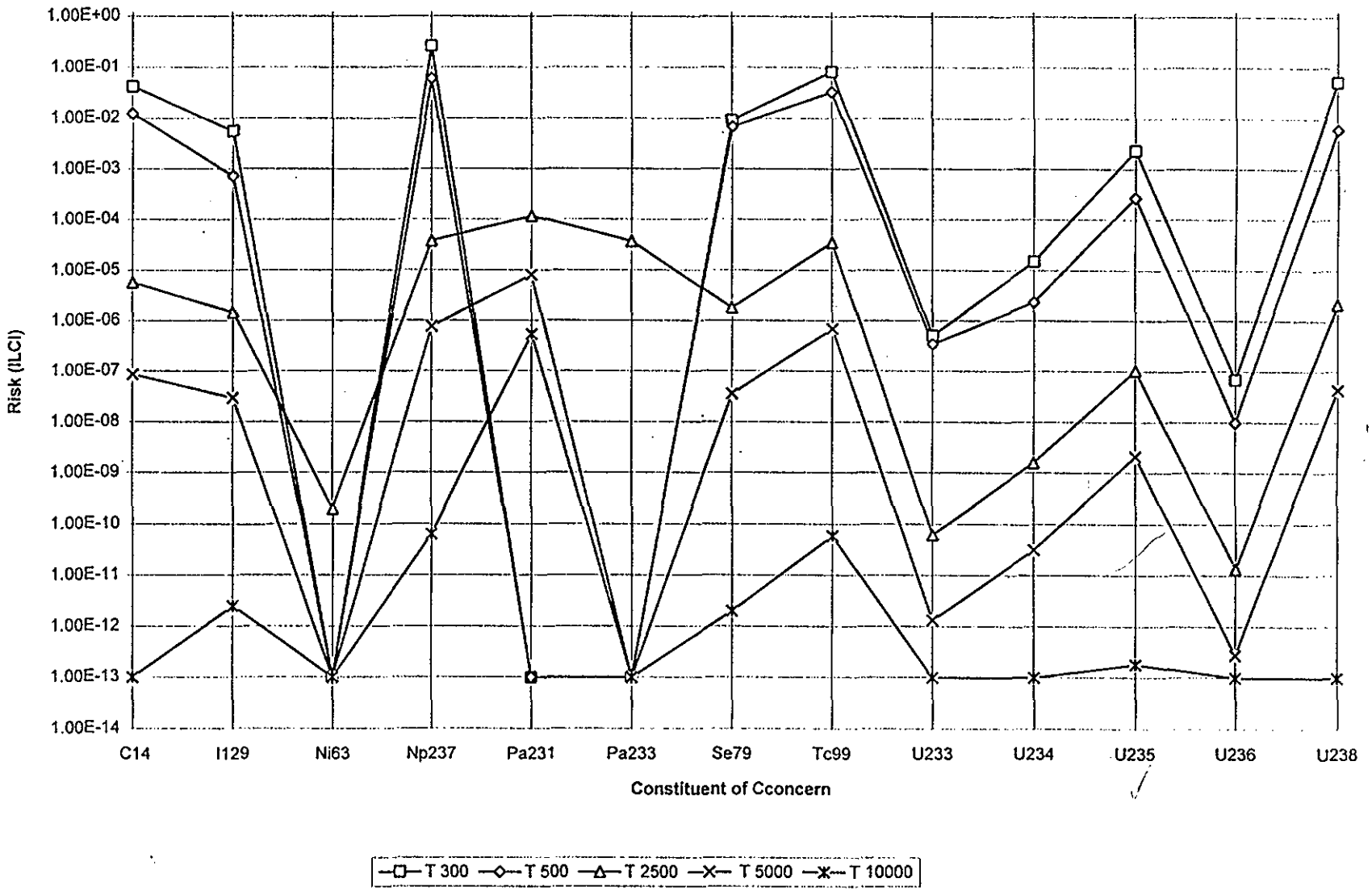
5/11

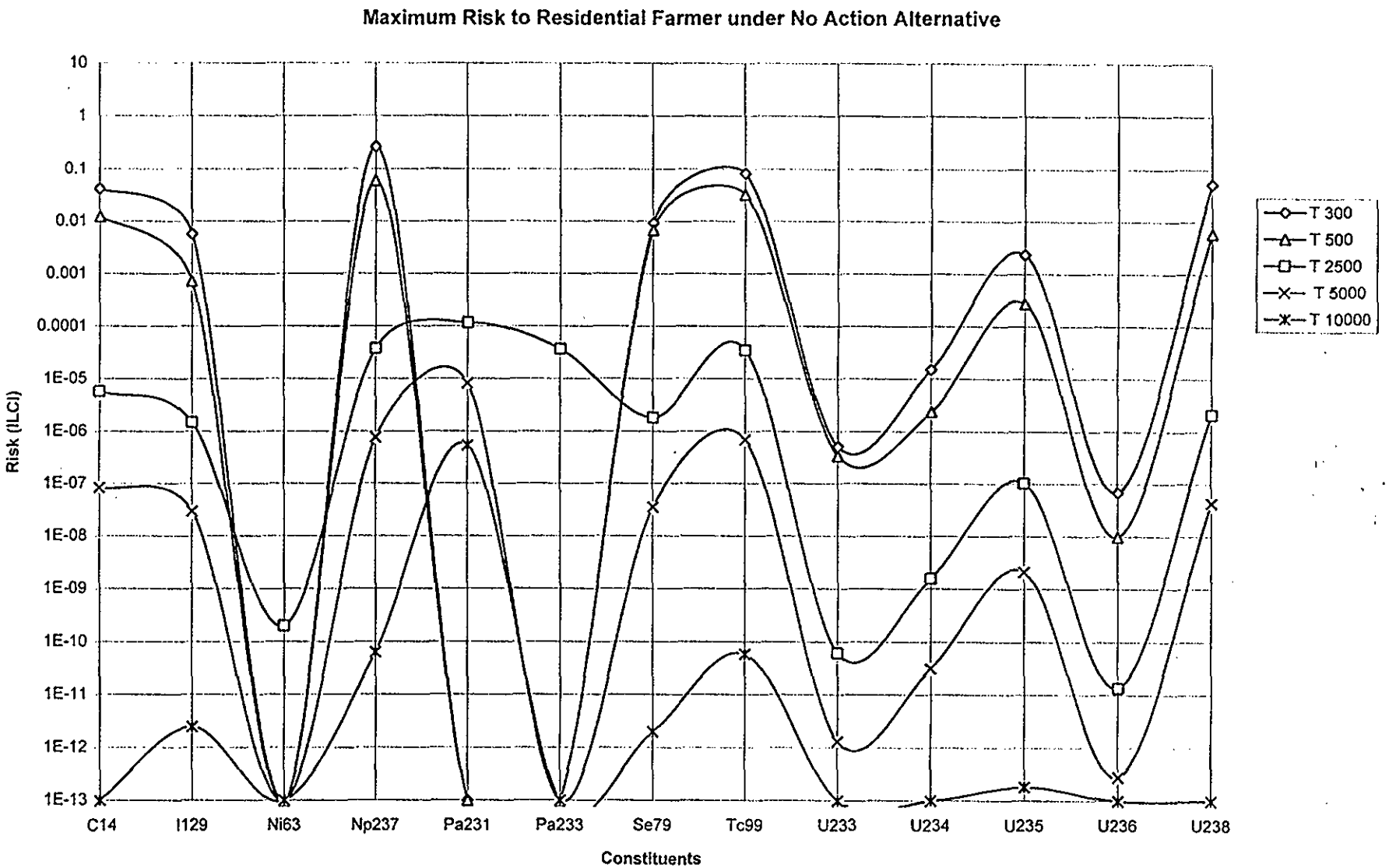
combo low

13	14	15	16	17	18	19	20	21	22	23	24	25
101AW	103-AN (2)	BX-105	104-AN (1)	101AY	C-105	TX-109	102AP	TX-118	TX-113	BY-104	BX-112	U-110
73.21%	75.09%	76.94%	78.60%	80.18%	81.51%	82.63%	83.74%	84.80%	84.81%	85.33%	85.33%	85.33%
72.74%	72.74%	73.74%	73.74%	73.74%	73.83%	75.99%	75.99%	78.05%	78.08%	79.26%	79.27%	79.28%
69.83%	69.96%	72.67%	72.67%	72.67%	74.40%	75.46%	75.50%	79.14%	79.18%	79.76%	79.77%	79.77%
58.64%	64.07%	66.34%	72.39%	73.70%	75.40%	76.76%	78.66%	79.94%	79.95%	80.59%	80.59%	80.59%
0.29%	0.29%	0.30%	0.30%	0.30%	3.28%	3.54%	3.54%	5.14%	26.52%	36.65%	44.87%	50.62%
46.96%	46.96%	52.36%	52.36%	52.36%	56.21%	59.47%	59.47%	62.54%	62.57%	64.09%	64.09%	64.09%
0.28%	0.28%	0.29%	0.29%	0.29%	3.22%	3.48%	3.48%	5.07%	25.95%	35.87%	43.89%	49.61%

6/11

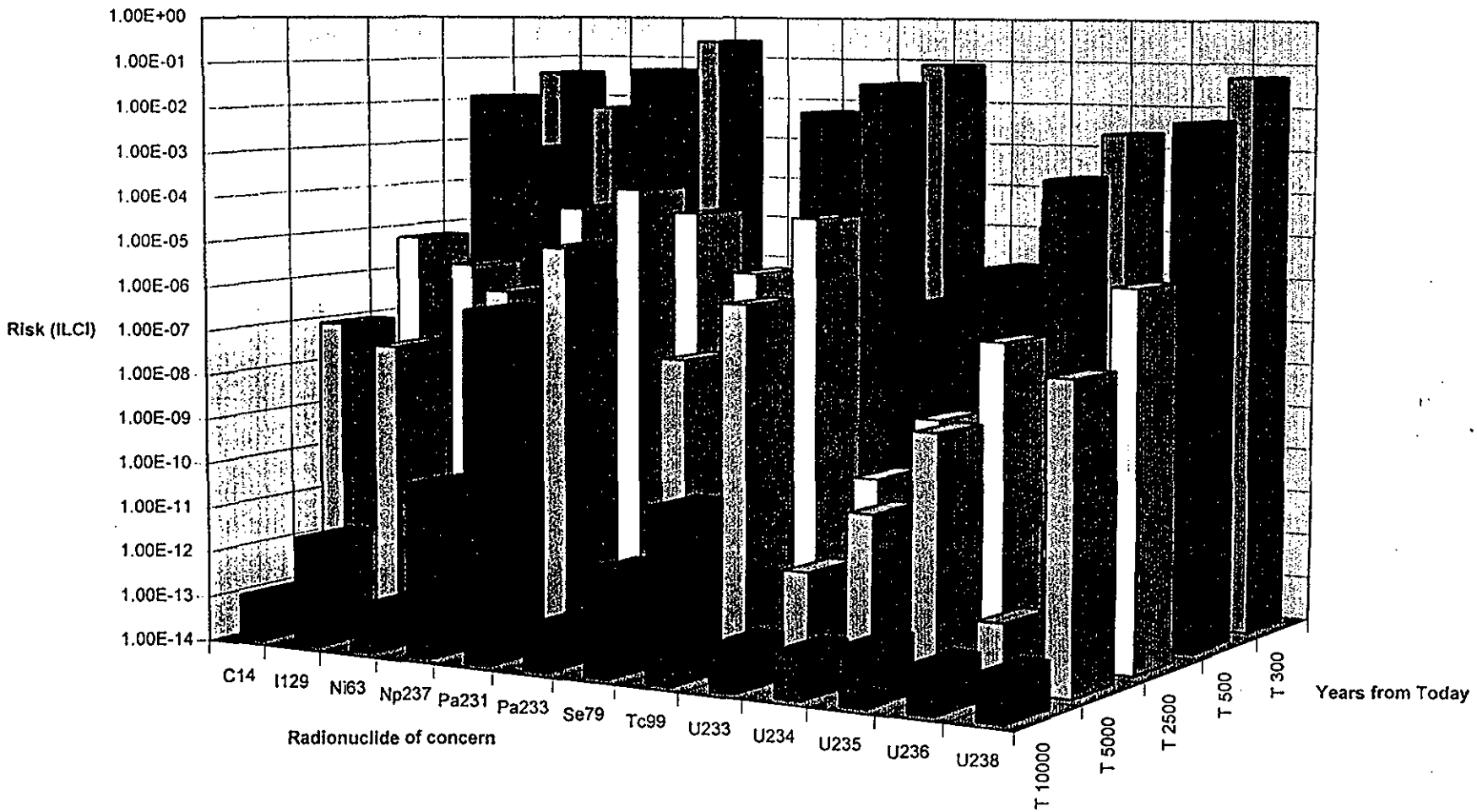
Figure 2. Maximum Risk to the Residential Farmer for No Action Alternative



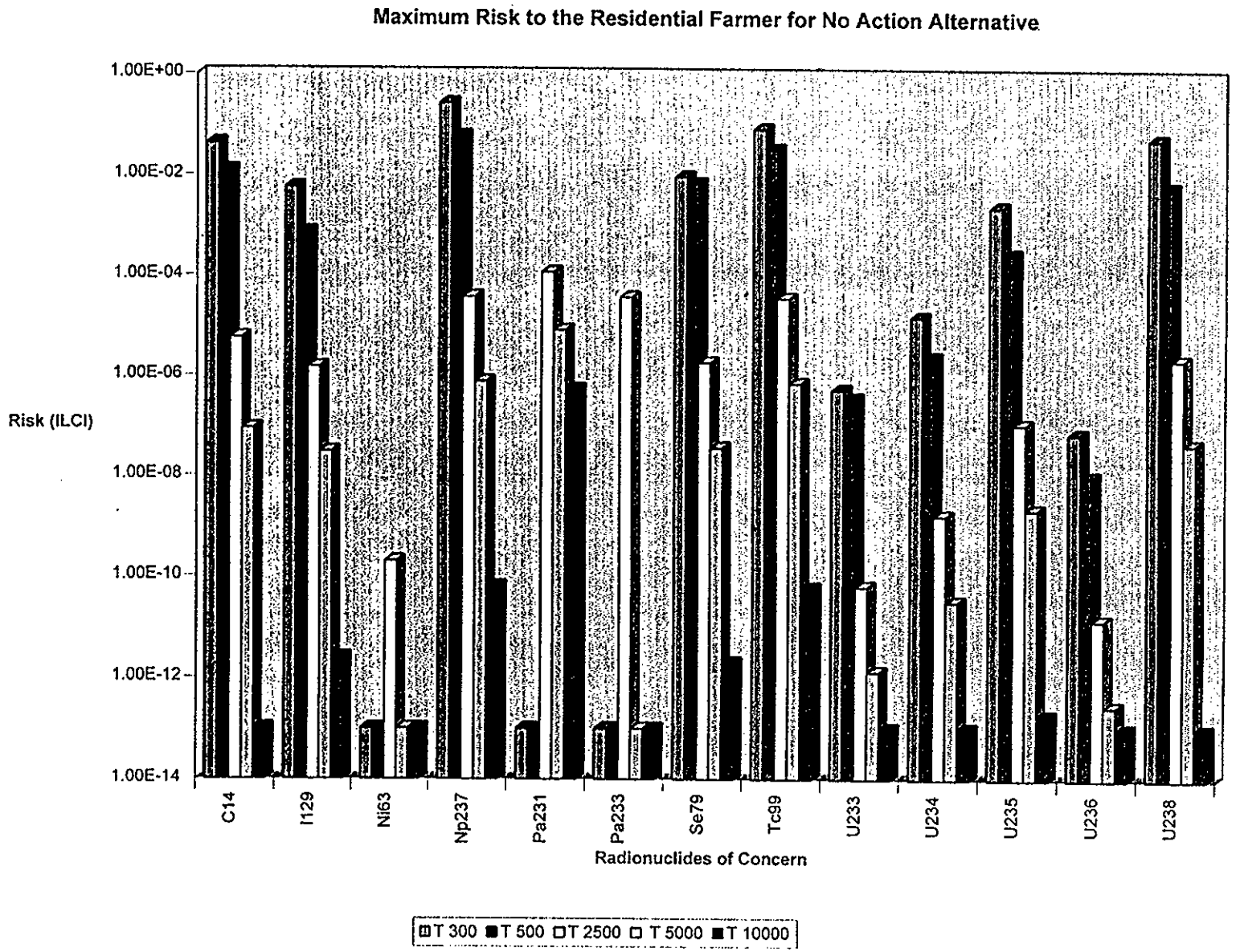

Maximum Risk to Residential Farmer under No Action Alternative
10
1
0.1
0.01
0.001
0.0001
1E-05
1E-06
1E-07
1E-08
1E-09
1E-10
1E-11
1E-12
1E-13
Risk (ILCI)
C14
I129
Ni63
Np237
Pa231
Pa233
Se79
Tc99
U233
U234
U235
U236
U238
Constituents
T 300
T 500
T 2500
T 5000
T 10000

11/8

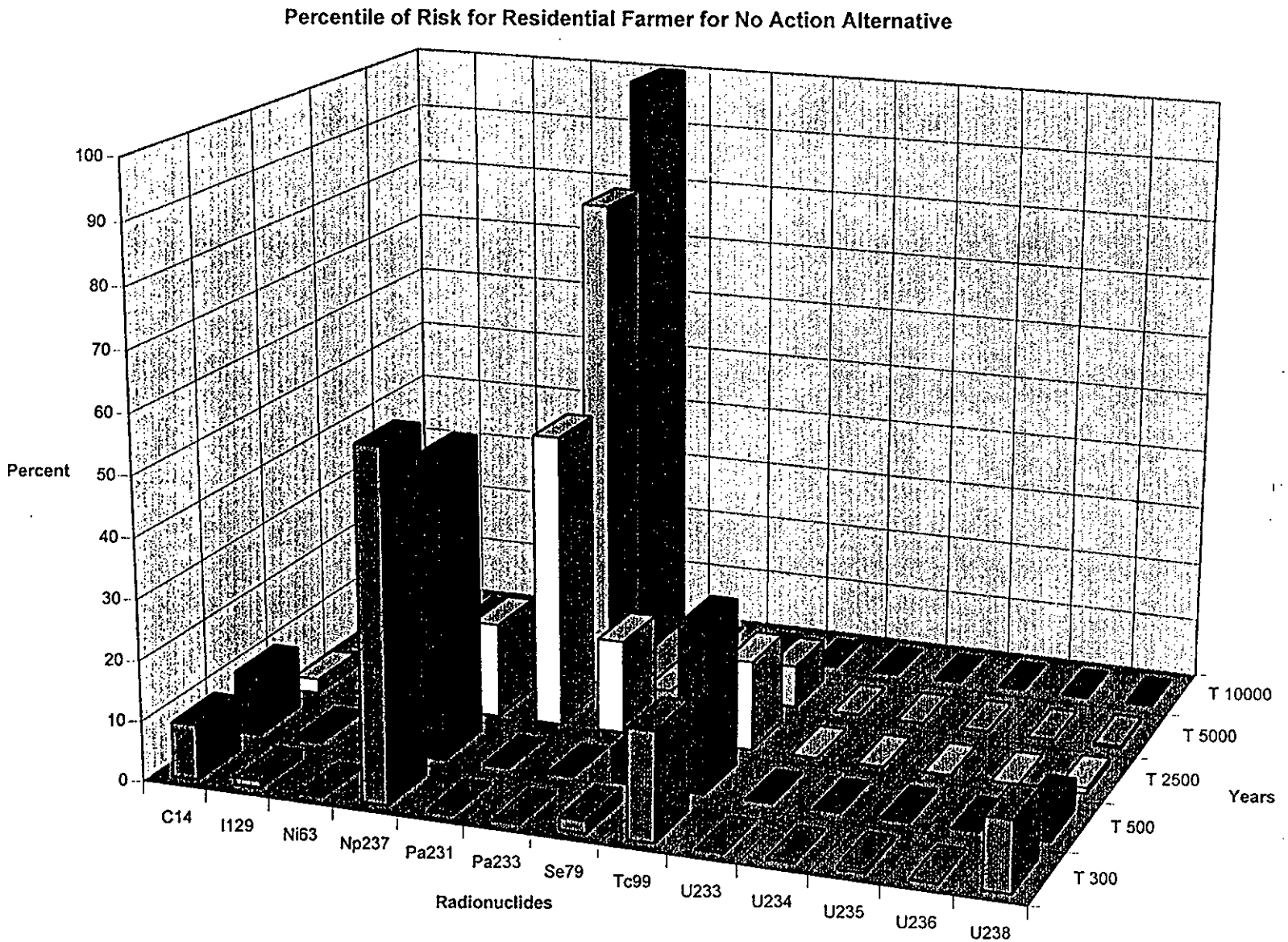
Maximum Risk to the Residential Farmer for No Action Alternative



9/11


Maximum Risk to the Residential Farmer for No Action Alternative
1.00E+00
1.00E-02
1.00E-04
1.00E-06
1.00E-08
1.00E-10
1.00E-12
1.00E-14
Risk (ILCI)
C14
I129
Ni63
Np237
Pa231
Pa233
Se79
Tc99
U233
U234
U235
U236
U238
Radionuclides of Concern
T 300
T 500
T 2500
T 5000
T 10000

10/11


Percentile of Risk for Residential Farmer for No Action Alternative
Percent
100
90
80
70
60
50
40
30
20
10
0
C14
I129
Ni63
Np237
Pa231
Pa233
Se79
Tc99
U233
U234
U235
U236
U238
Radionuclides
T 10000
T 5000
T 2500
T 500
T 300
Years

1/11

Attachment

TWRS EIS
CALCULATION COVER SHEET

DISCIPLINE & TITLE Engineering- Selective Retrieval Based on Risk Reduction

ORIGINATOR D. Murray DATE 12/28/95

REVISION NO. _____

OBJECTIVE See p2

METHODOLOGY See p2

ASSUMPTIONS See p2

(Continue on another sheet if necessary)

David J. Murray
SIGNATURE

CALCULATION & RESULTS ATTACHED

JACOBS\FORMS\CALCVR.SHT

Selective Retrieval Based on Risk Reduction

Objective: To develop a method of selective retrieval based on minimizing risk (expressed as cancer incidence) caused by mobile radionuclides.

Methodology:

1. Examine the risk caused by the mobile radionuclides (Tc-99 C-14, U-238 and I-129) and determine which of them is the primary contributor to risk.
2. Develop a selection process for both DSTs and SSTs which will rank the tanks in the decreasing order of the primary risk contributor.
3. Select the tanks for retrieval which contain the primary risk contributor, and retrieve 99% of the contents of those tanks, until a point of diminishing returns is reached.
4. Provide the results in tabular and graphical form for use by other disciplines to determine costs, accidents, etc.

Assumptions:

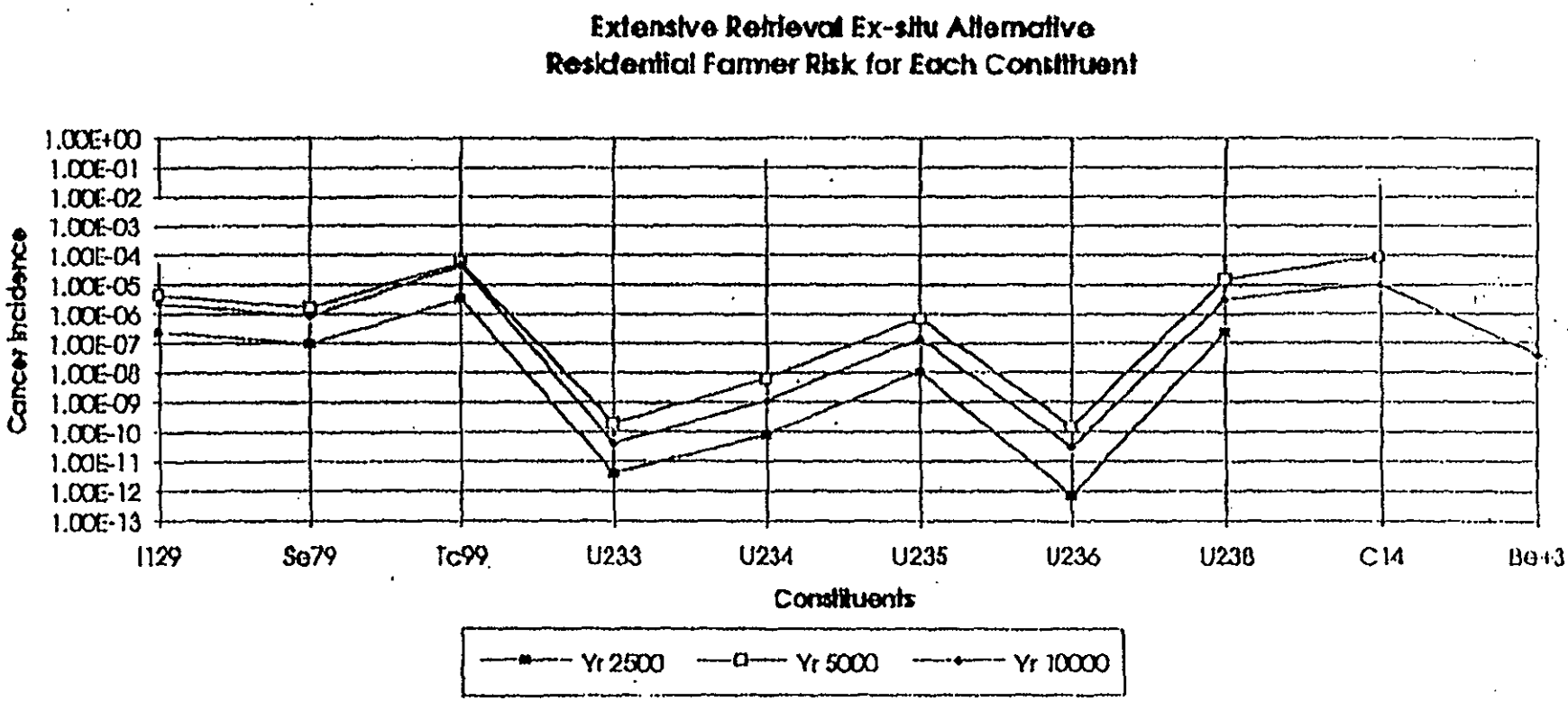
1. That the quantities given in g-moles for the SST spreadsheets for tank-by-tank inventories can be converted to Ci which will agree with the data in the Inventory Data Package.
2. The total risk is the sum of the risks from each of the radionuclides.

Results:

1. The primary contributors to risk to the residential farmer at 5,000 years caused by the residues remaining after retrieval Tc-99, C-14, U-238 and I-129. These are shown on the graph marked TPASORT.XLS Chart 1.
2. The risk contributors have been ranked according to the per cent of risk that each contributes on the table "Risk To Residential Farmer From Tank Residues, 5,000 Years." Tc-99 and C-14 each contribute 46% of the risk, U-238 contributes 5%, and I-129 contributes 3%. This table also shows Curies, risk per Ci, and relative risk per Ci. A Curie of C-14 has 6 times the risk as a Curie of Tc-99.
3. Previous investigations of selective retrieval have shown that retrieving Tc-99 will also retrieve almost an equal quantity of C-14. Since it would not be a practical matter to retrieve the C-14 (there is no practicable way of immobilizing it), the ranking and selection process was based on Tc-99.
4. The Tc-99 content of the SSTs was converted to Ci by using the conversion factor 16,600 g-moles = 11,000 Ci. The tanks were then ranked in descending order of Tc-99 content, and the cumulative percentage of Tc-99 recovery was calculated as a function of the number of tanks retrieved. The results of this ranking and recovery process are shown on the graph titled "Tc-99 Ci Retrieved from SSTs & DSTs." This graph shows that by the time 23 tanks have been retrieved, 85% of the Tc-99 will have been recovered for further processing. The details of the ranking and recovery process are shown on the chart titled "Retrieval of Mobile Radionuclides from DSTs and SSTs". The lines in the chart showing Ci, % of total (next to the bottom line for each radionuclide) represent the percent retrieved from each particular tank. As an

example, for tank 10 (SX-103) this is 2.57+ %. This means that Tc-99 recovery has increase by 2.57% by retrieving tank 10. An examination of the chart shows that the incremental recovery is 1.04% for tank 21, and after that it starts to drop below one per cent. For purposes of this calculation, the recovery process was terminated after 23 tanks.

5. The results of the ranking and recovery process on the remaining mobile radionuclides are shown on the chart titled "Per Cent Curies Retrieved From SSTs & DSTs." The recovery of C-14 is 79%, the recovery of I-129 is 66%, and the recovery of U-238 is 5%.
6. The number of Curies retrieved by the ranking and recovery process is shown on the graph titled "Curies Retrieved From SSTs & DSTs." The Curies recovered from Tc-99 are 2.75E+04, from C-14 they are 4.24E+03, from U-238 they are 2.64E+01, and from I-129 they are 1.07E+01.
7. A calculation of risk reduction is also shown in tabular form in the table titled "Risk Reduction, Sample Calculation." This shows that the risk has been reduced to 4.72E-05, which is 22% of the original value of 2.14E-04.


Extensive Retrieval Ex-situ Alternative
Residential Farmer Risk for Each Constituent
Cancer Incidence
1.00E+00
1.00E-01
1.00E-02
1.00E-03
1.00E-04
1.00E-05
1.00E-06
1.00E-07
1.00E-08
1.00E-09
1.00E-10
1.00E-11
1.00E-12
1.00E-13
I129
Se79
Tc99
U233
U234
U235
U236
U238
C14
Be+3
Constituents
Yr 2500
Yr 5000
Yr 10000

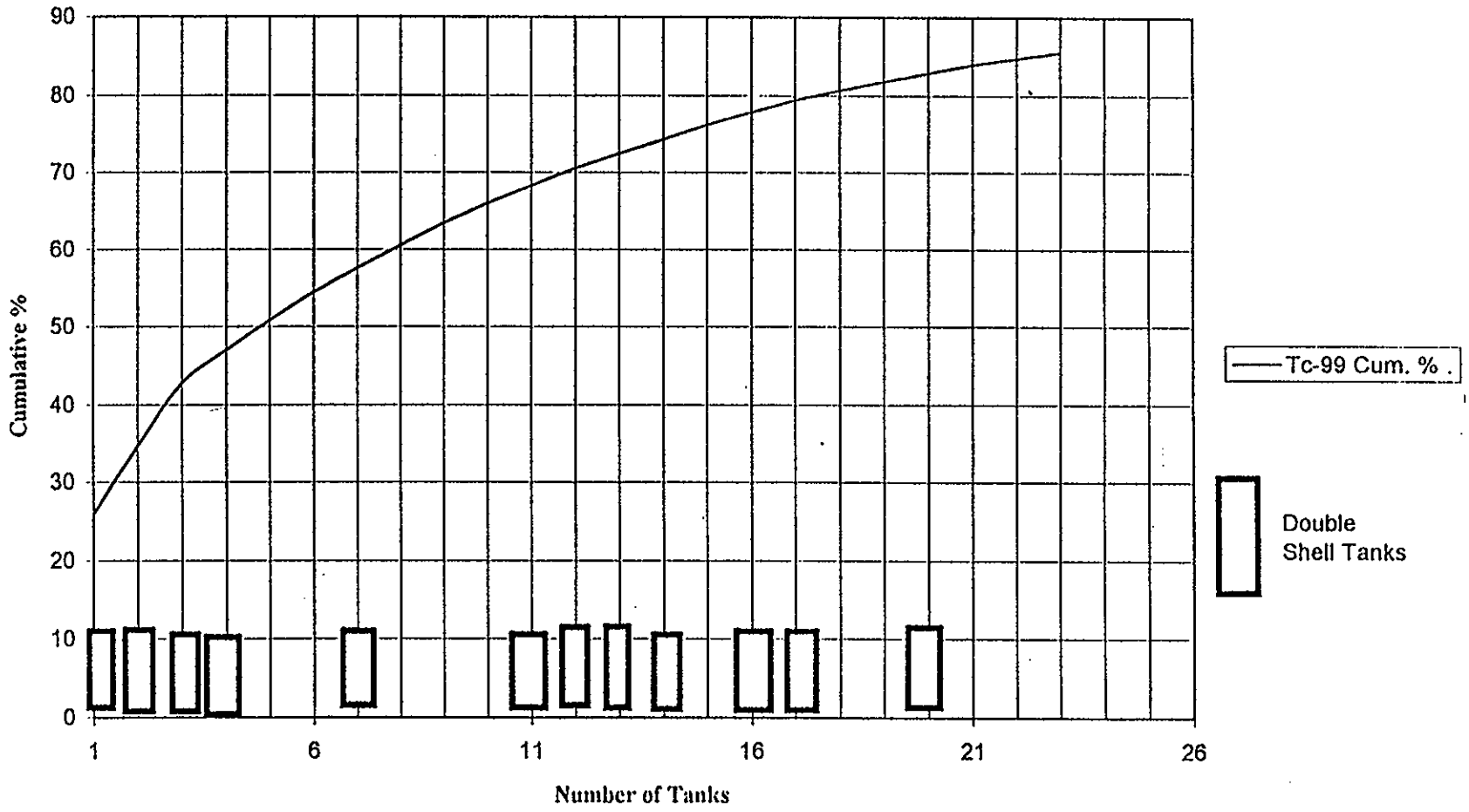
Risk To Residential Farmer
From Tank Residues
5,000 Years

Radionuclide	Cancer Incidence	% of Risk	SST Ci(1)	DST Ci(1)	Total Ci	Risk/Ci	Relative Risk/Ci
Tc-99	1.00E-04	46	1.10E+04	2.11E+04	3.21E+04	3.12E-09	1
C-14	1.00E-04	46	3.00E+03	2.34E+03	5.34E+03	1.87E-08	6
U-238	1.00E-05	5	481	NR	481	2.08E-08	7
I-129	5.00E-06	3	16	NR	16	3.13E-07	100
Total	2.15E-04	100					

(1) From Inventory Data Package

5/11

Tc-99 Ci Retrieved from SSTs & DSTs



DST vs SST Retrieval

2/11

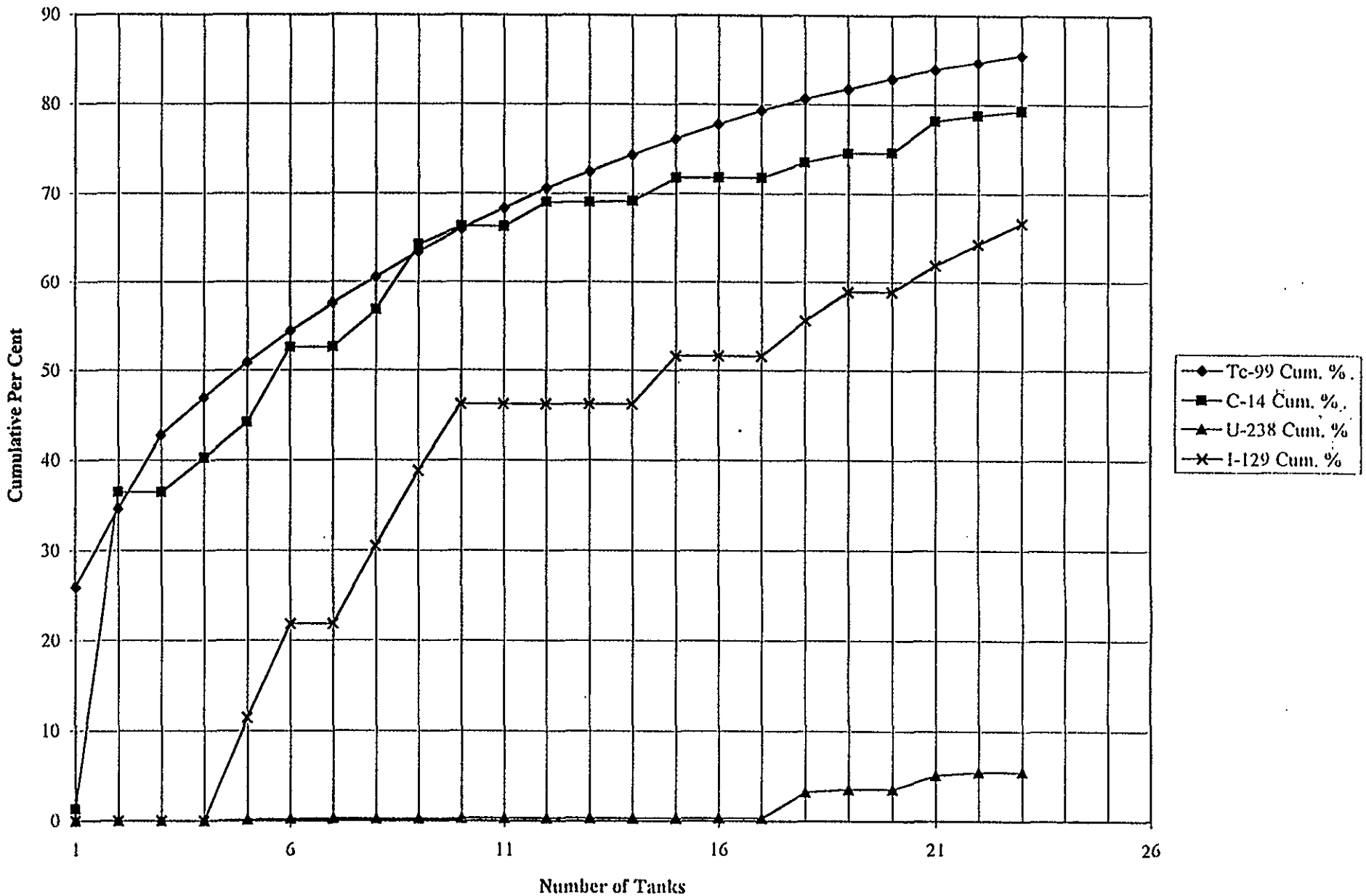
Retrieval of Mobile Radionuclides from DSTs and SSTs

Tc-99										
Tank No.	1	2	3	4	5	6	7	8	9	10
DSTs Outlined	102-AN	107AN	103SY	101AZ	BX-104	B-111	101SY	S-112	BX-106	SX-103
Ci, calc. from data pkg.(99%)	8.32E+03	2.80E+03	2.62E+03	1.35E+03	1.25E+03	1.15E+03	9.99E+02	9.51E+02	9.12E+02	8.27E+02
Tc-99 Cum. Ci	8.32E+03	1.11E+04	1.37E+04	1.51E+04	1.63E+04	1.75E+04	1.85E+04	1.94E+04	2.04E+04	2.12E+04
Ci, % of total	25.92003	8.710558	8.175741	4.193279	3.903302	3.59676	3.111796	2.96324	2.840623	2.574953
Tc-99 Cum. % .	25.92003	34.63059	42.80633	46.99961	50.90291	54.49967	57.61147	60.57471	63.41533	65.99028
C-14										
g-moles, SSTs only					18.7	40.1		20.2	34.8	9.72
Curies (100%)	68.72115	1898.571	0	203.7464	212.432	455.536	0	229.472	395.328	110.4192
Ci, from data pkg.(99%)	68.03394	1879.585	0	201.7089	210.3077	450.9806	0	227.1773	391.3747	109.315
C-14 Cum. Ci	6.80E+01	1.95E+03	1.95E+03	2.15E+03	2.36E+03	2.81E+03	2.81E+03	3.04E+03	3.43E+03	3.54E+03
Ci, % of total	1.27	35.20	0.00	3.78	3.94	8.45	0.00	4.25	7.33	2.05
C-14 Cum. % .	1.27	36.47	36.47	40.25	44.19	52.63	52.63	56.89	64.22	66.26
U-238										
g-moles, SSTs only					10400	5410		195	489	703
Curies (100%)					0.8424	0.43821		0.015795	0.039609	0.056943
Ci, from data pkg.(99%)					0.833976	0.433828		0.015637	0.039213	0.056374
U-238 Cum. Ci	0.00E+00	0.00E+00	0.00E+00	0.00E+00	8.34E-01	1.27E+00	1.27E+00	1.28E+00	1.32E+00	1.38E+00
Ci, % of total	0	0	0	0	0.173384	0.090193	0	0.003251	0.008152	0.01172
U-238 Cum. %	0	0.00	0.00	0.00	0.17	0.26	0.26	0.27	0.27	0.29
I-129										
g-moles, SSTs only					217	199		164	158	142
Curies (100%)	0	0	0	0	1.8445	1.6915	0	1.394	1.343	1.207
Ci, from data pkg.(99%)	0	0	0	0	1.826055	1.674585	0	1.38006	1.32957	1.19493
I-129 Cum. Ci	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.83E+00	3.50E+00	3.50E+00	4.88E+00	6.21E+00	7.41E+00
Ci, % of total	0	0	0	0	11.41284	10.46616	0	8.625375	8.309813	7.468313
I-129 Cum. %	0	0.00	0.00	0.00	11.41	21.88	21.88	30.50	38.81	46.28

11	12	13	14	15	16	17	18	19	20	21	22	23
105-AN (1)	102AZ	101AW	103-AN (2)	BX-105	104-AN (1)	101AY	C-105	TX-109	102AP	TX-118	TY-103	SX-105
7.42E+02	7.33E+02	6.08E+02	5.97E+02	5.87E+02	5.29E+02	5.03E+02	4.22E+02	3.56E+02	3.54E+02	3.35E+02	2.64E+02	2.60E+02
2.19E+04	2.27E+04	2.33E+04	2.39E+04	2.44E+04	2.50E+04	2.55E+04	2.59E+04	2.63E+04	2.66E+04	2.69E+04	2.72E+04	2.75E+04
2.310883	2.283356	1.893645	1.85972	1.829034	1.647233	1.565432	1.316087	1.107639	1.104112	1.042243	0.823576	0.809271
68.30116	70.58452	72.47817	74.33789	76.16692	77.81415	79.37958	80.69567	81.80331	82.90742	83.94967	84.77324	85.58251
				12.7			8.12	5.01		17.1	2.88	2.38
0	146.2536	1.5	7.09	144.272	0	0	92.2432	56.9136	1.75	194.256	32.7168	27.0368
0	144.7911	1.485	7.0191	142.8293	0	0	91.32077	56.34446	1.7325	192.3134	32.38963	26.76643
3.54E+03	3.68E+03	3.68E+03	3.69E+03	3.83E+03	3.83E+03	3.83E+03	3.93E+03	3.98E+03	3.98E+03	4.18E+03	4.21E+03	4.24E+03
0.00	2.71	0.03	0.13	2.67	0.00	0.00	1.71	1.06	0.03	3.60	0.61	0.50
66.26	68.98	69.00	69.13	71.81	71.81	71.81	73.52	74.57	74.61	78.21	78.81	79.32
				577			177000	15800		94700	23000	1230
				0.046737			14.337	1.2798		7.6707	1.863	0.09963
				0.04627			14.19363	1.267002		7.593993	1.84437	0.098634
1.38E+00	1.38E+00	1.38E+00	1.38E+00	1.43E+00	1.43E+00	1.43E+00	1.56E+01	1.69E+01	1.69E+01	2.45E+01	2.63E+01	2.64E+01
0	0	0	0	0.009619	0	0	2.950859	0.26341	0	1.578793	0.383445	0.020506
0.29	0.29	0.29	0.29	0.30	0.30	0.30	3.25	3.51	3.51	5.09	5.47	5.49
				102			76.5	61.2		57.6	45.6	44.9
0	0	0	0	0.867	0	0	0.65025	0.5202	0	0.4896	0.3876	0.38165
0	0	0	0	0.85833	0	0	0.643748	0.514998	0	0.484704	0.383724	0.377834
7.41E+00	7.41E+00	7.41E+00	7.41E+00	8.26E+00	8.26E+00	8.26E+00	8.91E+00	9.42E+00	9.42E+00	9.91E+00	1.03E+01	1.07E+01
0	0	0	0	5.364563	0	0	4.023422	3.218738	0	3.0294	2.398275	2.361459
46.28	46.28	46.28	46.28	51.65	51.65	51.65	55.67	58.89	58.89	61.92	64.32	66.68

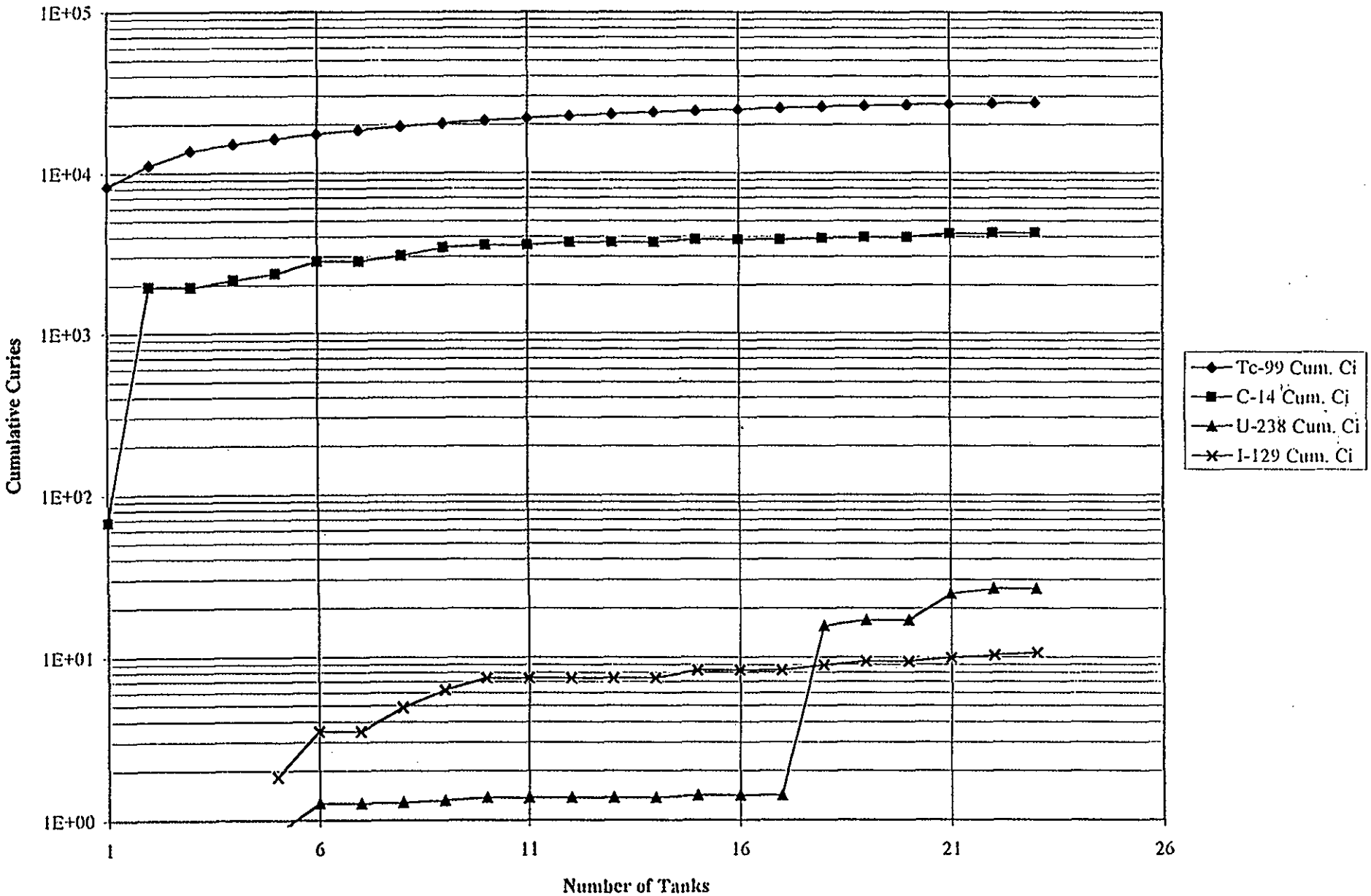
8/11

Per Cent Curies Retrieved From SSTs & DSTs



9/11

Curies Retrieved From SSTs & DSTs



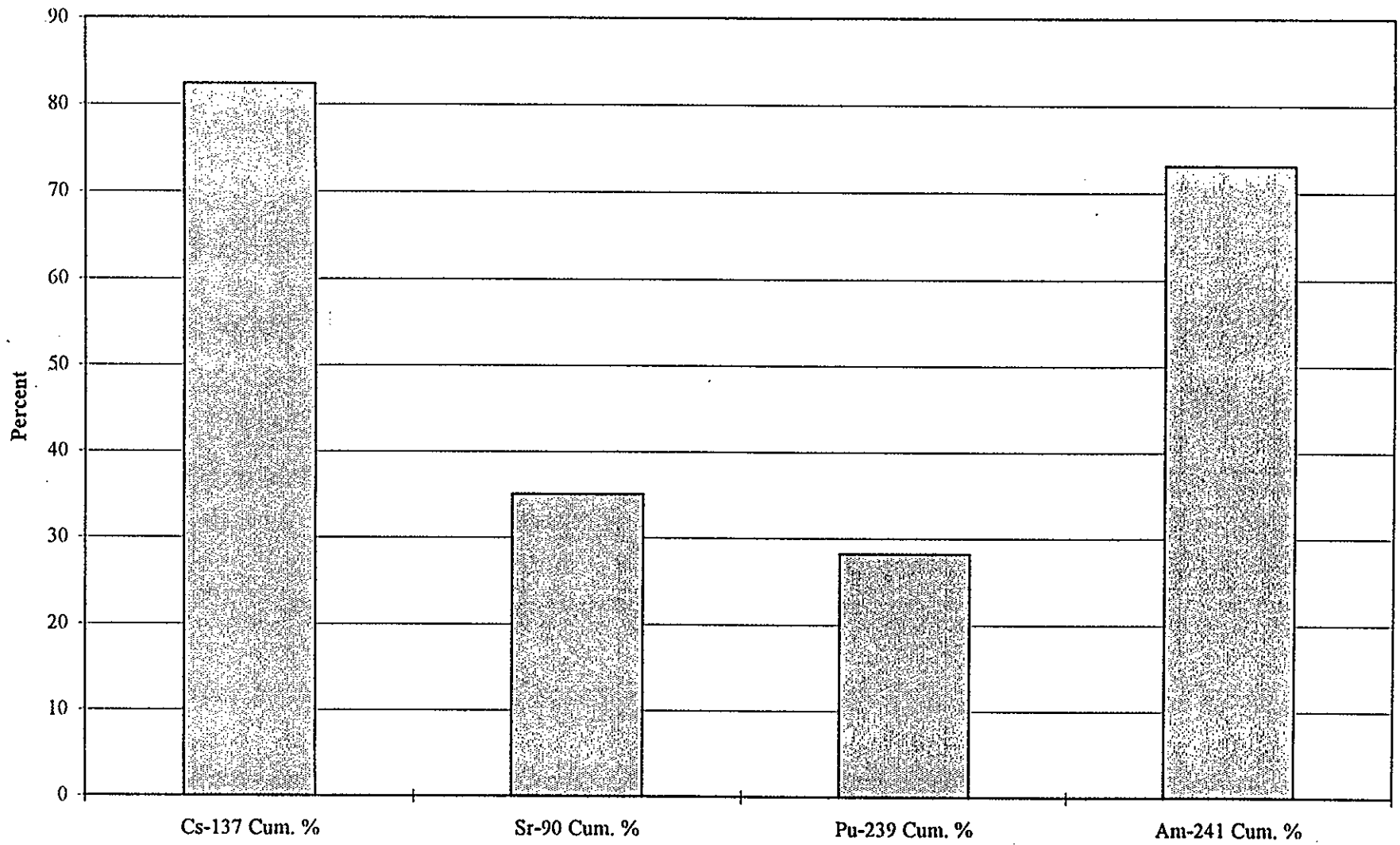
19/11

Risk Reduction
Sample Calculation

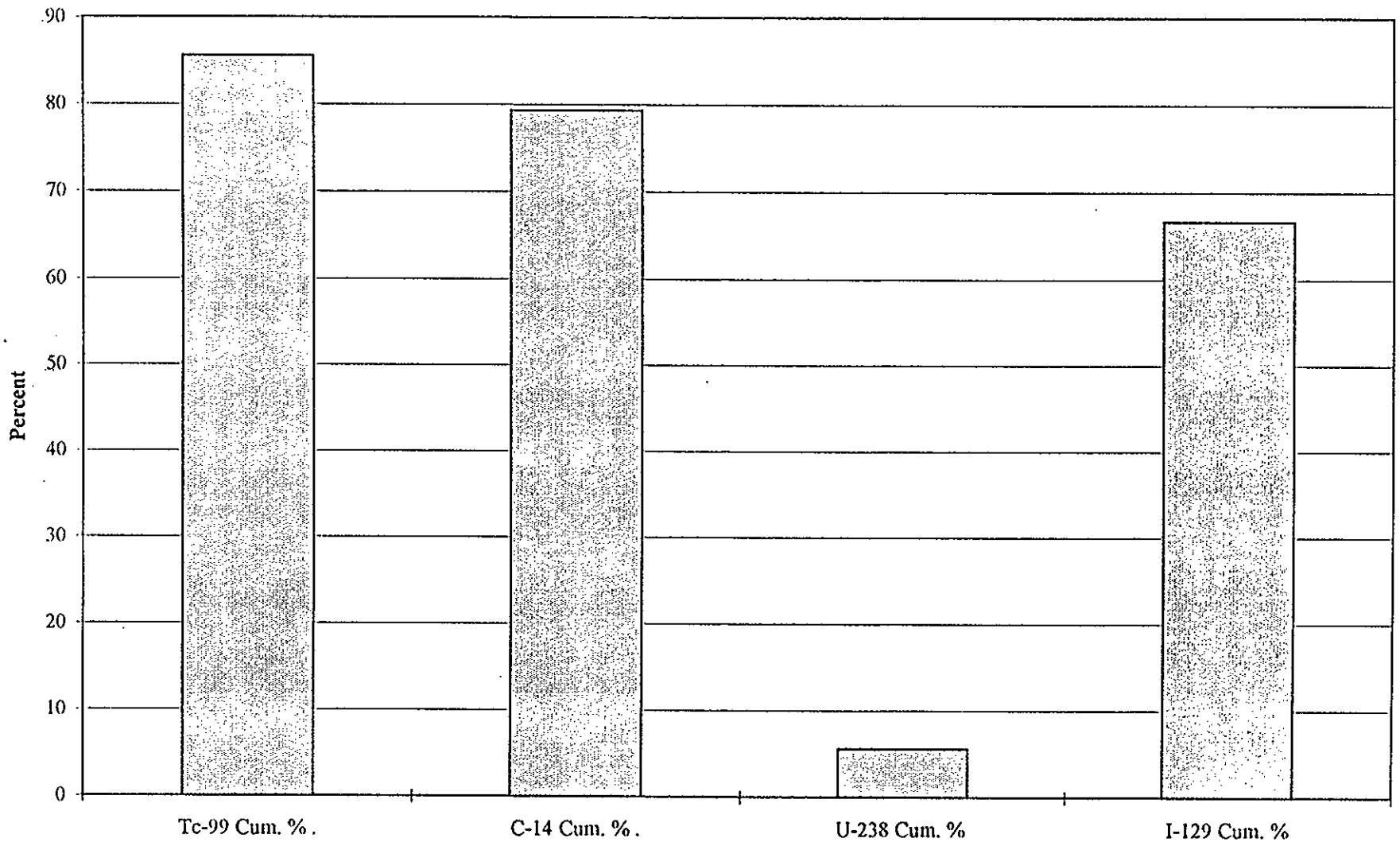
Radionuclide	% Retrieved	% Remaining	Remaining Cancer Incidence	
Tc-99	85	15	1.50E-05	
C-14	79	21	2.10E-05	
U-238	5	95	9.50E-06	
I-129	66	34	1.70E-06	
Total			4.72E-05	Cancer Incidence Is Now 22 % of What It Was

Bothret.xls

Retrieval of Other Radionuclides



Retrieval of Mobile Radionuclides



TWRS EIS
CALCULATION COVER SHEET

DISCIPLINE & TITLE RISK ASSESSMENT, LEAD RISK ASSESSOR

ORIGINATOR ALEX NAZARALI DATE 6-20-96

REVISION NO. _____

OBJECTIVE REVISE RISK RESULT FOR THE COLUMBIA RIVER USERS.

METHODOLOGY USE COMPUTER CODE DITTY

ASSUMPTIONS PER INPUT/OUTPUT PRINTOUT.

(Continue on another sheet if necessary)

6/20/96
SIGNATURE/DATE

6/21/96
CHECKED/DATE

CALCULATION & RESULTS
ATTACHED

1.9.2

JACOBS\FORMS\CALCVR.SHT

8.2.4.3

To	Marc Nelson
From	Alex Nazarali
Date	June 21, 1996
Subject	Cumulative Risk to the Columbia River User Local Population over 10,000 Years

The cumulative risk to the Columbia River user in the TWRS Draft EIS (Appendix D, Table D.5.14.3 and Volume One, Table 5.11.6) was calculated based on the unit dose factors generated by the DITTY computer code and published in Appendix F of the Disposal of Hanford Defense High-Level, Transuranic, and Tank Wastes Final Environmental Impact Statement (HDW-EIS).

The DITTY code has undergone significant modifications since the HDW-EIS was published. The new version of the DITTY code uses ICRP Publications 26 and 30 (ICRP 1977; ICRP 1979) instead of ICRP Publication 2 (ICRP 1959).

The new version of the DITTY code was run to estimate the cumulative dose for the TWRS Final EIS. The input/output of the DITTY code for each alternative and the new table that summarizes the cumulative dose and risk to the Columbia River users over 10,000 years are enclosed. The enclosed table will replace Tables D.5.14.3 and 5.11.6.

Note: The Ftrans.dat file in the DITTY code, which is the PNL food transport factors library was modified by Alex Nazarali on 6/16/96 for the new runs. In this modification, the leaching factors for neptunium and uranium changed from 3.3E-03 and 1.3E-03 respectively to 0.8. This change makes the leaching factors of neptunium and uranium consistent with carbon, iodine, and technetium. These five constituents are transported from the tanks to the receptors with the same transport properties. The leaching factors were different in the DITTY code, which should be the same for our analysis.

Table D.5.14.3 Estimated Fatality, Population Dose (person-rem), and Maximum Incremental Dose (mrem) for the Columbia River User over 10,000 Years for all Alternatives

Alternative	Total Fatality in 10,000 years	Cumulative Population Dose[1] (Person-rem)	Maximum Incremental Dose in mrem (Year Received)
No Action	2.7	5460	0.82 (2900)
Long-Term Management	2.2	4400	0.75 (2830)
In Situ Fill and Cap	25.4	50800	0.15 (12000)
In Situ Vitrification	1.00E-06	0.002	0
Ex Situ Intermediate Separation	0.5	896	0.005 (9060)
Ex Situ No Separation	0.5	896	0.005 (9060)
Ex Situ Extensive Separation	0.5	896	0.005 (9060)
Ex Situ/In Situ Combination	2.2	4420	0.02 (12000)
Phased Implementation	0.5	896	0.005 (9060)

1 The ICRP Publication 60 dose to risk conversion factor of 5.0E-04 cancer fatality per rem is used.

```
DITTY Long-Term Surface Water Release TWRS-EIS (No Action)
  5
C 14
I 129
NP237
TC99
U 238
 &INPUT IWAT=1, IPATH=2, LUW=1, IPOPL=2,
  CFLO=120000.,
  RM=1.0, TZ=1990., TZR=0.,
  PL1(1)=294830.,391538.,431210.,469891.,1273208.,4932964.,
  TL(1)=1990., 2100.,2200.,2300.,2990.,11900.,
  NTL=6,
  USAGE(1)=0.3,0.,0.,0.,438.,17.,17.,
  CONSUM(1)=15.,276.,20.,230.,40.,30.,8.5,
  EXTIM=2920.,MOPYR=6, RIRR=150.,
  GRWP(1)=90.,90.,90.,30.,3*90.,
  YELD(1)=1.5,4.,0.84,1.3,3*0.84,
 &END
  5
C 14       5
1990.   0.0
2219.   0.0
2220.   8.0125
2845.   8.0125
2846.   0.0
I 129      5
1990.   0.0
2219.   0.0
2220.   0.0256
2845.   0.0256
2846.   0.0
NP237      5
1990.   0.0
2219.   0.0
2220.   0.106
2845.   0.106
2846.   0.0
TC99       5
1990.   0.0
2219.   0.0
2220.   49.68
2845.   49.68
2846.   0.0
U 238      5
```

1990.	0.0
2219.	0.0
2220.	0.7696
2845.	0.7696
2846.	0.0

DITTY Dose Calculation Program
(GENII Version 1.485 3-Dec-90)

Integrated population dose calculated for chronic liquid release
Release from time 1990. A.D. onward for 10,000 years
Case title: DITTY Long-Term Surface Water Release TWRS-EIS (No Action)
Executed on: 06/18/96 at 10:54:15.6 Page 1

---- DATA LIBRARIES USED ----------(File)-----

Master Radionuclide Data: (2)
Radionuclide Master Library - Long Times (23-July-93 PDR)
Food Concentration Ratios: (8)
PNL Food Transfer Factor Library (by Z, Changed NP&U LF 6/18/96 AMN)
Fresh Water Bioaccumulation Factors: (9)
Bioaccumulation Factor Library - (30-Aug-88) RAP
External Exposure D.F.'s: (10)
External Dose Factors for GENII in person Sv/yr per Bq/X (8-May-90 RAP)
Inhalation/Ingestion D.F.'s: (30)
Worst-Case Solubilities, DITTY Internal Dose Factors (Sv/Bq) (23-Jul-93 PDR)
Waterborne Release Data: (31)
DITTY.IN

---- MASTER RADIONUCLIDE CONTROL LIST ----------
C 14 TC99 I 129 U 238 TH234 PA234 NP237
PA233

---- TERRESTRIAL/AQUATIC PATHWAY DATA FOR AN AVERAGE INDIVIDUAL

Pathway	Growing Period (days)	Yield (kg/m2)	Consumption (kg/yr)	Pathway (kg or hr/yr)	Usage
LEAFY VEG	9.0E+01	1.5E+00	1.5E+01	FISH	3.0E-01
OTHER VEG	9.0E+01	4.0E+00	2.8E+02	CRUSTACEA	0.0E+00
EGGS	9.0E+01	8.4E-01	2.0E+01	MOLLUSES	0.0E+00
MILK	3.0E+01	1.3E+00	2.3E+02	PLANTS	0.0E+00
BEEF	9.0E+01	8.4E-01	4.0E+01	DRINKING WATER	4.4E+02
PORK	9.0E+01	8.4E-01	3.0E+01	SEDIMENT EXPOSU	1.7E+01
POULTRY	9.0E+01	8.4E-01	8.5E+00	SWIMMING TIME	1.7E+01

External Exposure Time: 2.92E+03 hr/yr

---- LIQUID RELEASE PARAMETERS ----------

River Flow Rate, (ft3/sec) : 1.2E+05 Months/Year Irrigated : 6.0E+00
Reconcentration Ratio : 1.0E+00 Irrigation Rate
Mixing Ratio : 1.0E+00 (liters/m2/month) : 1.5E+02

Input Prepared By: _____ Date: _____

Input Checked By: _____ Date: _____

DITTY Dose Calculation Program
(GENII Version 1.485 3-Dec-90)

Integrated population dose calculated for chronic liquid release
Release from time 1990. A.D. onward for 10,000 years
Case title: DITTY Long-Term Surface Water Release TWRS-EIS (No Action)
Executed on: 06/18/96 at 10:54:15.6 Page 2

---- WATER RELEASE OF EACH RADIONCLIDE PER 70-YR PERIOD (Ci) ----

Radio-nuclide	Period/ Activity	Period/ Activity	Period/ Activity	Period/ Activity	Period/ Activity
C 14	4 6.3E-01	5 8.8E-01	6 8.8E-01	7 8.8E-01	8 8.8E-01
	9 8.8E-01	10 8.8E-01	11 8.8E-01	12 8.8E-01	13 2.0E-01
TC99	4 4.9E+02	5 6.8E+02	6 6.8E+02	7 6.8E+02	8 6.8E+02
	9 6.8E+02	10 6.8E+02	11 6.8E+02	12 6.8E+02	13 1.5E+02
I 129	4 1.3E+00	5 1.8E+00	6 1.8E+00	7 1.8E+00	8 1.8E+00
	9 1.8E+00	10 1.8E+00	11 1.8E+00	12 1.8E+00	13 4.0E-01
U 238	4 3.9E+01	5 5.4E+01	6 5.4E+01	7 5.4E+01	8 5.4E+01
	9 5.4E+01	10 5.4E+01	11 5.4E+01	12 5.4E+01	13 1.2E+01
NP237	4 5.4E+00	5 7.4E+00	6 7.4E+00	7 7.4E+00	8 7.4E+00
	9 7.4E+00	10 7.4E+00	11 7.4E+00	12 7.4E+00	13 1.6E+00

---- POPULATION DATA ----

Population for Chronic Waterborne Release at the following Times A.D.:

Time	Population
1990.	2.9E+05
2100.	3.9E+05
2200.	4.3E+05
2300.	4.7E+05
2990.	1.3E+06
11900.	4.9E+06

DITTY Dose Calculation Program
(GENII Version 1.485 3-Dec-90)

Integrated population dose calculated for chronic liquid release
Release from time 1990. A.D. onward for 10,000 years
Case title: DITTY Long-Term Surface Water Release TWRS-EIS (No Action)
Executed on: 06/18/96 at 10:54:15.6 Page 4

Lifetime Effective Cumulative Dose Equivalent as a Function of Time

Period	Year	Dose
until	until	
5	2270.	2.63E+02
6	2340.	6.52E+02
7	2410.	1.11E+03
8	2480.	1.63E+03
9	2550.	2.22E+03
10	2620.	2.88E+03
11	2690.	3.60E+03
12	2760.	4.39E+03
13	2830.	5.25E+03
14	2900.	5.46E+03
until	until	
144	12000.	5.46E+03

Dose in units of person-rem;
that is the cumulative population dose received by the local population over 10,000 years with an assumed 70-yr individual lifetime.

Cumulative Population Dose Equivalent by Radionuclide

Radio-nuclide	Effective Dose Equivalent	Annual External Dose	Effective Dose Equivalent	Percent Of Total Dose
C 14	1.1E+00	5.0E-05	1.1E+00	0
TC 99	1.5E+03	9.3E-04	1.5E+03	27
I 129	9.2E+01	2.9E-04	9.2E+01	1
U 238	6.6E+02	1.4E-04	6.6E+02	12
TH 234	6.9E-02	9.0E-02	1.6E-01	0
PA 234	2.3E-04	1.4E-02	1.4E-02	0
NP 237	3.2E+03	1.6E-02	3.2E+03	58
PA 233	3.2E-02	3.8E-01	4.1E-01	0

Dose in units of person-rem;
that is the cumulative population dose received by the local population
with an assumed 70-yr individual lifetime.

Maximum Dose Increment Received By Population
In Year 2900 (70-yr Time Period Number No: 13)

Organ	Cumulative Dose Equivalent	Weighting Factors	Weighted Cumulative Dose Equivalent
Gonads	1.1E+02	2.5E-01	2.7E+01
Breast	2.9E+01	1.5E-01	4.3E+00
R Marrow	1.0E+03	1.2E-01	1.3E+02
Lung	2.9E+01	1.2E-01	3.5E+00
Thyroid	1.1E+03	3.0E-02	3.3E+01
Bone Sur	1.3E+04	3.0E-02	3.8E+02
Stomach	2.7E+03	6.0E-02	1.6E+02
Kidneys	6.9E+02	6.0E-02	4.1E+01
LL Int.	5.5E+02	6.0E-02	3.3E+01
Liver	5.3E+02	6.0E-02	3.2E+01
UL Int.	2.0E+02	6.0E-02	1.2E+01

Cumulative Effective Dose Equivalent 8.6E+02
External Dose 7.9E-02

Lifetime Effective Cumulative
Dose Equivalent 8.6E+02

Dose in units of person-rem;
that is the cumulative population dose received by the local population
with an assumed 70-yr individual lifetime.

Maximum Dose Increment Received By Individual (rem)
In Year 2900 (70-yr Time Period Number No: 13)

Radio-nuclide	Effective Dose Equivalent	Annual External Dose	Effective Dose Equivalent	Percent Of Total Dose
C 14	1.6E-07	7.5E-12	1.6E-07	0
TC 99	2.3E-04	1.4E-10	2.3E-04	27
I 129	1.4E-05	4.4E-11	1.4E-05	1
U 238	9.9E-05	2.0E-11	9.9E-05	12
TH 234	1.0E-08	1.4E-08	2.4E-08	0
PA 234	3.5E-11	2.1E-09	2.1E-09	0
NP 237	4.8E-04	2.4E-09	4.8E-04	58
PA 233	4.8E-09	5.7E-08	6.2E-08	0

8.232E-4

Population Internal Dose To Organ by Radionuclide
In Year 2900 (70-yr Time Period Number No: 13)

Radionuclide	Lung	Stomach	S Int.	UL Int.	LL Int.	Bone Su	R Marro	Testes
C 14	1.8E-01	1.8E-01	1.8E-01	1.8E-01	1.8E-01	2.2E-01	2.2E-01	1.8E-01
TC 99	2.5E+01	2.7E+03	4.9E+01	1.6E+02	4.4E+02	2.9E+01	2.9E+01	2.5E+01
I 129	3.2E-02	4.5E-02	2.8E-02	2.8E-02	2.8E-02	3.8E-02	4.2E-02	2.6E-02
U 238	4.0E+00	5.4E+00	7.8E+00	2.7E+01	7.8E+01	1.4E+03	9.3E+01	3.7E+00
TH 234	8.0E-05	3.0E-03	7.2E-03	4.3E-02	1.3E-01	6.0E-05	5.1E-05	6.8E-06
PA 234	9.4E-07	4.6E-05	9.4E-05	2.0E-04	1.6E-04	1.7E-06	4.8E-06	1.4E-06
NP 237	7.0E-02	6.5E-01	1.6E+00	8.5E+00	2.6E+01	1.1E+04	9.2E+02	7.8E+01
PA 233	2.2E-05	1.5E-03	4.1E-03	1.8E-02	5.3E-02	5.1E-04	3.6E-04	1.1E-04
Total internal	2.9E+01	2.7E+03	5.8E+01	2.0E+02	5.5E+02	1.3E+04	1.0E+03	1.1E+02

Radionuclide	Ovaries	Muscle	Thyroid	Kidneys	Liver
C 14	1.8E-01	1.8E-01	1.8E-01	0.0E+00	0.0E+00
TC 99	2.5E+01	2.5E+01	6.2E+02	0.0E+00	3.4E+01
I 129	2.8E-02	6.7E-02	4.8E+02	0.0E+00	0.0E+00
U 238	3.9E+00	3.7E+00	3.9E+00	6.9E+02	0.0E+00
TH 234	8.5E-05	9.8E-06	8.7E-07	0.0E+00	1.2E-05
PA 234	2.0E-05	3.1E-06	1.1E-07	5.1E-06	3.7E-06
NP 237	7.8E+01	6.2E-02	4.6E-02	0.0E+00	5.0E+02
PA 233	1.3E-03	1.4E-04	2.6E-06	1.8E-04	1.2E-04
Total internal	1.1E+02	2.9E+01	1.1E+03	6.9E+02	5.3E+02

Population Air Submersion and External Incremental Dose by Radionuclide
In Year 2900 (70-yr Time Period Number No: 13)

Radionuclide	Air Submer-sion	External
C 14	9.9E-12	7.9E-06
TC 99	1.2E-10	1.5E-04
I 129	7.5E-11	4.6E-05
U 238	3.5E-11	2.1E-05
TH 234	5.6E-09	1.4E-02
PA 234	8.0E-10	2.2E-03
NP 237	4.9E-10	2.5E-03
PA 233	7.9E-09	6.0E-02
Tot l external	1.5E-08	7.9E-02

Dose in units of person-rem;
that is the cumulative population dose received by the local population with an assumed 70-yr individual lifetime.

Population Internal Dose To Organ by Exposure Pathway

In Year 2900 (70-yr Time Period Number No: 13)

Pathway	Lung	Stomach	S Int.	UL Int.	LL Int.	Bone Su	R Marro	Testes
Inhalation	2.8E-01	8.0E-05	1.3E-05	3.4E-05	8.4E-05	4.6E-01	3.6E-02	3.4E-03
Ingestion (Terr)	2.7E+01	2.7E+03	5.3E+01	1.8E+02	4.9E+02	5.8E+03	4.8E+02	6.0E+01
Ingestion (Aqua)	2.1E-01	2.0E+00	9.0E-01	4.1E+00	1.2E+01	4.6E+03	3.8E+02	3.2E+01
Drinking Water	1.8E+00	5.3E+01	3.9E+00	1.4E+01	4.0E+01	2.4E+03	1.9E+02	1.5E+01
Total internal	2.9E+01	2.7E+03	5.8E+01	2.0E+02	5.5E+02	1.3E+04	1.0E+03	1.1E+02

Pathway	Ovaries	Muscle	Thyroid	Kidneys	Liver
Inhalation	3.4E-03	9.6E-06	8.1E-05	4.7E-04	2.0E-02
Ingestion (Terr)	6.0E+01	2.7E+01	1.0E+03	4.4E+02	2.5E+02
Ingestion (Aqua)	3.2E+01	2.1E-01	9.6E-01	1.2E+01	2.0E+02
Drinking Water	1.5E+01	1.8E+00	6.2E+01	2.4E+02	8.3E+01
Total internal	1.1E+02	2.9E+01	1.1E+03	6.9E+02	5.3E+02

Dose in units of person-rem;
that is the cumulative population dose received by the local population
with an assumed 70-yr individual lifetime.

```
DITTY Long-Term Surface Water Release TWRS-EIS (Long Term Management)
  5
C 14
I 129
NP237
TC99
U 238
 &INPUT IWAT=1, IPATH=2, LUW=1, IPOPL=2,
  CFLO=120000.,
  RM=1.0, TZ=1990., TZR=0.,
  PL1(1)=294830.,391538.,431210.,469891.,1273208.,4932964.,
  TL(1)=1990., 2100.,2200.,2300.,2990.,11900.,
  NTL=6,
  USAGE(1)=0.3,0.,0.,0.,438.,17.,17.,
  CONSUM(1)=15.,276.,20.,230.,40.,30.,8.5,
  EXTIM=2920.,MOPYR=6, RIRR=150.,
  GRWP(1)=90.,90.,90.,30.,3*90.,
  YELD(1)=1.5,4.,0.84,1.3,3*0.84,
 &END
  5
C 14       5
1990.   0.0
2219.   0.0
2220.   8.7092
2795.   8.7092
2796.   0.0
I 129      5
1990.   0.0
2219.   0.0
2220.   0.0278
2795.   0.0278
2796.   0.0
NP237      5
1990.   0.0
2219.   0.0
2220.   0.1151
2795.   0.1151
2796.   0.0
TC99       5
1990.   0.0
2219.   0.0
2220.   54.00
2795.   54.00
2796.   0.0
U 238      5
```

1990.	0.0
2219.	0.0
2220.	0.8365
2795.	0.8365
2796.	0.0

DITTY Dose Calculation Program
(GENII Version 1.485 3-Dec-90)

Integrated population dose calculated for chronic liquid release
Release from time 1990. A.D. onward for 10,000 years
Case title: DITTY Long-Term Surface Water Release TWRS-EIS (Long Term Management)
Executed on: 06/18/96 at 10:54:24.7 Page 1

---- DATA LIBRARIES USED ----------(File)-----

Master Radionuclide Data: (2)
Radionuclide Master Library - Long Times (23-July-93 PDR)
Food Concentration Ratios: (8)
PNL Food Transfer Factor Library (by Z, Changed NP&U LF 6/18/96 AMN)
Fresh Water Bioaccumulation Factors: (9)
Bioaccumulation Factor Library - (30-Aug-88) RAP
External Exposure D.F.'s: (10)
External Dose Factors for GENII in person Sv/yr per Bq/X (8-May-90 RAP)
Inhalation/Ingestion D.F.'s: (30)
Worst-Case Solubilities, DITTY Internal Dose Factors (Sv/Bq) (23-Jul-93 PDR)
Waterborne Release Data: (31)
DITTY.IN

---- MASTER RADIONUCLIDE CONTROL LIST ----------
C 14 TC99 I 129 U 238 TH234 PA234 NP237
PA233

---- TERRESTRIAL/AQUATIC PATHWAY DATA FOR AN AVERAGE INDIVIDUAL

Pathway	Growing Period (days)	Yield (kg/m2)	Consumption (kg/yr)	Pathway	Usage (kg or hr/yr)
LEAFY VEG	9.0E+01	1.5E+00	1.5E+01	FISH	3.0E-01
OTHER VEG	9.0E+01	4.0E+00	2.8E+02	CRUSTACEA	0.0E+00
EGGS	9.0E+01	8.4E-01	2.0E+01	MOLLUSES	0.0E+00
MILK	3.0E+01	1.3E+00	2.3E+02	PLANTS	0.0E+00
BEEF	9.0E+01	8.4E-01	4.0E+01	DRINKING WATER	4.4E+02
PORK	9.0E+01	8.4E-01	3.0E+01	SEDIMENT EXPOSU	1.7E+01
POULTRY	9.0E+01	8.4E-01	8.5E+00	SWIMMING TIME	1.7E+01

External Exposure Time: 2.92E+03 hr/yr

----- LIQUID RELEASE PARAMETERS ----------

River Flow Rate, (ft3/sec) : 1.2E+05 Months/Year Irrigated : 6.0E+00
Reconcentration Ratio : 1.0E+00 Irrigation Rate
Mixing Ratio : 1.0E+00 (liters/m2/month) : 1.5E+02

Input Prepared By: _____ Date: _____

Input Checked By: _____ Date: _____

DITTY Dose Calculation Program
(GENII Version 1.485 3-Dec-90)

Integrated population dose calculated for chronic liquid release
Release from time 1990. A.D. onward for 10,000 years
Case title: DITTY Long-Term Surface Water Release TWRS-EIS (Long Term Management)
Executed on: 06/18/96 at 10:54:24.7 Page 2

---- WATER RELEASE OF EACH RADIONCLIDE PER 70-YR PERIOD (Ci) ----------

Radio-nuclide	Period/ Activity	Period/ Activity	Period/ Activity	Period/ Activity	Period/ Activity
C 14	4 3.6E+01	5 5.0E+01	6 5.0E+01	7 5.0E+01	8 5.0E+01
	9 5.0E+01	10 5.0E+01	11 5.0E+01	12 2.5E+01	
TC99	4 2.0E+02	5 2.8E+02	6 2.8E+02	7 2.8E+02	8 2.8E+02
	9 2.8E+02	10 2.8E+02	11 2.8E+02	12 1.4E+02	
I 129	4 1.4E+00	5 1.9E+00	6 1.9E+00	7 1.9E+00	8 1.9E+00
	9 1.9E+00	10 1.9E+00	11 1.9E+00	12 9.9E-01	
U 238	4 4.2E+01	5 5.9E+01	6 5.9E+01	7 5.9E+01	8 5.9E+01
	9 5.9E+01	10 5.9E+01	11 5.9E+01	12 3.0E+01	
NP237	4 5.8E+00	5 8.1E+00	6 8.1E+00	7 8.1E+00	8 8.1E+00
	9 8.1E+00	10 8.1E+00	11 8.1E+00	12 4.1E+00	

---- POPULATION DATA ----

Population for Chronic Waterborne Release at the following Times A.D.:

Time	Population
1990.	2.9E+05
2100.	3.9E+05
2200.	4.3E+05
2300.	4.7E+05
2990.	1.3E+06
11900.	4.9E+06

DITTY Dose Calculation Program
(GENII Version 1.485 3-Dec-90)

Integrated population dose calculated for chronic liquid release
Release from time 1990. A.D. onward for 10,000 years
Case title: DITTY Long-Term Surface Water Release TWRS-EIS (Long Term Management)
Executed on: 06/18/96 at 10:54:24.7

Lifetime Effective Cumulative Dose Equivalent as a Function of Time

Period	Year	Dose
until	until	
5	2270.	2.39E+02
6	2340.	5.94E+02
7	2410.	1.01E+03
8	2480.	1.49E+03
9	2550.	2.02E+03
10	2620.	2.62E+03
11	2690.	3.28E+03
12	2760.	4.00E+03
13	2830.	4.40E+03
until	until	
144	12000.	4.40E+03

Dose in units of person-rem;
that is the cumulative population dose received by the local population over 10,000 years with an assumed 70-yr individual lifetime.

Cumulative Population Dose Equivalent by Radionuclide

Radio-nuclide	Effective Dose Equivalent	Annual External Dose	Effective Dose Equivalent	Percent Of Total Dose
C 14	5.5E+01	2.5E-03	5.5E+01	1
TC 99	5.6E+02	3.4E-04	5.6E+02	12
I 129	8.8E+01	2.8E-04	8.8E+01	2
U 238	6.3E+02	1.3E-04	6.3E+02	14
TH 234	6.7E-02	8.7E-02	1.5E-01	0
PA 234	2.2E-04	1.3E-02	1.4E-02	0
NP 237	3.1E+03	1.5E-02	3.1E+03	69
PA 233	3.1E-02	3.6E-01	4.0E-01	0

Dose in units of person-rem;
that is the cumulative population dose received by the local population
with an assumed 70-yr individual lifetime.

Maximum Dose Increment Received By Population
In Year 2830 (70-yr Time Period Number No: 12)

Organ	Cumulative Dose Equivalent	Weighting Factors	Weighted Cumulative Dose Equivalent
Gonads	1.0E+02	2.5E-01	2.5E+01
Breast	2.3E+01	1.5E-01	3.4E+00
R Marrow	1.0E+03	1.2E-01	1.2E+02
Lung	2.3E+01	1.2E-01	2.7E+00
Thyroid	7.3E+02	3.0E-02	2.2E+01
Bone Sur	1.3E+04	3.0E-02	3.8E+02
Stomach	1.0E+03	6.0E-02	6.3E+01
Kidneys	6.9E+02	6.0E-02	4.1E+01
Liver	5.1E+02	6.0E-02	3.1E+01
LL Int.	2.8E+02	6.0E-02	1.7E+01
UL Int.	1.1E+02	6.0E-02	6.4E+00

Cumulative Effective Dose Equivalent 7.2E+02
External Dose 7.9E-02

Lifetime Effective Cumulative
Dose Equivalent 7.2E+02

Dose in units of person-rem;
that is the cumulative population dose received by the local population
with an assumed 70-yr individual lifetime.

Maximum Dose Increment Received By Individual (rem)
In Year 2830 (70-yr Time Period Number No: 12)

Radio-nuclide	Effective Dose Equivalent	Annual External Dose	Effective Dose Equivalent	Percent Of Total Dose
C 14	9.3E-06	4.3E-10	9.3E-06	1
TC 99	9.5E-05	5.8E-11	9.5E-05	12
I 129	1.5E-05	4.7E-11	1.5E-05	2
U 238	1.1E-04	2.2E-11	1.1E-04	14
TH 234	1.1E-08	1.5E-08	2.6E-08	0
PA 234	3.8E-11	2.3E-09	2.3E-09	0
NP 237	5.2E-04	2.6E-09	5.2E-04	69
PA 233	5.2E-09	6.2E-08	6.7E-08	0

7.494E-4

Population Internal Dose To Organ by Radionuclide
In Year 2830 (70-yr Time Period Number No: 12)

Radionuclide	Lung	Stomach S Int.	UL Int.	LL Int.	Bone Su	R Marro	Testes
C 14	9.2E+00	9.2E+00	9.2E+00	9.2E+00	9.2E+00	1.1E+01	1.1E+01	9.2E+00
TC 99	9.5E+00	1.0E+03	1.9E+01	6.2E+01	1.7E+02	1.1E+01	1.1E+01	9.5E+00
I 129	3.2E-02	4.5E-02	2.8E-02	2.8E-02	2.8E-02	3.9E-02	4.2E-02	2.6E-02
U 238	4.0E+00	5.4E+00	7.9E+00	2.7E+01	7.9E+01	1.4E+03	9.3E+01	3.7E+00
TH 234	8.1E-05	3.0E-03	7.3E-03	4.3E-02	1.3E-01	6.0E-05	5.1E-05	6.8E-06
PA 234	9.4E-07	4.6E-05	9.4E-05	2.0E-04	1.6E-04	1.7E-06	4.9E-06	1.4E-06
NP 237	7.0E-02	6.5E-01	1.6E+00	8.5E+00	2.6E+01	1.1E+04	9.2E+02	7.8E+01
PA 233	2.2E-05	1.5E-03	4.1E-03	1.8E-02	5.3E-02	5.1E-04	3.6E-04	1.1E-04
Total internal	2.3E+01	1.0E+03	3.7E+01	1.1E+02	2.8E+02	1.3E+04	1.0E+03	1.0E+02

Radionuclide	Ovaries	Muscle	Thyroid	Kidneys	Liver
C 14	9.2E+00	9.2E+00	9.2E+00	0.0E+00	0.0E+00
TC 99	9.5E+00	9.5E+00	2.4E+02	0.0E+00	1.3E+01
I 129	2.8E-02	6.7E-02	4.8E+02	0.0E+00	0.0E+00
U 238	3.9E+00	3.7E+00	3.9E+00	6.9E+02	0.0E+00
TH 234	8.5E-05	9.8E-06	8.7E-07	0.0E+00	1.2E-05
PA 234	2.0E-05	3.1E-06	1.1E-07	5.1E-06	3.7E-06
NP 237	7.8E+01	6.3E-02	4.6E-02	0.0E+00	5.0E+02
PA 233	1.3E-03	1.4E-04	2.6E-06	1.8E-04	1.2E-04
Total internal	1.0E+02	2.3E+01	7.3E+02	6.9E+02	5.1E+02

Population Air Submersion and External Incremental Dose by Radionuclide
In Year 2830 (70-yr Time Period Number No: 12)

Radionuclide	Air Submer-sion	External
C 14	5.2E-10	4.1E-04
TC 99	4.6E-11	5.6E-05
I 129	7.5E-11	4.6E-05
U 238	3.5E-11	2.1E-05
TH 234	5.6E-09	1.4E-02
PA 234	8.0E-10	2.2E-03
NP 237	4.9E-10	2.5E-03
PA 233	8.0E-09	6.0E-02
Total external	1.6E-08	7.9E-02

Dose in units of person-rem;
that is the cumulative population dose received by the local population with an assumed 70-yr individual lifetime.

DITTY Dose Calculation Program
(GENII Version 1.485 3-Dec-90)

Integrated population dose calculated for chronic liquid release
Release from time 1990. A.D. onward for 10,000 years
Case title: DITTY Long-Term Surface Water Release TWRS-EIS (Long Term Management)
Executed on: 06/18/96 at 10:54:24.7 Page 9

Population Internal Dose To Organ by Exposure Pathway

In Year 2830 (70-yr Time Period Number No: 12)

Pathway	Lung	Stomach	S Int.	UL Int.	LL Int.	Bone	Su R	Marro	Testes
Inhalation	2.8E-01	2.1E-04	1.9E-04	2.1E-04	2.5E-04	4.6E-01		3.6E-02	3.5E-03
Ingestion (Terr)	1.5E+01	1.0E+03	2.7E+01	8.5E+01	2.3E+02	5.8E+03		4.7E+02	4.8E+01
Ingestion (Aqua)	5.8E+00	6.6E+00	6.4E+00	9.6E+00	1.8E+01	4.6E+03		3.8E+02	3.7E+01
Drinking Water	1.9E+00	2.2E+01	3.8E+00	1.2E+01	3.5E+01	2.4E+03		1.9E+02	1.5E+01
Total internal	2.3E+01	1.0E+03	3.7E+01	1.1E+02	2.8E+02	1.3E+04		1.0E+03	1.0E+02

Pathway	Ovaries	Muscle	Thyroid	Kidneys	Liver
Inhalation	3.5E-03	1.8E-04	2.4E-04	4.7E-04	2.0E-02
Ingestion (Terr)	4.9E+01	1.5E+01	6.7E+02	4 4E+02	2.3E+02
Ingestion (Aqua)	3.7E+01	5.8E+00	6.3E+00	1.2E+01	2.0E+02
Drinking Water	1.5E+01	1.9E+00	5.5E+01	2.4E+02	8.3E+01
Total internal	1.0E+02	2.3E+01	7.3E+02	6.9E+02	5.1E+02

Dose in units of person-rem;
that is the cumulative population dose received by the local population
with an assumed 70-yr individual lifetime.

```
DITTY Long-Term Surface Water Release TWRS-EIS (In Situ Fill & Cap)
  5
C 14
I 129
NP237
TC99
U 238
 &INPUT IWAT=1, IPATH=2, LUW=1, IPOPL=2,
  CFLO=120000.,
  RM=1.0, TZ=1990., TZR=0.,
  PL1(1)=294830.,391538.,431210.,469891.,1273208.,4932964.,
  TL(1)=1990., 2100.,2200.,2300.,2990.,11900.,
  NTL=6,
  USAGE(1)=0.3,0.,0.,0.,438.,17.,17.,
  CONSUM(1)=15.,276.,20.,230.,40.,30.,8.5,
  EXTIM=2920.,MOPYR=6, RIRR=150.,
  GRWP(1)=90.,90.,90.,30.,3*90.,
  YELD(1)=1.5,4.,0.84,1.3,3*0.84,
 &END
  5
C 14       5
 1990.   0.0
 4994.   0.0
 4995.   0.3518
11995.   0.3518
11996.   0.0
I 129      5
 1990.   0.0
 4994.   0.0
 4995.   0.0021
11995.   0.0021
11996.   0.0
NP237      5
 1990.   0.0
 4994.   0.0
 4995.   0.0085
11995.   0.0085
11996.   0.0
TC99       5
 1990.   0.0
 4994.   0.0
 4995.   3.929
11995.   3.929
11996.   0.0
U 238      5
```

1990.	0.0
4994.	0.0
4995.	0.0619
11995.	0.0619
11996.	0.0

DITTY Dose Calculation Program
(GENII Version 1.485 3-Dec-90)

Integrated population dose calculated for chronic liquid release
Release from time 1990. A.D. onward for 10,000 years
Case title: DITTY Long-Term Surface Water Release TWRS-EIS (In Situ Fill & Cap)
Executed on: 06/18/96 at 10:54:36.0 Page 1

---- DATA LIBRARIES USED ----------(File)-----

Master Radionuclide Data: (2)
Radionuclide Master Library - Long Times (23-July-93 PDR)
Food Concentration Ratios: (8)
PNL Food Transfer Factor Library (by Z, Changed NP&U LF 6/18/96 AMN)
Fresh Water Bioaccumulation Factors: (9)
Bioaccumulation Factor Library - (30-Aug-88) RAP
External Exposure D.F.'s: (10)
External Dose Factors for GENII in person Sv/yr per Bq/X (8-May-90 RAP)
Inhalation/Ingestion D.F.'s: (30)
Worst-Case Solubilities, DITTY Internal Dose Factors (Sv/Bq) (23-Jul-93 PDR)
Waterborne Release Data: (31)
DITTY.IN

---- MASTER RADIONUCLIDE CONTROL LIST ----------
C 14 TC99 I 129 U 238 TH234 PA234 NP237
PA233

---- TERRESTRIAL/AQUATIC PATHWAY DATA FOR AN AVERAGE INDIVIDUAL

Pathway	Growing Period (days)	Yield (kg/m2)	Consumption (kg/yr)	Pathway	Usage (kg or hr/yr)
LEAFY VEG	9.0E+01	1.5E+00	1.5E+01	FISH	3.0E-01
OTHER VEG	9.0E+01	4.0E+00	2.8E+02	CRUSTACEA	0.0E+00
EGGS	9.0E+01	8.4E-01	2.0E+01	MOLLUSES	0.0E+00
MILK	3.0E+01	1.3E+00	2.3E+02	PLANTS	0.0E+00
BEEF	9.0E+01	8.4E-01	4.0E+01	DRINKING WATER	4.4E+02
PORK	9.0E+01	8.4E-01	3.0E+01	SEDIMENT EXPOSU	1.7E+01
POULTRY	9.0E+01	8.4E-01	8.5E+00	SWIMMING TIME	1.7E+01

External Exposure Time: 2.92E+03 hr/yr

---- LIQUID RELEASE PARAMETERS ----------

River Flow Rate, (ft3/sec) : 1.2E+05 Months/Year Irrigated : 6.0E+00
Reconcentration Ratio : 1.0E+00 Irrigation Rate
Mixing Ratio : 1.0E+00 (liters/m2/month) : 1.5E+02

Input Prepared By: _____ Date: _____

Input Checked By: _____ Date: _____

DITTY Dose Calculation Program
(GENII Version 1.485 3-Dec-90)

Integrated population dose calculated for chronic liquid release
Release from time 1990. A.D. onward for 10,000 years
Case title: DITTY Long-Term Surface Water Release TWRS-EIS (In Situ Fill & Cap)
Executed on: 06/18/96 at 10:54:36.0 Page 2

---- WATER RELEASE OF EACH RADIONCLIDE PER 70-YR PERIOD (Ci) ----------

Radio-nuclide	Period/ Activity	Period/ Activity	Period/ Activity	Period/ Activity	Period/ Activity
C 14	43 1.9E+00	44 2.5E+01	45 2.5E+01	46 2.5E+01	47 2.5E+01
	48 2.5E+01	49 2.5E+01	50 2.5E+01	51 2.5E+01	52 2.5E+01
	53 2.5E+01	54 2.5E+01	55 2.5E+01	56 2.5E+01	57 2.5E+01
	58 2.5E+01	59 2.5E+01	60 2.5E+01	61 2.5E+01	62 2.5E+01
	63 2.5E+01	64 2.5E+01	65 2.5E+01	66 2.5E+01	67 2.5E+01
	68 2.5E+01	69 2.5E+01	70 2.5E+01	71 2.5E+01	72 2.5E+01
	73 2.5E+01	74 2.5E+01	75 2.5E+01	76 2.5E+01	77 2.5E+01
	78 2.5E+01	79 2.5E+01	80 2.5E+01	81 2.5E+01	82 2.5E+01
	83 2.5E+01	84 2.5E+01	85 2.5E+01	86 2.5E+01	87 2.5E+01
	88 2.5E+01	89 2.5E+01	90 2.5E+01	91 2.5E+01	92 2.5E+01
	93 .5E+01	94 2.5E+01	95 2.5E+01	96 2.5E+01	97 2.5E+01
	98 2.5E+01	99 2.5E+01	100 2.5E+01	101 2.5E+01	102 2.5E+01
	103 2.5E+01	104 2.5E+01	105 2.5E+01	106 2.5E+01	107 2.5E+01
	108 2.5E+01	109 2.5E+01	110 2.5E+01	111 2.5E+01	112 2.5E+01
	113 2.5E+01	114 2.5E+01	115 2.5E+01	116 2.5E+01	117 2.5E+01
	118 2.5E+01	119 2.5E+01	120 2.5E+01	121 2.5E+01	122 2.5E+01
	123 2.5E+01	124 2.5E+01	125 2.5E+01	126 2.5E+01	127 2.5E+01
	128 2.5E+01	129 2.5E+01	130 2.5E+01	131 2.5E+01	132 2.5E+01
	133 2.5E+01	134 2.5E+01	135 2.5E+01	136 2.5E+01	137 2.5E+01
	138 2.5E+01	139 2.5E+01	140 2.5E+01	141 2.5E+01	142 2.5E+01
	143 2.3E+01				
TC99	43 2.2E+01	44 2.8E+02	45 2.8E+02	46 2.8E+02	47 2.8E+02
	48 2.8E+02	49 2.8E+02	50 2.8E+02	51 2.8E+02	52 2.8E+02
	53 2.8E+02	54 2.8E+02	55 2.8E+02	56 2.8E+02	57 2.8E+02
	58 2.8E+02	59 2.8E+02	60 2.8E+02	61 2.8E+02	62 2.8E+02
	63 2.8E+02	64 2.8E+02	65 2.8E+02	66 2.8E+02	67 2.8E+02
	68 2.8E+02	69 2.8E+02	70 2.8E+02	71 2.8E+02	72 2.8E+02
	73 2.8E+02	74 2.8E+02	75 2.8E+02	76 2.8E+02	77 2.8E+02
	78 2.8E+02	79 2.8E+02	80 2.8E+02	81 2.8E+02	82 2.8E+02
	83 2.8E+02	84 2.8E+02	85 2.8E+02	86 2.8E+02	87 2.8E+02

88 2.8E+02 89 2.8E+02 90 2.8E+02 91 2.8E+02 92 2.8E+02
93 2.8E+02 94 2.8E+02 95 2.8E+02 96 2.8E+02 97 2.8E+02
98 2.8E+02 99 2.8E+02 100 2.8E+02 101 2.8E+02 102 2.8E+02
103 2.8E+02 104 2.8E+02 105 2.8E+02 106 2.8E+02 107 2.8E+02
108 2.8E+02 109 2.8E+02 110 2.8E+02 111 2.8E+02 112 2.8E+02
113 2.8E+02 114 2.8E+02 115 2.8E+02 116 2.8E+02 117 2.8E+02
118 2.8E+02 119 2.8E+02 120 2.8E+02 121 2.8E+02 122 2.8E+02
123 2.8E+02 124 2.8E+02 125 2.8E+02 126 2.8E+02 127 2.8E+02
128 2.8E+02 129 2.8E+02 130 2.8E+02 131 2.8E+02 132 2.8E+02
133 2.8E+02 134 2.8E+02 135 2.8E+02 136 2.8E+02 137 2.8E+02
138 2.8E+02 139 2.8E+02 140 2.8E+02 141 2.8E+02 142 2.8E+02
143 2.6E+02

I 129 43 1.2E-02 44 1.5E-01 45 1.5E-01 46 1.5E-01 47 1.5E-01
48 1.5E-01 49 1.5E-01 50 1.5E-01 51 1.5E-01 52 1.5E-01
53 1.5E-01 54 1.5E-01 55 1.5E-01 56 1.5E-01 57 1.5E-01
58 1.5E-01 59 1.5E-01 60 1.5E-01 61 1.5E-01 62 1.5E-01
63 1.5E-01 64 1.5E-01 65 1.5E-01 66 1.5E-01 67 1.5E-01
68 1.5E-01 69 1.5E-01 70 1.5E-01 71 1.5E-01 72 1.5E-01
73 1.5E-01 74 1.5E-01 75 1.5E-01 76 1.5E-01 77 1.5E-01
78 1.5E-01 79 1.5E-01 80 1.5E-01 81 1.5E-01 82 1.5E-01
83 1.5E-01 84 1.5E-01 85 1.5E-01 86 1.5E-01 87 1.5E-01
88 1.5E-01 89 1.5E-01 90 1.5E-01 91 1.5E-01 92 1.5E-01
93 1.5E-01 94 1.5E-01 95 1.5E-01 96 1.5E-01 97 1.5E-01
98 1.5E-01 99 1.5E-01 100 1.5E-01 101 1.5E-01 102 1.5E-01
103 1.5E-01 104 1.5E-01 105 1.5E-01 106 1.5E-01 107 1.5E-01
108 1.5E-01 109 1.5E-01 110 1.5E-01 111 1.5E-01 112 1.5E-01
113 1.5E-01 114 1.5E-01 115 1.5E-01 116 1.5E-01 117 1.5E-01
118 1.5E-01 119 1.5E-01 120 1.5E-01 121 1.5E-01 122 1.5E-01
123 1.5E-01 124 1.5E-01 125 1.5E-01 126 1.5E-01 127 1.5E-01
128 1.5E-01 129 1.5E-01 130 1.5E-01 131 1.5E-01 132 1.5E-01
133 1.5E-01 134 1.5E-01 135 1.5E-01 136 1.5E-01 137 1.5E-01
138 1.5E-01 139 1.5E-01 140 1.5E-01 141 1.5E-01 142 1.5E-01
143 1.4E-01

U 238 43 3.4E-01 44 4.3E+00 45 4.3E+00 46 4.3E+00 47 4.3E+00
48 4.3E+00 49 4.3E+00 50 4.3E+00 51 4.3E+00 52 4.3E+00
53 4.3E+00 54 4.3E+00 55 4.3E+00 56 4.3E+00 57 4.3E+00
58 4.3E+00 59 4.3E+00 60 4.3E+00 61 4.3E+00 62 4.3E+00
63 4.3E+00 64 4.3E+00 65 4.3E+00 66 4.3E+00 67 4.3E+00
68 4.3E+00 69 4.3E+00 70 4.3E+00 71 4.3E+00 72 4.3E+00
73 4.3E+00 74 4.3E+00 75 4.3E+00 76 4.3E+00 77 4.3E+00
78 4.3E+00 79 4.3E+00 80 4.3E+00 81 4.3E+00 82 4.3E+00
83 4.3E+00 84 4.3E+00 85 4.3E+00 86 4.3E+00 87 4.3E+00
88 4.3E+00 89 4.3E+00 90 4.3E+00 91 4.3E+00 92 4.3E+00
93 4.3E+00 94 4.3E+00 95 4.3E+00 96 4.3E+00 97 4.3E+00
98 4.3E+00 99 4.3E+00 100 4.3E+00 101 4.3E+00 102 4.3E+00

103 4.3E+00 104 4.3E+00 105 4.3E+00 106 4.3E+00 107 4.3E+00
108 4.3E+00 109 4.3E+00 110 4.3E+00 111 4.3E+00 112 4.3E+00
113 4.3E+00 114 4.3E+00 115 4.3E+00 116 4.3E+00 117 4.3E+00
118 4.3E+00 119 4.3E+00 120 4.3E+00 121 4.3E+00 122 4.3E+00
123 4.3E+00 124 4.3E+00 125 4.3E+00 126 4.3E+00 127 4.3E+00
128 4.3E+00 129 4.3E+00 130 4.3E+00 131 4.3E+00 132 4.3E+00
133 4.3E+00 134 4.3E+00 135 4.3E+00 136 4.3E+00 137 4.3E+00
138 4.3E+00 139 4.3E+00 140 4.3E+00 141 4.3E+00 142 4.3E+00
143 4.1E+00

NP237 43 4.7E-02 44 6.0E-01 45 6.0E-01 46 6.0E-01 47 6.0E-01
48 6.0E-01 49 6.0E-01 50 6.0E-01 51 6.0E-01 52 6.0E-01
53 6.0E-01 54 6.0E-01 55 6.0E-01 56 6.0E-01 57 6.0E-01
58 6.0E-01 59 6.0E-01 60 6.0E-01 61 6.0E-01 62 6.0E-01
63 6.0E-01 64 6.0E-01 65 6.0E-01 66 6.0E-01 67 6.0E-01
68 6.0E-01 69 6.0E-01 70 6.0E-01 71 6.0E-01 72 6.0E-01
73 6.0E-01 74 6.0E-01 75 6.0E-01 76 6.0E-01 77 6.0E-01
78 6.0E-01 79 6.0E-01 80 6.0E-01 81 6.0E-01 82 6.0E-01
83 6.0E-01 84 6.0E-01 85 6.0E-01 86 6.0E-01 87 6.0E-01
88 6.0E-01 89 6.0E-01 90 6.0E-01 91 6.0E-01 92 6.0E-01
93 6.0E-01 94 6.0E-01 95 6.0E-01 96 6.0E-01 97 6.0E-01
98 6.0E-01 99 6.0E-01 100 6.0E-01 101 6.0E-01 102 6.0E-01
103 6.0E-01 104 6.0E-01 105 6.0E-01 106 6.0E-01 107 6.0E-01
108 6.0E-01 109 6.0E-01 110 6.0E-01 111 6.0E-01 112 6.0E-01
113 6.0E-01 114 6.0E-01 115 6.0E-01 116 6.0E-01 117 6.0E-01
118 6.0E-01 119 6.0E-01 120 6.0E-01 121 6.0E-01 122 6.0E-01
123 6.0E-01 124 6.0E-01 125 6.0E-01 126 6.0E-01 127 6.0E-01
128 6.0E-01 129 6.0E-01 130 6.0E-01 131 6.0E-01 132 6.0E-01
133 6.0E-01 134 6.0E-01 135 6.0E-01 136 6.0E-01 137 6.0E-01
138 6.0E-01 139 6.0E-01 140 6.0E-01 141 6.0E-01 142 6.0E-01
143 5.6E-01

DITTY Dose Calculation Program
(GENII Version 1.485 3-Dec-90)

Integrated population dose calculated for chronic liquid release
Release from time 1990. A.D. onward for 10,000 years
Case title: DITTY Long-Term Surface Water Release TWRS-EIS (In Situ Fill & Cap)
Executed on: 06/18/96 at 10:54:36.0 Page 3

---- POPULATION DATA ----

Population for Chronic Waterborne Release at the following Times A.D.:

Time	Population
1990.	2.9E+05
2100.	3.9E+05
2200.	4.3E+05
2300.	4.7E+05
2990.	1.3E+06
11900.	4.9E+06

Lifetime Effective Cumulative Dose Equivalent as a Function of Time

Period	Year	Dose
until	until	
44	5000.	2.36E+01
45	5070.	3.27E+02
46	5140.	6.36E+02
47	5210.	9.48E+02
48	5280.	1.26E+03
49	5350.	1.58E+03
50	5420.	1.91E+03
51	5490.	2.24E+03
52	5560.	2.57E+03
53	5630.	2.91E+03
54	5700.	3.25E+03
55	5770.	3.59E+03
56	5840.	3.94E+03
57	5910.	4.30E+03
58	5980.	4.65E+03
59	6050.	5.02E+03
60	6120.	5.38E+03
61	6190.	5.75E+03
62	6260.	6.13E+03
63	6330.	6.51E+03
64	6400.	6.89E+03
65	6470.	7.27E+03
66	6540.	7.66E+03
67	6610.	8.06E+03
68	6680.	8.46E+03
69	6750.	8.86E+03
70	6820.	9.27E+03
71	6890.	9.68E+03
72	6960.	1.01E+04

73	7030.	1.05E+04
74	7100.	1.09E+04
75	7170.	1.14E+04
76	7240.	1.18E+04
77	7310.	1.22E+04
78	7380.	1.27E+04
79	7450.	1.31E+04
80	7520.	1.36E+04
81	7590.	1.40E+04
82	7660.	1.45E+04
83	7730.	1.49E+04
84	7800.	1.54E+04
85	7870.	1.59E+04

Lifetime Effective Cumulative Dose Equivalent as a Function of Time

Period	Year	Dose
86	7940.	1.63E+04
87	8010.	1.68E+04
88	8080.	1.73E+04
89	8150.	1.78E+04
90	8220.	1.83E+04
91	8290.	1.88E+04
92	8360.	1.93E+04
93	8430.	1.98E+04
94	8500.	2.03E+04
95	8570.	2.08E+04
96	8640.	2.13E+04
97	8710.	2.18E+04
98	8780.	2.24E+04
99	8850.	2.29E+04
100	8920.	2.34E+04
101	8990.	2.39E+04
102	9060.	2.45E+04
103	9130.	2.50E+04
104	9200.	2.56E+04
105	9270.	2.61E+04
106	9340.	2.67E+04
107	9410.	2.72E+04
108	9480.	2.78E+04
109	9550.	2.84E+04
110	9620.	2.90E+04
111	9690.	2.95E+04
112	9760.	3.01E+04
113	9830.	3.07E+04
114	9900.	3.13E+04
115	9970.	3.19E+04

116	10040.	3.25E+04
117	10110.	3.31E+04
118	10180.	3.37E+04
119	10250.	3.43E+04
120	10320.	3.49E+04
121	10390.	3.55E+04
122	10460.	3.61E+04
123	10530.	3.68E+04
124	10600.	3.74E+04
125	10670.	3.80E+04
126	10740.	3.87E+04
127	10810.	3.93E+04
128	10880.	4.00E+04
---	---	---

No
See Next page

Lifetime Effective Cumulative Dose Equivalent as a Function of Time

Period	Year	Dose
129	10950.	4.06E+04
130	11020.	4.13E+04
131	11090.	4.19E+04
132	11160.	4.26E+04
133	11230.	4.33E+04
134	11300.	4.39E+04
135	11370.	4.46E+04
136	11440.	4.53E+04
137	11510.	4.60E+04
138	11580.	4.67E+04
139	11650.	4.74E+04
140	11720.	4.81E+04
141	11790.	4.88E+04
142	11860.	4.95E+04
143	11930.	5.02E+04
144	12000.	5.08E+04

Dose in units of person-rem;
that is the cumulative population dose received by the local population over 10,000 years with an assumed 70-yr individual lifetime.

Cumulative Population Dose Equivalent by Radionuclide

Radio-nuclide	Effective Dose Equivalent	Annual External Dose	Effective Dose Equivalent	Percent Of Total Dose
C 14	1.6E+03	7.5E-02	1.6E+03	3
TC 99	3.3E+04	2.0E-02	3.3E+04	64
I 129	4.0E+02	1.3E-03	4.0E+02	0
U 238	2.8E+03	5.8E-04	2.8E+03	5
TH 234	3.0E-01	3.8E-01	6.8E-01	0
PA 234	9.9E-04	6.0E-02	6.1E-02	0
NP 237	1.4E+04	6.8E-02	1.4E+04	26
PA 233	1.4E-01	1.6E+00	1.8E+00	0

Dose in units of person-rem;
that is the cumulative population dose received by the local population
with an assumed 70-yr individual lifetime.

Maximum Dose Increment Received By Population
In Year 12000 (70-yr Time Period Number No: 143)

Organ	Cumulative Dose Equivalent	Weighting Factors	Weighted Cumulative Dose Equivalent
Gonads	1.0E+02	2.5E-01	2.5E+01
Breast	7.2E+01	1.5E-01	1.1E+01
R Marrow	4.7E+02	1.2E-01	5.6E+01
Lung	7.2E+01	1.2E-01	8.7E+00
Thyroid	1.4E+03	3.0E-02	4.2E+01
Bone Sur	4.9E+03	3.0E-02	1.5E+02
Stomach	5.2E+03	6.0E-02	3.1E+02
LL Int.	9.1E+02	6.0E-02	5.4E+01
UL Int.	3.5E+02	6.0E-02	2.1E+01
Kidneys	2.6E+02	6.0E-02	1.6E+01
Liver	2.5E+02	6.0E-02	1.5E+01

Cumulative Effective Dose Equivalent 7.1E+02
External Dose 3.1E-02

Lifetime Effective Cumulative
Dose Equivalent 7.1E+02

Dose in units of person-rem;
that is the cumulative population dose received by the local population
with an assumed 70-yr individual lifetime.

DITTY Dose Calculation Program
(GENII Version 1.485 3-Dec-90)

Integrated population dose calculated for chronic liquid release
Release from time 1990. A.D. onward for 10,000 years
Case title: DITTY Long-Term Surface Water Release TWRS-EIS (In Situ Fill & Cap)
Executed on: 06/18/96 at 10:54:36.0 Page 9

Maximum Dose Increment Received By Individual (rem)
In Year 12000 (70-yr Time Period Number No: 143)

Radio-nuclide	Effective Dose Equivalent	Annual Effective External Dose	Effective Dose Equivalent	Percent Of Total Dose
C 14	4.6E-06	2.1E-10	4.6E-06	3
TC 99	9.3E-05	5.7E-11	9.3E-05	64
I 129	1.1E-06	3.6E-12	1.1E-06	0
U 238	8.0E-06	1.6E-12	8.0E-06	5
TH 234	8.4E-10	1.1E-09	1.9E-09	0
PA 234	2.8E-12	1.7E-10	1.7E-10	0
NP 237	3.9E-05	1.9E-10	3.9E-05	26
PA 233	3.8E-10	4.6E-09	5.0E-09	0

1.457E-4

Population Internal Dose To Organ by Radionuclide
In Year 12000 (70-yr Time Period Number No: 143)

Radionuclide	Lung	Stomach	S Int.	UL Int.	LL Int.	Bone Su	R Marro	Testes
C 14	2.3E+01	2.3E+01	2.3E+01	2.3E+01	2.3E+01	2.9E+01	2.9E+01	2.3E+01
TC 99	4.8E+01	5.2E+03	9.3E+01	3.1E+02	8.4E+02	5.6E+01	5.6E+01	4.8E+01
I 129	1.2E-02	1.7E-02	1.1E-02	1.1E-02	1.1E-02	1.5E-02	1.6E-02	9.9E-03
U 238	1.5E+00	2.0E+00	3.0E+00	1.0E+01	3.0E+01	5.3E+02	3.5E+01	1.4E+00
TH 234	3.0E-05	1.1E-03	2.7E-03	1.6E-02	4.8E-02	2.3E-05	1.9E-05	2.6E-06
PA 234	3.6E-07	1.7E-05	3.5E-05	7.4E-05	6.1E-05	6.5E-07	1.8E-06	5.5E-07
NP 237	2.6E-02	2.5E-01	5.9E-01	3.2E+00	9.9E+00	4.3E+03	3.5E+02	3.0E+01
PA 233	8.3E-06	5.5E-04	1.5E-03	6.9E-03	2.0E-02	1.9E-04	1.4E-04	4.2E-05
Total internal	7.2E+01	5.2E+03	1.2E+02	3.5E+02	9.1E+02	4.9E+03	4.7E+02	1.0E+02

Radionuclide	Ovaries	Muscle	Thyroid	Kidneys	Liver
C 14	2.3E+01	2.3E+01	2.3E+01	0.0E+00	0.0E+00
TC 99	4.8E+01	4.8E+01	1.2E+03	0.0E+00	6.5E+01
I 129	1.1E-02	2.6E-02	1.9E+02	0.0E+00	0.0E+00
U 238	1.5E+00	1.4E+00	1.5E+00	2.6E+02	0.0E+00
TH 234	3.2E-05	3.7E-06	3.3E-07	0.0E+00	4.5E-06
PA 234	7.7E-06	1.2E-06	4.2E-08	1.9E-06	1.4E-06
NP 237	3.0E+01	2.4E-02	1.7E-02	0.0E+00	1.9E+02
PA 233	5.0E-04	5.3E-05	9.7E-07	6.6E-05	4.7E-05
Total internal	1.0E+02	7.2E+01	1.4E+03	2.6E+02	2.5E+02

Population Air Submersion and External Incremental Dose by Radionuclide
In Year 12000 (70-yr Time Period Number No: 143)

Radionuclide	Air Submer-sion	External
C 14	1.3E-09	1.0E-03
TC 99	2.3E-10	2.8E-04
I 129	2.9E-11	1.8E-05
U 238	1.3E-11	8.1E-06
TH 234	2.1E-09	5.4E-03
PA 234	3.0E-10	8.4E-04
NP 237	1.8E-10	9.5E-04
PA 233	3.0E-09	2.3E-02
Total external	7.2E-09	3.1E-02

Dose in units of person-rem;
that is the cumulative population dose received by the local population with an assumed 70-yr individual lifetime.

Population Internal Dose To Organ by Exposure Pathway

In Year 12000 (70-yr Time Period Number No: 143)

Pathway	Lung	Stomach S Int.	UL Int.	LL Int.	Bone Su	R Marro	Testes	
Inhalation	1.1E-01	5.9E-04	4.5E-04	4.7E-04	4.9E-04	1.7E-01	1.4E-02	1.7E-03
Ingestion (Terr)	5.6E+01	5.1E+03	1.0E+02	3.2E+02	8.6E+02	2.2E+03	2.4E+02	6.8E+01
Ingestion (Aqua)	1.4E+01	1.7E+01	1.5E+01	1.6E+01	1.9E+01	1.8E+03	1.6E+02	2.6E+01
Drinking Water	2.4E+00	1.0E+02	3.9E+00	1.1E+01	2.9E+01	9.0E+02	7.2E+01	7.3E+00
Total internal	7.2E+01	5.2E+03	1.2E+02	3.5E+02	9.1E+02	4.9E+03	4.7E+02	1.0E+02

Pathway	Ovaries	Muscle	Thyroid	Kidneys	Liver
Inhalation	1.7E-03	4.5E-04	5.0E-04	1.8E-04	7.6E-03
Ingestion (Terr)	6.8E+01	5.6E+01	1.3E+03	1.7E+02	1.4E+02
Ingestion (Aqua)	2.6E+01	1.4E+01	1.5E+01	4.4E+00	7.6E+01
Drinking Water	7.4E+00	2.4E+00	4.3E+01	9.0E+01	3.2E+01
Total internal	1.0E+02	7.2E+01	1.4E+03	2.6E+02	2.5E+02

Dose in units of person-rem;
that is the cumulative population dose received by the local population
with an assumed 70-yr individual lifetime.

```
DITTY Long-Term Surface Water Release TWRS-EIS (Ex Situ In Situ Combo)
  5
C 14
I 129
NP237
TC99
U 238
 &INPUT IWAT=1, IPATH=2, LUW=1, IPOPL=2,
  CFLO=120000.,
  RM=1.0, TZ=1990., TZR=0.,
  PL1(1)=294830.,391538.,431210.,469891.,1273208.,4932964.,
  TL(1)=1990., 2100.,2200.,2300.,2990.,11900.,
  NTL=6,
  USAGE(1)=0.3,0.,0.,0.,438.,17.,17.,
  CONSUM(1)=15.,276.,20.,230.,40.,30.,8.5,
  EXTIM=2920.,MOPYR=6, RIRR=150.,
  GRWP(1)=90.,90.,90.,30.,3*90.,
  YELD(1)=1.5,4.,0.84,1.3,3*0.84,
 &END
  5
C 14       5
 1990.   0.0
 4244.   0.0
 4245.   0.0199
11995.   0.0199
11996.   0.0
I 129      5
 1990.   0.0
 4244.   0.0
 4245.   0.0002
11995.   0.0002
11996.   0.0
NP237      5
 1990.   0.0
 4244.   0.0
 4245.   0.0006
11995.   0.0006
11996.   0.0
TC99       5
 1990.   0.0
 4244.   0.0
 4245.   0.3326
11995.   0.3326
11996.   0.0
U 238      5
```

1990.	0.0
4244.	0.0
4245.	0.0075
11995.	0.0075
11996.	0.0

DITTY Dose Calculation Program
(GENII Version 1.485 3-Dec-90)

Integrated population dose calculated for chronic liquid release
Release from time 1990. A.D. onward for 10,000 years
Case title: DITTY Long-Term Surface Water Release TWRS-EIS (Ex Situ In Situ Combo)
Executed on: 06/18/96 at 10:54:54.8 Page 1

---- DATA LIBRARIES USED ----------(File)-----

Master Radionuclide Data: (2)
Radionuclide Master Library - Long Times (23-July-93 PDR)
Food Concentration Ratios: (8)
PNL Food Transfer Factor Library (by Z, Changed NP&U LF 6/18/96 AMN)
Fresh Water Bioaccumulation Factors: (9)
Bioaccumulation Factor Library - (30-Aug-88) RAP
External Exposure D.F.'s: (10)
External Dose Factors for GENII in person Sv/yr per Bq/X (8-May-90 RAP)
Inhalation/Ingestion D.F.'s: (30)
Worst-Case Solubilities, DITTY Internal Dose Factors (Sv/Bq) (23-Jul-93 PDR)
Waterborne Release Data: (31)
DITTY.IN

---- MASTER RADIONUCLIDE CONTROL LIST ----------
C 14 TC99 I 129 U 238 TH234 PA234 NP237
PA233

---- TERRESTRIAL/AQUATIC PATHWAY DATA FOR AN AVERAGE INDIVIDUAL

Pathway	Growing Period (days)	Yield (kg/m2)	Consumption (kg/yr)	Pathway	Usage (kg or hr/yr)
LEAFY VEG	9.0E+01	1.5E+00	1.5E+01	FISH	3.0E-01
OTHER VEG	9.0E+01	4.0E+00	2.8E+02	CRUSTACEA	0.0E+00
EGGS	9.0E+01	8.4E-01	2.0E+01	MOLLUSES	0.0E+00
MILK	3.0E+01	1.3E+00	2.3E+02	PLANTS	0.0E+00
BEEF	9.0E+01	8.4E-01	4.0E+01	DRINKING WATER	4.4E+02
PORK	9.0E+01	8.4E-01	3.0E+01	SEDIMENT EXPOSU	1.7E+01
POULTRY	9.0E+01	8.4E-01	8.5E+00	SWIMMING TIME	1.7E+01

External Exposure Time: 2.92E+03 hr/yr

---- LIQUID RELEASE PARAMETERS ----------

River Flow Rate, (ft3/sec) : 1.2E+05 Months/Year Irrigated : 6.0E+00
Reconcentration Ratio : 1.0E+00 Irrigation Rate
Mixing Ratio : 1.0E+00 (liters/m2/month) : 1.5E+02

Input Prepared By: _____ Date: _____

Input Checked By: _____ Date: _____

DITTY Dose Calculation Program
(GENII Version 1.485 3-Dec-90)

Integrated population dose calculated for chronic liquid release
Release from time 1990. A.D. onward for 10,000 years
Case title: DITTY Long-Term Surface Water Release TWRS-EIS (Ex Situ In Situ Combo)
Executed on: 06/18/96 at 10:54:54.8 Page 2

---- WATER RELEASE OF EACH RADIONCLIDE PER 70-YR PERIOD (Ci) ----------

Radio-nuclide	Period/ Activity	Period/ Activity	Period/ Activity	Period/ Activity	Period/ Activity
C 14	33 1.1E+00	34 1.4E+00	35 1.4E+00	36 1.4E+00	37 1.4E+00
	38 1.4E+00	39 1.4E+00	40 1.4E+00	41 1.4E+00	42 1.4E+00
	43 1.4E+00	44 1.4E+00	45 1.4E+00	46 1.4E+00	47 1.4E+00
	48 1.4E+00	49 1.4E+00	50 1.4E+00	51 1.4E+00	52 1.4E+00
	53 1.4E+00	54 1.4E+00	55 1.4E+00	56 1.4E+00	57 1.4E+00
	58 1.4E+00	59 1.4E+00	60 1.4E+00	61 1.4E+00	62 1.4E+00
	63 1.4E+00	64 1.4E+00	65 1.4E+00	66 1.4E+00	67 1.4E+00
	68 1.4E+00	69 1.4E+00	70 1.4E+00	71 1.4E+00	72 1.4E+00
	73 1.4E+00	74 1.4E+00	75 1.4E+00	76 1.4E+00	77 1.4E+00
	78 1.4E+00	79 1.4E+00	80 1.4E+00	81 1.4E+00	82 1.4E+00
	83 1.4E+00	84 1.4E+00	85 1.4E+00	86 1.4E+00	87 1.4E+00
	88 1.4E+00	89 1.4E+00	90 1.4E+00	91 1.4E+00	92 1.4E+00
	93 1.4E+00	94 1.4E+00	95 1.4E+00	96 1.4E+00	97 1.4E+00
	98 1.4E+00	99 1.4E+00	100 1.4E+00	101 1.4E+00	102 1.4E+00
	103 1.4E+00	104 1.4E+00	105 1.4E+00	106 1.4E+00	107 1.4E+00
	108 1.4E+00	109 1.4E+00	110 1.4E+00	111 1.4E+00	112 1.4E+00
	113 1.4E+00	114 1.4E+00	115 1.4E+00	116 1.4E+00	117 1.4E+00
	118 1.4E+00	119 1.4E+00	120 1.4E+00	121 1.4E+00	122 1.4E+00
	123 1.4E+00	124 1.4E+00	125 1.4E+00	126 1.4E+00	127 1.4E+00
	128 1.4E+00	129 1.4E+00	130 1.4E+00	131 1.4E+00	132 1.4E+00
	133 1.4E+00	134 1.4E+00	135 1.4E+00	136 1.4E+00	137 1.4E+00
	138 1.4E+00	139 1.4E+00	140 1.4E+00	141 1.4E+00	142 1.4E+00
	143 1.3E+00				
TC99	33 1.8E+01	34 2.3E+01	35 2.3E+01	36 2.3E+01	37 2.3E+01
	38 2.3E+01	39 2.3E+01	40 2.3E+01	41 2.3E+01	42 2.3E+01
	43 2.3E+01	44 2.3E+01	45 2.3E+01	46 2.3E+01	47 2.3E+01
	48 2.3E+01	49 2.3E+01	50 2.3E+01	51 2.3E+01	52 2.3E+01
	53 2.3E+01	54 2.3E+01	55 2.3E+01	56 2.3E+01	57 2.3E+01
	58 2.3E+01	59 2.3E+01	60 2.3E+01	61 2.3E+01	62 2.3E+01
	63 2.3E+01	64 2.3E+01	65 2.3E+01	66 2.3E+01	67 2.3E+01

68 2.3E+01 69 2.3E+01 70 2.3E+01 71 2.3E+01 72 2.3E+01
73 2.3E+01 74 2.3E+01 75 2.3E+01 76 2.3E+01 77 2.3E+01
78 2.3E+01 79 2.3E+01 80 2.3E+01 81 2.3E+01 82 2.3E+01
83 2.3E+01 84 2.3E+01 85 2.3E+01 86 2.3E+01 87 2.3E+01
88 2.3E+01 89 2.3E+01 90 2.3E+01 91 2.3E+01 92 2.3E+01
93 2.3E+01 94 2.3E+01 95 2.3E+01 96 2.3E+01 97 2.3E+01
98 2.3E+01 99 2.3E+01 100 2.3E+01 101 2.3E+01 102 2.3E+01
103 2.3E+01 104 2.3E+01 105 2.3E+01 106 2.3E+01 107 2.3E+01
108 2.3E+01 109 2.3E+01 110 2.3E+01 111 2.3E+01 112 2.3E+01
113 2.3E+01 114 2.3E+01 115 2.3E+01 116 2.3E+01 117 2.3E+01
118 2.3E+01 119 2.3E+01 120 2.3E+01 121 2.3E+01 122 2.3E+01
123 2.3E+01 124 2.3E+01 125 2.3E+01 126 2.3E+01 127 2.3E+01
128 2.3E+01 129 2.3E+01 130 2.3E+01 131 2.3E+01 132 2.3E+01
133 2.3E+01 134 2.3E+01 135 2.3E+01 136 2.3E+01 137 2.3E+01
138 2.3E+01 139 2.3E+01 140 2.3E+01 141 2.3E+01 142 2.3E+01
143 2.2E+01

I 129 33 1.1E-02 34 1.4E-02 35 1.4E-02 36 1.4E-02 37 1.4E-02
38 1.4E-02 39 1.4E-02 40 1.4E-02 41 1.4E-02 42 1.4E-02
43 1.4E-02 44 1.4E-02 45 1.4E-02 46 1.4E-02 47 1.4E-02
48 1.4E-02 49 1.4E-02 50 1.4E-02 51 1.4E-02 52 1.4E-02
53 1.4E-02 54 1.4E-02 55 1.4E-02 56 1.4E-02 57 1.4E-02
58 1.4E-02 59 1.4E-02 60 1.4E-02 61 1.4E-02 62 1.4E-02
63 1.4E-02 64 1.4E-02 65 1.4E-02 66 1.4E-02 67 1.4E-02
68 1.4E-02 69 1.4E-02 70 1.4E-02 71 1.4E-02 72 1.4E-02
73 1.4E-02 74 1.4E-02 75 1.4E-02 76 1.4E-02 77 1.4E-02
78 1.4E-02 79 1.4E-02 80 1.4E-02 81 1.4E-02 82 1.4E-02
83 1.4E-02 84 1.4E-02 85 1.4E-02 86 1.4E-02 87 1.4E-02
88 1.4E-02 89 1.4E-02 90 1.4E-02 91 1.4E-02 92 1.4E-02
93 1.4E-02 94 1.4E-02 95 1.4E-02 96 1.4E-02 97 1.4E-02
98 1.4E-02 99 1.4E-02 100 1.4E-02 101 1.4E-02 102 1.4E-02
103 1.4E-02 104 1.4E-02 105 1.4E-02 106 1.4E-02 107 1.4E-02
108 1.4E-02 109 1.4E-02 110 1.4E-02 111 1.4E-02 112 1.4E-02
113 1.4E-02 114 1.4E-02 115 1.4E-02 116 1.4E-02 117 1.4E-02
118 1.4E-02 119 1.4E-02 120 1.4E-02 121 1.4E-02 122 1.4E-02
123 1.4E-02 124 1.4E-02 125 1.4E-02 126 1.4E-02 127 1.4E-02
128 1.4E-02 129 1.4E-02 130 1.4E-02 131 1.4E-02 132 1.4E-02
133 1.4E-02 134 1.4E-02 135 1.4E-02 136 1.4E-02 137 1.4E-02
138 1.4E-02 139 1.4E-02 140 1.4E-02 141 1.4E-02 142 1.4E-02
143 1.3E-02

U 238 33 4.2E-01 34 5.2E-01 35 5.2E-01 36 5.2E-01 37 5.2E-01
38 5.2E-01 39 5.2E-01 40 5.2E-01 41 5.2E-01 42 5.2E-01
43 5.2E-01 44 5.2E-01 45 5.2E-01 46 5.2E-01 47 5.2E-01
48 5.2E-01 49 5.2E-01 50 5.2E-01 51 5.2E-01 52 5.2E-01
53 5.2E-01 54 5.2E-01 55 5.2E-01 56 5.2E-01 57 5.2E-01
58 5.2E-01 59 5.2E-01 60 5.2E-01 61 5.2E-01 62 5.2E-01

63 5.2E-01 64 5.2E-01 65 5.2E-01 66 5.2E-01 67 5.2E-01
68 5.2E-01 69 5.2E-01 70 5.2E-01 71 5.2E-01 72 5.2E-01
73 5.2E-01 74 5.2E-01 75 5.2E-01 76 5.2E-01 77 5.2E-01
78 5.2E-01 79 5.2E-01 80 5.2E-01 81 5.2E-01 82 5.2E-01
83 5.2E-01 84 5.2E-01 85 5.2E-01 86 5.2E-01 87 5.2E-01
88 5.2E-01 89 5.2E-01 90 5.2E-01 91 5.2E-01 92 5.2E-01
93 5.2E-01 94 5.2E-01 95 5.2E-01 96 5.2E-01 97 5.2E-01
98 5.2E-01 99 5.2E-01 100 5.2E-01 101 5.2E-01 102 5.2E-01
103 5.2E-01 104 5.2E-01 105 5.2E-01 106 5.2E-01 107 5.2E-01
108 5.2E-01 109 5.2E-01 110 5.2E-01 111 5.2E-01 112 5.2E-01
113 5.2E-01 114 5.2E-01 115 5.2E-01 116 5.2E-01 117 5.2E-01
118 5.2E-01 119 5.2E-01 120 5.2E-01 121 5.2E-01 122 5.2E-01
123 5.2E-01 124 5.2E-01 125 5.2E-01 126 5.2E-01 127 5.2E-01
128 5.2E-01 129 5.2E-01 130 5.2E-01 131 5.2E-01 132 5.2E-01
133 5.2E-01 134 5.2E-01 135 5.2E-01 136 5.2E-01 137 5.2E-01
138 5.2E-01 139 5.2E-01 140 5.2E-01 141 5.2E-01 142 5.2E-01
143 4.9E-01

NP237 33 3.3E-02 34 4.2E-02 35 4.2E-02 36 4.2E-02 37 4.2E-02
38 4.2E-02 39 4.2E-02 40 4.2E-02 41 4.2E-02 42 4.2E-02
43 4.2E-02 44 4.2E-02 45 4.2E-02 46 4.2E-02 47 4.2E-02
48 4.2E-02 49 4.2E-02 50 4.2E-02 51 4.2E-02 52 4.2E-02
53 4.2E-02 54 4.2E-02 55 4.2E-02 56 4.2E-02 57 4.2E-02
58 4.2E-02 59 4.2E-02 60 4.2E-02 61 4.2E-02 62 4.2E-02
63 4.2E-02 64 4.2E-02 65 4.2E-02 66 4.2E-02 67 4.2E-02
68 4.2E-02 69 4.2E-02 70 4.2E-02 71 4.2E-02 72 4.2E-02
73 4.2E-02 74 4.2E-02 75 4.2E-02 76 4.2E-02 77 4.2E-02
78 4.2E-02 79 4.2E-02 80 4.2E-02 81 4.2E-02 82 4.2E-02
83 4.2E-02 84 4.2E-02 85 4.2E-02 86 4.2E-02 87 4.2E-02
88 4.2E-02 89 4.2E-02 90 4.2E-02 91 4.2E-02 92 4.2E-02
93 4.2E-02 94 4.2E-02 95 4.2E-02 96 4.2E-02 97 4.2E-02
98 4.2E-02 99 4.2E-02 100 4.2E-02 101 4.2E-02 102 4.2E-02
103 4.2E-02 104 4.2E-02 105 4.2E-02 106 4.2E-02 107 4.2E-02
108 4.2E-02 109 4.2E-02 110 4.2E-02 111 4.2E-02 112 4.2E-02
113 4.2E-02 114 4.2E-02 115 4.2E-02 116 4.2E-02 117 4.2E-02
118 4.2E-02 119 4.2E-02 120 4.2E-02 121 4.2E-02 122 4.2E-02
123 4.2E-02 124 4.2E-02 125 4.2E-02 126 4.2E-02 127 4.2E-02
128 4.2E-02 129 4.2E-02 130 4.2E-02 131 4.2E-02 132 4.2E-02
133 4.2E-02 134 4.2E-02 135 4.2E-02 136 4.2E-02 137 4.2E-02
138 4.2E-02 139 4.2E-02 140 4.2E-02 141 4.2E-02 142 4.2E-02
143 3.9E-02

Lifetime Effective Cumulative Dose Equivalent as a Function of Time

Period	Year	Dose
until	until	
34	4300.	1.68E+01
35	4370.	3.84E+01
36	4440.	6.03E+01
37	4510.	8.25E+01
38	4580.	1.05E+02
39	4650.	1.28E+02
40	4720.	1.51E+02
41	4790.	1.75E+02
42	4860.	1.99E+02
43	4930.	2.23E+02
44	5000.	2.48E+02
45	5070.	2.73E+02
46	5140.	2.98E+02
47	5210.	3.24E+02
48	5280.	3.50E+02
49	5350.	3.76E+02
50	5420.	4.03E+02
51	5490.	4.30E+02
52	5560.	4.57E+02
53	5630.	4.85E+02
54	5700.	5.13E+02
55	5770.	5.41E+02
56	5840.	5.70E+02
57	5910.	5.99E+02
58	5980.	6.28E+02
59	6050.	6.58E+02
60	6120.	6.88E+02
61	6190.	7.18E+02
62	6260.	7.49E+02

63	6330.	7.80E+02
64	6400.	8.11E+02
65	6470.	8.43E+02
66	6540.	8.75E+02
67	6610.	9.08E+02
68	6680.	9.41E+02
69	6750.	9.74E+02
70	6820.	1.01E+03
71	6890.	1.04E+03
72	6960.	1.08E+03
73	7030.	1.11E+03
74	7100.	1.14E+03
75	7170.	1.18E+03

Lifetime Effective Cumulative Dose Equivalent as a Function of Time

Period	Year	Dose
76	7240.	1.21E+03
77	7310.	1.25E+03
78	7380.	1.29E+03
79	7450.	1.32E+03
80	7520.	1.36E+03
81	7590.	1.40E+03
82	7660.	1.44E+03
83	7730.	1.47E+03
84	7800.	1.51E+03
85	7870.	1.55E+03
86	7940.	1.59E+03
87	8010.	1.63E+03
88	8080.	1.67E+03
89	8150.	1.71E+03
90	8220.	1.75E+03
91	8290.	1.79E+03
92	8360.	1.83E+03
93	8430.	1.87E+03
94	8500.	1.91E+03
95	8570.	1.95E+03
96	8640.	2.00E+03
97	8710.	2.04E+03
98	8780.	2.08E+03
99	8850.	2.12E+03
100	8920.	2.17E+03
101	8990.	2.21E+03
102	9060.	2.26E+03
103	9130.	2.30E+03
104	9200.	2.35E+03
105	9270.	2.39E+03

106	9340.	2.44E+03
107	9410.	2.48E+03
108	9480.	2.53E+03
109	9550.	2.58E+03
110	9620.	2.62E+03
111	9690.	2.67E+03
112	9760.	2.72E+03
113	9830.	2.77E+03
114	9900.	2.82E+03
115	9970.	2.86E+03
116	10040.	2.91E+03
117	10110.	2.96E+03
118	10180.	3.01E+03

DITTY Dose Calculation Program
(GENII Version 1.485 3-Dec-90)

Integrated population dose calculated for chronic liquid release
Release from time 1990. A.D. onward for 10,000 years
Case title: DITTY Long-Term Surface Water Release TWRS-EIS (Ex Situ In Situ Combo)
Executed on: 06/18/96 at 10:54:54.8

Lifetime Effective Cumulative Dose Equivalent as a Function of Time

Period	Year	Dose
119	10250.	3.06E+03
120	10320.	3.11E+03
121	10390.	3.16E+03
122	10460.	3.21E+03
123	10530.	3.27E+03
124	10600.	3.32E+03
125	10670.	3.37E+03
126	10740.	3.42E+03
127	10810.	3.48E+03
128	10880.	3.53E+03
129	10950.	3.58E+03
130	11020.	3.64E+03
131	11090.	3.69E+03
132	11160.	3.74E+03
133	11230.	3.80E+03
134	11300.	3.85E+03
135	11370.	3.91E+03
136	11440.	3.97E+03
137	11510.	4.02E+03
138	11580.	4.08E+03
139	11650.	4.14E+03
140	11720.	4.19E+03
141	11790.	4.25E+03
142	11860.	4.31E+03
143	11930.	4.37E+03
144	12000.	4.42E+03

Dose in units of person-rem;

that is the cumulative population dose received by the local population over 10,000 years with an assumed 70-yr individual lifetime.

Cumulative Population Dose Equivalent by Radionuclide

Radio-nuclide	Effective Dose Equivalent	Annual External Dose	Effective Dose Equivalent	Percent Of Total Dose
C 14	9.8E+01	4.5E-03	9.8E+01	2
TC 99	2.9E+03	1.8E-03	2.9E+03	66
I 129	4.0E+01	1.3E-04	4.0E+01	0
U 238	3.6E+02	7.4E-05	3.6E+02	8
TH 234	3.8E-02	4.9E-02	8.7E-02	0
PA 234	1.3E-04	7.7E-03	7.8E-03	0
NP 237	1.0E+03	5.1E-03	1.0E+03	23
PA 233	1.0E-02	1.2E-01	1.3E-01	0

Dose in units of person-rem;
that is the cumulative population dose received by the local population
with an assumed 70-yr individual lifetime.

Maximum Dose Increment Received By Population
In Year 12000 (70-yr Time Period Number No: 143)

Organ	Cumulative Dose Equivalent	Weighting Factors	Weighted Cumulative Dose Equivalent
Gonads	7.6E+00	2.5E-01	1.9E+00
Breast	5.5E+00	1.5E-01	8.3E-01.
R Marrow	3.5E+01	1.2E-01	4.2E+00
Lung	5.5E+00	1.2E-01	6.6E-01
Thyroid	1.2E+02	3.0E-02	3.6E+00
Bone Sur	3.7E+02	3.0E-02	1.1E+01
Stomach	4.4E+02	6.0E-02	2.6E+01
LL Int.	7.7E+01	6.0E-02	4.6E+00
Kidneys	3.2E+01	6.0E-02	1.9E+00
UL Int.	2.9E+01	6.0E-02	1.8E+00
Liver	1.9E+01	6.0E-02	1.1E+00

Cumulative Effective Dose Equivalent 5.8E+01
External Dose 2.5E-03

Lifetime Effective Cumulative
Dose Equivalent 5.8E+01

Dose in units of person-rem;
that is the cumulative population dose received by the local population
with an assumed 70-yr individual lifetime.

Maximum Dose Increment Received By Individual (rem)
In Year 12000 (70-yr Time Period Number No: 43)

Radio-nuclide	Effective Dose Equivalent	Annual External Dose	Effective Dose Equivalent	Percent Of Total Dose
C 14	2.6E-07	1.2E-11	2.6E-07	2
TC 99	7.9E-06	4.8E-12	7.9E-06	66
I 129	1.1E-07	3.4E-13	1.1E-07	0
U 238	9.6E-07	2.0E-13	9.6E-07	8
TH 234	1.0E-10	1.3E-10	2.3E-10	0
PA 234	3.4E-13	2.1E-11	2.1E-11	0
NP 237	2.7E-06	1.4E-11	2.7E-06	23
PA 233	2.7E-11	3.2E-10	3.5E-10	0

1.193E-5

Population Internal Dose To Organ by Radionuclide
In Year 12000 (70-yr Time Period Number No: 143)

Radionuclide	Lung	Stomach	S Int.	UL Int.	LL Int.	Bone	Su R	Marro	Testes
C 14	1.3E+00	1.3E+00	1.3E+00	1.3E+00	1.3E+00	1.6E+00	1.6E+00	1.3E+00	
TC 99	4.0E+00	4.4E+02	7.9E+00	2.7E+01	7.1E+01	4.8E+00	4.8E+00	4.0E+00	
I 129	1.2E-03	1.7E-03	1.0E-03	1.0E-03	1.0E-03	1.4E-03	1.5E-03	9.4E-04	
U 238	1.8E-01	2.5E-01	3.6E-01	1.2E+00	3.6E+00	6.4E+01	4.3E+00	1.7E-01	
TH 234	3.7E-06	1.4E-04	3.3E-04	2.0E-03	5.9E-03	2.8E-06	2.4E-06	3.1E-07	
PA 234	4.3E-08	2.1E-06	4.3E-06	9.0E-06	7.4E-06	7.8E-08	2.2E-07	6.6E-08	
NP 237	1.9E-03	1.7E-02	4.2E-02	2.3E-01	7.0E-01	3.0E+02	2.5E+01	2.1E+00	
PA 233	5.8E-07	3.9E-05	1.1E-04	4.9E-04	1.4E-03	1.4E-05	9.6E-06	2.9E-06	
Total internal	5.5E+00	4.4E+02	9.6E+00	2.9E+01	7.7E+01	3.7E+02	3.5E+01	7.6E+00	

Radionuclide	Ovaries	Muscle	Thyroid	Kidneys	Liver
C 14	1.3E+00	1.3E+00	1.3E+00	0.0E+00	0.0E+00
TC 99	4.0E+00	4.0E+00	1.0E+02	0.0E+00	5.5E+00
I 129	1.0E-03	2.5E-03	1.8E+01	0.0E+00	0.0E+00
U 238	1.8E-01	1.7E-01	1.8E-01	3.2E+01	0.0E+00
TH 234	3.9E-06	4.5E-07	4.0E-08	0.0E+00	5.5E-07
PA 234	9.4E-07	1.4E-07	5.1E-09	2.3E-07	1.7E-07
NP 237	2.1E+00	1.7E-03	1.2E-03	0.0E+00	1.3E+01
PA 233	3.5E-05	3.7E-06	6.9E-08	4.7E-06	3.3E-06
Total internal	7.6E+00	5.5E+00	1.2E+02	3.2E+01	1.9E+01

Population Air Submersion and External Incremental Dose by Radionuclide
In Year 12000 (70-yr Time Period Number No: 143)

Radionuclide	Air Submer-sion	External
C 14	7.4E-11	5.9E-05
TC 99	2.0E-11	2.4E-05
I 129	2.8E-12	1.7E-06
U 238	1.6E-12	9.8E-07
TH 234	2.6E-10	6.5E-04
PA 234	3.7E-11	1.0E-04
NP 237	1.3E-11	6.7E-05
PA 233	2.1E-10	1.6E-03
Total external	6.2E-10	2.5E-03

Dose in units of person-rem;
that is the cumulative population dose received by the local population with an assumed 70-yr individual lifetime.

Population Internal Dose To Organ by Exposure Pathway

In Year 12000 (70-yr Time Period Number No: 143)

Pathway	Lung	Stomach S Int.	UL Int.	LL Int.	Bone Su	R Marro	Testes
Inhalation	1.3E-02	3.7E-05	2.6E-05	2.7E-05	3.0E-05	1.2E-02	9.9E-04	1.2E-04
Ingestion (Terr)	4.5E+00	4.3E+02	8.4E+00	2.7E+01	7.3E+01	1.8E+02	1.9E+01	5.4E+00
Ingestion (Aqua)	8.2E-01	1.1E+00	8.4E-01	9.4E-01	1.2E+00	1.2E+02	1.1E+01	1.7E+00
Drinking Water	1.9E-01	8.5E+00	3.4E-01	1.0E+00	2.8E+00	7.3E+01	5.7E+00	5.4E-01
Total internal	5.5E+00	4.4E+02	9.6E+00	2.9E+01	7.7E+01	3.7E+02	3.5E+01	7.6E+00

Pathway	Ovaries	Muscle	Thyroid	Kidneys	Liver
Inhalation	1.2E-04	2.6E-05	3.0E-05	2.2E-05	5.4E-04
Ingestion (Terr)	5.4E+00	4.5E+00	1.2E+02	2.0E+01	1.1E+01
Ingestion (Aqua)	1.7E+00	8.2E-01	8.9E-01	5.4E-01	5.4E+00
Drinking Water	5.4E-01	2.0E-01	3.8E+00	1.1E+01	2.3E+00
Total internal	7.6E+00	5.5E+00	1.2E+02	3.2E+01	1.9E+01

Dose in units of person-rem;
that is the cumulative population dose received by the local population
with an assumed 70-yr individual lifetime.

```
DITTY Long-Term Surface Water Release TWRS-EIS (Ex Situ Exten. Sepa.)
  5
C 14
I 129
NP237
TC99
U 238
 &INPUT IWAT=1, IPATH=2, LUW=1, IPOPL=2,
  CFLO=120000.,
  RM=1.0, TZ=1990., TZR=0.,
  PL1(1)=294830.,391538.,431210.,469891.,1273208.,4932964.,
  TL(1)=1990., 2100.,2200.,2300.,2990.,11900.,
  NTL=6,
  USAGE(1)=0.3,0.,0.,0.,438.,17.,17.,
  CONSUM(1)=15.,276.,20.,230.,40.,30.,8.5,
  EXTIM=2920.,MOPYR=6, RIRR=150.,
  GRWP(1)=90.,90.,90.,30.,3*90.,
  YELD(1)=1.5,4.,0.84,1.3,3*0.84,
 &END
  5
C 14       5
1990.   0.0
4244.   0.0
4245.   0.0183
8995.   0.0183
8996.   0.0
I 129      5
1990.   0.0
4244.   0.0
4245.   0.0001
8995.   0.0001
8996.   0.0
NP237      5
1990.   0.0
4244.   0.0
4245.   0.00023
8995.   0.00023
8996.   0.0
TC99       5
1990.   0.0
4244.   0.0
4245.   0.1126
8995.   0.1126
8996.   0.0
U 238      5
```

1990.	0.0
4244.	0.0
4245.	0.0064
8995.	0.0064
8996.	0.0

DITTY Dose Calculation Program
(GENII Version 1.485 3-Dec-90)

Integrated population dose calculated for chronic liquid release
Release from time 1990. A.D. onward for 10,000 years
Case title: DITTY Long-Term Surface Water Release TWRS-EIS (Ex Situ Exten. Sepa.)
Executed on: 06/21/96 at 07:04:30.8 Page 1

---- DATA LIBRARIES USED ----------(File)-----

Master Radionuclide Data: (2)
Radionuclide Master Library - Long Times (23-July-93 PDR)
Food Concentration Ratios: (8)
PNL Food Transfer Factor Library (by Z, Changed NP&U LF 6/18/96 AMN)
Fresh Water Bioaccumulation Factors: (9)
Bioaccumulation Factor Library - (30-Aug-88) RAP
External Exposure D.F.'s: (10)
External Dose Factors for GENII in person Sv/yr per Bq/X (8-May-90 RAP)
Inhalation/Ingestion D.F.'s: (30)
Worst-Case Solubilities, DITTY Internal Dose Factors (Sv/Bq) (23-Jul-93 PDR)
Waterborne Release Data: (31)
DITTY.IN

---- MASTER RADIONUCLIDE CONTROL LIST ----------
C 14 TC99 I 129 U 238 TH234 PA234 NP237
PA233

---- TERRESTRIAL/AQUATIC PATHWAY DATA FOR AN AVERAGE INDIVIDUAL

Pathway	Growing Period (days)	Yield (kg/m2)	Consumption (kg/yr)	Pathway	Usage (kg or hr/yr)
LEAFY VEG	9.0E+01	1.5E+00	1.5E+01	FISH	3.0E-01
OTHER VEG	9.0E+01	4.0E+00	2.8E+02	CRUSTACEA	0.0E+00
EGGS	9.0E+01	8.4E-01	2.0E+01	MOLLUSES	0.0E+00
MILK	3.0E+01	1.3E+00	2.3E+02	PLANTS	0.0E+00
BEEF	9.0E+01	8.4E-01	4.0E+01	DRINKING WATER	4.4E+02
PORK	9.0E+01	8.4E-01	3.0E+01	SEDIMENT EXPOSU	1.7E+01
POULTRY	9.0E+01	8.4E-01	8.5E+00	SWIMMING TIME	1.7E+01

External Exposure Time: 2.92E+03 hr/yr

---- LIQUID RELEASE PARAMETERS ----------

River Flow Rate, (ft3/sec) : 1.2E+05 Months/Year Irrigated : 6.0E+00
Reconcentration Ratio : 1.0E+00 Irrigation Rate
Mixing Ratio : 1.0E+00 (liters/m2/month) : 1.5E+02

Input Prepared By: _____ Date: _____

Input Checked By: _____ Date: _____

DITTY Dose Calculation Program
(GENII Version 1.485 3-Dec-90)

Integrated population dose calculated for chronic liquid release
Release from time 1990. A.D. onward for 10,000 years
Case title: DITTY Long-Term Surface Water Release TWRS-EIS (Ex Situ Exten. Sepa.)
Executed on: 06/21/96 at 07:04:30.8 Page 2

---- WATER RELEASE OF EACH RADIONCLIDE PER 70-YR PERIOD (Ci) ----------

Radio-nuclide	Period/ Activity	Period/ Activity	Period/ Activity	Period/ Activity	Period/ Activity
C 14	33 1.0E+00	34 1.3E+00	35 1.3E+00	36 1.3E+00	37 1.3E+00
	38 1.3E+00	39 1.3E+00	40 1.3E+00	41 1.3E+00	42 1.3E+00
	43 1.3E+00	44 1.3E+00	45 1.3E+00	46 1.3E+00	47 1.3E+00
	48 1.3E+00	49 1.3E+00	50 1.3E+00	51 1.3E+00	52 1.3E+00
	53 1.3E+00	54 1.3E+00	55 1.3E+00	56 1.3E+00	57 1.3E+00
	58 1.3E+00	59 1.3E+00	60 1.3E+00	61 1.3E+00	62 1.3E+00
	63 1.3E+00	64 1.3E+00	65 1.3E+00	66 1.3E+00	67 1.3E+00
	68 1.3E+00	69 1.3E+00	70 1.3E+00	71 1.3E+00	72 1.3E+00
	73 1.3E+00	74 1.3E+00	75 1.3E+00	76 1.3E+00	77 1.3E+00
	78 1.3E+00	79 1.3E+00	80 1.3E+00	81 1.3E+00	82 1.3E+00
	83 1.3E+00	84 1.3E+00	85 1.3E+00	86 1.3E+00	87 1.3E+00
	88 1.3E+00	89 1.3E+00	90 1.3E+00	91 1.3E+00	92 1.3E+00
	93 1.3E+00	94 1.3E+00	95 1.3E+00	96 1.3E+00	97 1.3E+00
	98 1.3E+00	99 1.3E+00	100 1.3E+00	101 1.0E-01	
TC99	33 6.2E+00	34 7.9E+00	35 7.9E+00	36 7.9E+00	37 7.9E+00
	38 7.9E+00	39 7.9E+00	40 7.9E+00	41 7.9E+00	42 7.9E+00
	43 7.9E+00	44 7.9E+00	45 7.9E+00	46 7.9E+00	47 7.9E+00
	48 7.9E+00	49 7.9E+00	50 7.9E+00	51 7.9E+00	52 7.9E+00
	53 7.9E+00	54 7.9E+00	55 7.9E+00	56 7.9E+00	57 7.9E+00
	58 7.9E+00	59 7.9E+00	60 7.9E+00	61 7.9E+00	62 7.9E+00
	63 7.9E+00	64 7.9E+00	65 7.9E+00	66 7.9E+00	67 7.9E+00
	68 7.9E+00	69 7.9E+00	70 7.9E+00	71 7.9E+00	72 7.9E+00
	73 7.9E+00	74 7.9E+00	75 7.9E+00	76 7.9E+00	77 7.9E+00
	78 7.9E+00	79 7.9E+00	80 7.9E+00	81 7.9E+00	82 7.9E+00
	83 7.9E+00	84 7.9E+00	85 7.9E+00	86 7.9E+00	87 7.9E+00
	88 7.9E+00	89 7.9E+00	90 7.9E+00	91 7.9E+00	92 7.9E+00
	93 7.9E+00	94 7.9E+00	95 7.9E+00	96 7.9E+00	97 7.9E+00
	98 7.9E+00	99 7.9E+00	100 7.9E+00	101 6.2E-01	
I 129	33 5.5E-03	34 7.0E-03	35 7.0E-03	36 7.0E-03	37 7.0E-03
	38 7.0E-03	39 7.0E-03	40 7.0E-03	41 7.0E-03	42 7.0E-03

43 7.0E-03 44 7.0E-03 45 7.0E-03 46 7.0E-03 47 7.0E-03
48 7.0E-03 49 7.0E-03 50 7.0E-03 51 7.0E-03 52 7.0E-03
53 7.0E-03 54 7.0E-03 55 7.0E-03 56 7.0E-03 57 7.0E-03
58 7.0E-03 59 7.0E-03 60 7.0E-03 61 7.0E-03 62 7.0E-03
63 7.0E-03 64 7.0E-03 65 7.0E-03 66 7.0E-03 67 7.0E-03
68 7.0E-03 69 7.0E-03 70 7.0E-03 71 7.0E-03 72 7.0E-03
73 7.0E-03 74 7.0E-03 75 7.0E-03 76 7.0E-03 77 7.0E-03
78 7.0E-03 79 7.0E-03 80 7.0E-03 81 7.0E-03 82 7.0E-03
83 7.0E-03 84 7.0E-03 85 7.0E-03 86 7.0E-03 87 7.0E-03
88 7.0E-03 89 7.0E-03 90 7.0E-03 91 7.0E-03 92 7.0E-03
93 7.0E-03 94 7.0E-03 95 7.0E-03 96 7.0E-03 97 7.0E-03
98 7.0E-03 99 7.0E-03 100 7.0E-03 101 5.5E-04

U 238 33 3.6E-01 34 4.5E-01 35 4.5E-01 36 4.5E-01 37 4.5E-01
38 4.5E-01 39 4.5E-01 40 4.5E-01 41 4.5E-01 42 4.5E-01
43 4.5E-01 44 4.5E-01 45 4.5E-01 46 4.5E-01 47 4.5E-01
48 4.5E-01 49 4.5E-01 50 4.5E-01 51 4.5E-01 52 4.5E-01
53 4.5E-01 54 4.5E-01 55 4.5E-01 56 4.5E-01 57 4.5E-01
58 4.5E-01 59 4.5E-01 60 4.5E-01 61 4.5E-01 62 4.5E-01
63 4.5E-01 64 4.5E-01 65 4.5E-01 66 4.5E-01 67 4.5E-01
68 4.5E-01 69 4.5E-01 70 4.5E-01 71 4.5E-01 72 4.5E-01
73 4.5E-01 74 4.5E-01 75 4.5E-01 76 4.5E-01 77 4.5E-01
78 4.5E-01 79 4.5E-01 80 4.5E-01 81 4.5E-01 82 4.5E-01
83 4.5E-01 84 4.5E-01 85 4.5E-01 86 4.5E-01 87 4.5E-01
88 4.5E-01 89 4.5E-01 90 4.5E-01 91 4.5E-01 92 4.5E-01
93 4.5E-01 94 4.5E-01 95 4.5E-01 96 4.5E-01 97 4.5E-01
98 4.5E-01 99 4.5E-01 100 4.5E-01 101 3.5E-02

NP237 33 1.3E-02 34 1.6E-02 35 1.6E-02 36 1.6E-02 37 1.6E-02
38 1.6E-02 39 1.6E-02 40 1.6E-02 41 1.6E-02 42 1.6E-02
43 1.6E-02 44 1.6E-02 45 1.6E-02 46 1.6E-02 47 1.6E-02
48 1.6E-02 49 1.6E-02 50 1.6E-02 51 1.6E-02 52 1.6E-02
53 1.6E-02 54 1.6E-02 55 1.6E-02 56 1.6E-02 57 1.6E-02
58 1.6E-02 59 1.6E-02 60 1.6E-02 61 1.6E-02 62 1.6E-02
63 1.6E-02 64 1.6E-02 65 1.6E-02 66 1.6E-02 67 1.6E-02
68 1.6E-02 69 1.6E-02 70 1.6E-02 71 1.6E-02 72 1.6E-02
73 1.6E-02 74 1.6E-02 75 1.6E-02 76 1.6E-02 77 1.6E-02
78 1.6E-02 79 1.6E-02 80 1.6E-02 81 1.6E-02 82 1.6E-02
83 1.6E-02 84 1.6E-02 85 1.6E-02 86 1.6E-02 87 1.6E-02
88 1.6E-02 89 1.6E-02 90 1.6E-02 91 1.6E-02 92 1.6E-02
93 1.6E-02 94 1.6E-02 95 1.6E-02 96 1.6E-02 97 1.6E-02
98 1.6E-02 99 1.6E-02 100 1.6E-02 101 1.3E-03

---- POPULATION DATA ----

Population for Chronic Waterborne Release at the following Times A.D.:

Time	Population
1990.	2.9E+05
2100.	3.9E+05
2200.	4.3E+05
2300.	4.7E+05
2990.	1.3E+06
11900.	4.9E+06

DITTY Dose Calculation Program
(GENII Version 1.485 3-Dec-90)

Integrated population dose calculated for chronic liquid release
Release from time 1990. A.D. onward for 10,000 years
Case title: DITTY Long-Term Surface Water Release TWRS-EIS (Ex Situ Exten. Sepa.)
Executed on: 06/21/96 at 07:04:30.8

Lifetime Effective Cumulative Dose Equivalent as a Function of Time

Period	Year	Dose
until	until	
34	4300.	6.80E+00
35	4370.	1.55E+01
36	4440.	2.44E+01
37	4510.	3.34E+01
38	4580.	4.25E+01
39	4650.	5.18E+01
40	4720.	6.12E+01
41	4790.	7.07E+01
42	4860.	8.04E+01
43	4930.	9.02E+01
44	5000.	1.00E+02
45	5070.	1.10E+02
46	5140.	1.20E+02
47	5210.	1.31E+02
48	5280.	1.41E+02
49	5350.	1.52E+02
50	5420.	1.63E+02
51	5490.	1.74E+02
52	5560.	1.85E+02
53	5630.	1.96E+02
54	5700.	2.07E+02
55	5770.	2.19E+02
56	5840.	2.30E+02
57	5910.	2.42E+02
58	5980.	2.54E+02
59	6050.	2.66E+02
60	6120.	2.78E+02
61	6190.	2.90E+02
62	6260.	3.03E+02

63	6330.	3.15E+02
64	6400.	3.28E+02
65	6470.	3.41E+02
66	6540.	3.54E+02
67	6610.	3.67E+02
68	6680.	3.80E+02
69	6750.	3.94E+02
70	6820.	4.07E+02
71	6890.	4.21E+02
72	6960.	4.35E+02
73	7030.	4.48E+02
74	7100.	4.63E+02
75	7170.	4.77E+02

Lifetime Effective Cumulative Dose Equivalent as a Function of Time

Period	Year	Dose
76	7240.	4.91E+02
77	7310.	5.06E+02
78	7380.	5.20E+02
79	7450.	5.35E+02
80	7520.	5.50E+02
81	7590.	5.65E+02
82	7660.	5.80E+02
83	7730.	5.95E+02
84	7800.	6.11E+02
85	7870.	6.26E+02
86	7940.	6.42E+02
87	8010.	6.58E+02
88	8080.	6.74E+02
89	8150.	6.90E+02
90	8220.	7.06E+02
91	8290.	7.23E+02
92	8360.	7.39E+02
93	8430.	7.56E+02
94	8500.	7.73E+02
95	8570.	7.90E+02
96	8640.	8.07E+02
97	8710.	8.24E+02
98	8780.	8.41E+02
99	8850.	8.59E+02
100	8920.	8.77E+02
101	8990.	8.94E+02
102	9060.	8.96E+02
until	until	
144	12000.	8.96E+02

Dose in units of person-rem;
that is the cumulative population dose received by the local population over 10,000 years with an assumed 70-yr individual lifetime.

Cumulative Population Dose Equivalent by Radionuclide

Radio-nuclide	Effective Dose Equivalent	Annual External Dose	Effective Dose Equivalent	Percent Of Total Dose
C 14	4.5E+01	2.1E-03	4.5E+01	5
TC 99	5.0E+02	3.1E-04	5.0E+02	55
I 129	1.0E+01	3.2E-05	1.0E+01	1
U 238	1.5E+02	3.2E-05	1.5E+02	17
TH 234	1.6E-02	2.1E-02	3.7E-02	0
PA 234	5.4E-05	3.3E-03	3.3E-03	0
NP 237	2.0E+02	9.8E-04	2.0E+02	21
PA 233	2.0E-03	2.3E-02	2.5E-02	0

Dose in units of person-rem;
that is the cumulative population dose received by the local population
with an assumed 70-yr individual lifetime.

Maximum Dose Increment Received By Population
In Year 9060 (70-yr Time Period Number No: 101)

Organ	Cumulative Dose Equivalent	Weighting Factors	Weighted Cumulative Dose Equivalent
Gonads	2.7E+00	2.5E-01	6.7E-01
Breast	2.1E+00	1.5E-01	3.1E-01
R Marrow	1.2E+01	1.2E-01	1.5E+00
Lung	2.1E+00	1.2E-01	2.5E-01
Thyroid	3.3E+01	3.0E-02	1.0E+00
Bone Sur	1.3E+02	3.0E-02	3.9E+00
Stomach	1.1E+02	6.0E-02	6.8E+00
LL Int.	2.2E+01	6.0E-02	1.3E+00
Kidneys	2.0E+01	6.0E-02	1.2E+00
UL Int.	8.6E+00	6.0E-02	5.1E-01
Liver	5.2E+00	6.0E-02	3.1E-01

Cumulative Effective Dose Equivalent 1.8E+01
External Dose 1.0E-03

Lifetime Effective Cumulative
Dose Equivalent 1.8E+01

Dose in units of person-rem;
that is the cumulative population dose received by the local population
with an assumed 70-yr individual lifetime.

Maximum Dose Increment Received By Individual (rem)
In Year 9060 (70-yr Time Period Number No: 101)

Radio-nuclide	Effective Dose Equivalent	Annual External Dose	Effective Dose Equivalent	Percent Of Total Dose
C 14	2.4E-07	1.1E-11	2.4E-07	5
TC 99	2.7E-06	1.6E-12	2.7E-06	55
I 129	5.4E-08	1.7E-13	5.4E-08	1
U 238	8.2E-07	1.7E-13	8.2E-07	17
TH 234	8.6E-11	1.1E-10	2.0E-10	0
PA 234	2.9E-13	1.8E-11	1.8E-11	0
NP 237	1.0E-06	5.2E-12	1.0E-06	21
PA 233	1.0E-11	1.2E-10	1.3E-10	0

4.814 E-6

Population Internal Dose To Organ by Radionuclide
In Year 9060 (70-yr Time Period Number No: 101)

Radionuclide	Lung	Stomach S Int.	UL Int.	LL Int.	Bone Su	R Marro	Testes
C 14	9.2E-01	9.2E-01	9.2E-01	9.2E-01	9.2E-01	1.1E+00	1.1E+00	9.2E-01
TC 99	1.0E+00	1.1E+02	2.0E+00	6.8E+00	1.8E+01	1.2E+00	1.2E+00	1.0E+00
I 129	4.5E-04	6.2E-04	3.9E-04	3.9E-04	3.9E-04	5.3E-04	5.8E-04	3.6E-04
U 238	1.2E-01	1.6E-01	2.3E-01	8.0E-01	2.3E+00	4.1E+01	2.8E+00	1.1E-01
TH 234	2.4E-06	8.8E-05	2.1E-04	1.3E-03	3.8E-03	1.8E-06	1.5E-06	2.0E-07
PA 234	2.8E-08	1.4E-06	2.8E-06	5.8E-06	4.8E-06	5.0E-08	1.4E-07	4.3E-08
NP 237	5.4E-04	5.0E-03	1.2E-02	6.6E-02	2.0E-01	8.8E+01	7.1E+00	6.0E-01
PA 233	1.7E-07	1.1E-05	3.2E-05	1.4E-04	4.1E-04	4.0E-06	2.8E-06	8.5E-07
Total internal	2.1E+00	1.1E+02	3.2E+00	8.6E+00	2.2E+01	1.3E+02	1.2E+01	2.7E+00

Radionuclide	Ovaries	Muscle	Thyroid	Kidneys	Liver
C 14	9.2E-01	9.2E-01	9.2E-01	0.0E+00	0.0E+00
TC 99	1.0E+00	1.0E+00	2.6E+01	0.0E+00	1.4E+00
I 129	3.9E-04	9.4E-04	6.7E+00	0.0E+00	0.0E+00
U 238	1.2E-01	1.1E-01	1.2E-01	2.0E+01	0.0E+00
TH 234	2.5E-06	2.9E-07	2.6E-08	0.0E+00	3.5E-07
PA 234	6.0E-07	9.1E-08	3.3E-09	1.5E-07	1.1E-07
NP 237	6.0E-01	4.8E-04	3.6E-04	0.0E+00	3.8E+00
PA 233	1.0E-05	1.1E-06	2.0E-08	1.4E-06	9.6E-07
Total internal	2.7E+00	2.1E+00	3.3E+01	2.0E+01	5.2E+00

Population Air Submersion and External Incremental Dose by Radionuclide
In Year 9060 (70-yr Time Period Number No: 101)

Radionuclide	Air Submer-sion	External
C 14	5.2E-11	4.1E-05
TC 99	5.0E-12	6.1E-06
I 129	1.0E-12	6.3E-07
U 238	1.0E-12	6.3E-07
TH 234	1.7E-10	4.2E-04
PA 234	2.4E-11	6.5E-05
NP 237	3.8E-12	1.9E-05
PA 233	6.1E-11	4.6E-04
Total external	3.1E-10	1.0E-03

Dose in units of person-rem;
that is the cumulative population dose received by the local population with an assumed 70-yr individual lifetime.

Population Internal Dose To Organ by Exposure Pathway

In Year 9060 (70-yr Time Period Number No: 101)

Pathway	Lung	Stomach	S Int.	UL Int.	LL Int.	Bone	Su R	Marro	Testes
Inhalation	8.3E-03	2.1E-05	1.8E-05	1.8E-05	2.0E-05	3.6E-03	3.0E-04	4.4E-05	
Ingestion (Terr)	1.4E+00	1.1E+02	2.4E+00	7.5E+00	2.0E+01	6.6E+01	6.4E+00	1.7E+00	
Ingestion (Aqua)	5.7E-01	6.3E-01	5.7E-01	6.1E-01	7.0E-01	3:7E+01	3.6E+00	8.1E-01	
Drinking Water	9.9E-02	2.2E+00	1.6E-01	4.6E-01	1.2E+00	2.9E+01	2.2E+00	2.0E-01	
Total internal	2.1E+00	1.1E+02	3.2E+00	8.6E+00	2.2E+01	1.3E+02	1.2E+01	2.7E+00	

Pathway	Ovaries	Muscle	Thyroid	Kidneys	Liver
Inhalation	4.4E-05	1.8E-05	1.9E-05	1.4E-05	1.6E-04
Ingestion (Terr)	1.7E+00	1.4E+00	3.2E+01	1.3E+01	3.0E+00
Ingestion (Aqua)	8.1E-01	5.7E-01	5.9E-01	3.5E-01	1.6E+00
Drinking Water	2.0E-01	9.9E-02	1.2E+00	7.1E+00	6.6E-01
Total internal	2.7E+00	2.1E+00	3.3E+01	2.0E+01	5.2E+00

Dose in units of person-rem;
that is the cumulative population dose received by the local population
with an assumed 70-yr individual lifetime.

```
DITTY Long-Term Surface Water Release TWRS-EIS (Ex Situ Inter. Sepa.)
  5
C 14
I 129
NP237
TC99
U 238
 &INPUT IWAT=1, IPATH=2, LUW=1, IPOPL=2,
  CFLO=120000.,
  RM=1.0, TZ=1990., TZR=0.,
  PL1(1)=294830.,391538.,431210.,469891.,1273208.,4932964.,
  TL(1)=1990., 2100.,2200.,2300.,2990.,11900.,
  NTL=6,
  USAGE(1)=0.3,0.,0.,0.,438.,17.,17.,
  CONSUM(1)=15.,276.,20.,230.,40.,30.,8.5,
  EXTIM=2920.,MOPYR=6, RIRR=150.,
  GRWP(1)=90.,90.,90.,30.,3*90.,
  YELD(1)=1.5,4.,0.84,1.3,3*0.84,
 &END
  5
C 14      5
1990.   0.0
4244.   0.0
4245.   0.0183
8995.   0.0183
8996.   0.0
I 129      5
1990.   0.0
4244.   0.0
4245.   0.0001
8995.   0.0001
8996.   0.0
NP237      5
1990.   0.0
4244.   0.0
4245.   0.00023
8995.   0.00023
8996.   0.0
TC99      5
1990.   0.0
4244.   0.0
4245.   0.1126
8995.   0.1126
8996.   0.0
U 238      5
```

1990.	0.0
4244.	0.0
4245.	0.0064
8995.	0.0064
8996.	0.0

DITTY Dose Calculation Program
(GENII Version 1.485 3-Dec-90)

Integrated population dose calculated for chronic liquid release
Release from time 1990. A.D. onward for 10,000 years
Case title: DITTY Long-Term Surface Water Release TWRS-EIS (Ex Situ Inter. Sepa.)
Executed on: 06/21/96 at 07:02:01.6 Page 1

---- DATA LIBRARIES USED ----------(File)-----

Master Radionuclide Data: (2)
Radionuclide Master Library - Long Times (23-July-93 PDR)
Food Concentration Ratios: (8)
PNL Food Transfer Factor Library (by Z, Changed NP&U LF 6/18/96 AMN)
Fresh Water Bioaccumulation Factors: (9)
Bioaccumulation Factor Library - (30-Aug-88) RAP
External Exposure D.F.'s: (10)
External Dose Factors for GENII in person Sv/yr per Bq/X (8-May-90 RAP)
Inhalation/Ingestion D.F.'s: (30)
Worst-Case Solubilities, DITTY Internal Dose Factors (Sv/Bq) (23-Jul-93 PDR)
Waterborne Release Data: (31)
DITTY.IN

---- MASTER RADIONUCLIDE CONTROL LIST ----------
C 14 TC99 I 129 U 238 TH234 PA234 NP237
PA233

---- TERRESTRIAL/AQUATIC PATHWAY DATA FOR AN AVERAGE INDIVIDUAL ----------

Pathway	Growing Period (days)	Yield (kg/m2)	Consumption (kg/yr)	Pathway	Usage (kg or hr/yr)
LEAFY VEG	9.0E+01	1.5E+00	1.5E+01	FISH	3.0E-01
OTHER VEG	9.0E+01	4.0E+00	2.8E+02	CRUSTACEA	0.0E+00
EGGS	9.0E+01	8.4E-01	2.0E+01	MOLLUSES	0.0E+00
MILK	3.0E+01	1.3E+00	2.3E+02	PLANTS	0.0E+00
BEEF	9.0E+01	8.4E-01	4.0E+01	DRINKING WATER	4.4E+02
PORK	9.0E+01	8.4E-01	3.0E+01	SEDIMENT EXPOSU	1.7E+01
POULTRY	9.0E+01	8.4E-01	8.5E+00	SWIMMING TIME	1.7E+01

External Exposure Time: 2.92E+03 hr/yr

---- LIQUID RELEASE PARAMETERS ----------

River Flow Rate, (ft3/sec) : 1.2E+05 Months/Year Irrigated : 6.0E+00
Reconcentration Ratio : 1.0E+00 Irrigation Rate
Mixing Ratio : 1.0E+00 (liters/m2/month) : 1.5E+02

Input Prepared By: _____ Date: _____

Input Checked By: _____ Date: _____

DITTY Dose Calculation Program
(GENII Version 1.485 3-Dec-90)

Integrated population dose calculated for chronic liquid release
Release from time 1990. A.D. onward for 10,000 years
Case title: DITTY Long-Term Surface Water Release TWRS-EIS (Ex Situ Inter. Sepa.)
Executed on: 06/21/96 at 07:02:01.6 Page 2

---- WATER RELEASE OF EACH RADIONCLIDE PER 70-YR PERIOD (Ci) ----------

Radio-nuclide	Period/ Activity	Period/ Activity	Period/ Activity	Period/ Activity	Period/ Activity
C 14	33 1.0E+00	34 1.3E+00	35 1.3E+00	36 1.3E+00	37 1.3E+00
	38 1.3E+00	39 1.3E+00	40 1.3E+00	41 1.3E+00	42 1.3E+00
	43 1.3E+00	44 1.3E+00	45 1.3E+00	46 1.3E+00	47 1.3E+00
	48 1.3E+00	49 1.3E+00	50 1.3E+00	51 1.3E+00	52 1.3E+00
	53 1.3E+00	54 1.3E+00	55 1.3E+00	56 1.3E+00	57 1.3E+00
	58 1.3E+00	59 1.3E+00	60 1.3E+00	61 1.3E+00	62 1.3E+00
	63 1.3E+00	64 1.3E+00	65 1.3E+00	66 1.3E+00	67 1.3E+00
	68 1.3E+00	69 1.3E+00	70 1.3E+00	71 1.3E+00	72 1.3E+00
	73 1.3E+00	74 1.3E+00	75 1.3E+00	76 1.3E+00	77 1.3E+00
	78 1.3E+00	79 1.3E+00	80 1.3E+00	81 1.3E+00	82 1.3E+00
	83 1.3E+00	84 1.3E+00	85 1.3E+00	86 1.3E+00	87 1.3E+00
	88 1.3E+00	89 1.3E+00	90 1.3E+00	91 1.3E+00	92 1.3E+00
	93 1.3E+00	94 1.3E+00	95 1.3E+00	96 1.3E+00	97 1.3E+00
	98 1.3E+00	99 1.3E+00	100 1.3E+00	101 1.0E-01	
TC99	33 6.2E+00	34 7.9E+00	35 7.9E+00	36 7.9E+00	37 7.9E+00
	38 7.9E+00	39 7.9E+00	40 7.9E+00	41 7.9E+00	42 7.9E+00
	43 7.9E+00	44 7.9E+00	45 7.9E+00	46 7.9E+00	47 7.9E+00
	48 7.9E+00	49 7.9E+00	50 7.9E+00	51 7.9E+00	52 7.9E+00
	53 7.9E+00	54 7.9E+00	55 7.9E+00	56 7.9E+00	57 7.9E+00
	58 7.9E+00	59 7.9E+00	60 7.9E+00	61 7.9E+00	62 7.9E+00
	63 7.9E+00	64 7.9E+00	65 7.9E+00	66 7.9E+00	67 7.9E+00
	68 7.9E+00	69 7.9E+00	70 7.9E+00	71 7.9E+00	72 7.9E+00
	73 7.9E+00	74 7.9E+00	75 7.9E+00	76 7.9E+00	77 7.9E+00
	78 7.9E+00	79 7.9E+00	80 7.9E+00	81 7.9E+00	82 7.9E+00
	83 7.9E+00	84 7.9E+00	85 7.9E+00	86 7.9E+00	87 7.9E+00
	88 7.9E+00	89 7.9E+00	90 7.9E+00	91 7.9E+00	92 7.9E+00
	93 7.9E+00	94 7.9E+00	95 7.9E+00	96 7.9E+00	97 7.9E+00
	98 7.9E+00	99 7.9E+00	100 7.9E+00	101 6.2E-01	
I 129	33 5.5E-03	34 7.0E-03	35 7.0E-03	36 7.0E-03	37 7.0E-03
	38 7.0E-03	39 7.0E-03	40 7.0E-03	41 7.0E-03	42 7.0E-03

43 7.0E-03 44 7.0E-03 45 7.0E-03 46 7.0E-03 47 7.0E-03
48 7.0E-03 49 7.0E-03 50 7.0E-03 51 7.0E-03 52 7.0E-03
53 7.0E-03 54 7.0E-03 55 7.0E-03 56 7.0E-03 57 7.0E-03
58 7.0E-03 59 7.0E-03 60 7.0E-03 61 7.0E-03 62 7.0E-03
63 7.0E-03 64 7.0E-03 65 7.0E-03 66 7.0E-03 67 7.0E-03
68 7.0E-03 69 7.0E-03 70 7.0E-03 71 7.0E-03 72 7.0E-03
73 7.0E-03 74 7.0E-03 75 7.0E-03 76 7.0E-03 77 7.0E-03
78 7.0E-03 79 7.0E-03 80 7.0E-03 81 7.0E-03 82 7.0E-03
83 7.0E-03 84 7.0E-03 85 7.0E-03 86 7.0E-03 87 7.0E-03
88 7.0E-03 89 7.0E-03 90 7.0E-03 91 7.0E-03 92 7.0E-03
93 7.0E-03 94 7.0E-03 95 7.0E-03 96 7.0E-03 97 7.0E-03
98 7.0E-03 99 7.0E-03 100 7.0E-03 101 5.5E-04

U 238 33 3.6E-01 34 4.5E-01 35 4.5E-01 36 4.5E-01 37 4.5E-01
38 4.5E-01 39 4.5E-01 40 4.5E-01 41 4.5E-01 42 4.5E-01
43 4.5E-01 44 4.5E-01 45 4.5E-01 46 4.5E-01 47 4.5E-01
48 4.5E-01 49 4.5E-01 50 4.5E-01 51 4.5E-01 52 4.5E-01
53 4.5E-01 54 4.5E-01 55 4.5E-01 56 4.5E-01 57 4.5E-01
58 4.5E-01 59 4.5E-01 60 4.5E-01 61 4.5E-01 62 4.5E-01
63 4.5E-01 64 4.5E-01 65 4.5E-01 66 4.5E-01 67 4.5E-01
68 4.5E-01 69 4.5E-01 70 4.5E-01 71 4.5E-01 72 4.5E-01
73 4.5E-01 74 4.5E-01 75 4.5E-01 76 4.5E-01 77 4.5E-01
78 4.5E-01 79 4.5E-01 80 4.5E-01 81 4.5E-01 82 4.5E-01
83 4.5E-01 84 4.5E-01 85 4.5E-01 86 4.5E-01 87 4.5E-01
88 4.5E-01 89 4.5E-01 90 4.5E-01 91 4.5E-01 92 4.5E-01
93 4.5E-01 94 4.5E-01 95 4.5E-01 96 4.5E-01 97 4.5E-01
98 4.5E-01 99 4.5E-01 100 4.5E-01 101 3.5E-02

NP237 33 1.3E-02 34 1.6E-02 35 1.6E-02 36 1.6E-02 37 1.6E-02
38 1.6E-02 39 1.6E-02 40 1.6E-02 41 1.6E-02 42 1.6E-02
43 1.6E-02 44 1.6E-02 45 1.6E-02 46 1.6E-02 47 1.6E-02
48 1.6E-02 49 1.6E-02 50 1.6E-02 51 1.6E-02 52 1.6E-02
53 1.6E-02 54 1.6E-02 55 1.6E-02 56 1.6E-02 57 1.6E-02
58 1.6E-02 59 1.6E-02 60 1.6E-02 61 1.6E-02 62 1.6E-02
63 1.6E-02 64 1.6E-02 65 1.6E-02 66 1.6E-02 67 1.6E-02
68 1.6E-02 69 1.6E-02 70 1.6E-02 71 1.6E-02 72 1.6E-02
73 1.6E-02 74 1.6E-02 75 1.6E-02 76 1.6E-02 77 1.6E-02
78 1.6E-02 79 1.6E-02 80 1.6E-02 81 1.6E-02 82 1.6E-02
83 1.6E-02 84 1.6E-02 85 1.6E-02 86 1.6E-02 87 1.6E-02
88 1.6E-02 89 1.6E-02 90 1.6E-02 91 1.6E-02 92 1.6E-02
93 1.6E-02 94 1.6E-02 95 1.6E-02 96 1.6E-02 97 1.6E-02
98 1.6E-02 99 1.6E-02 100 1.6E-02 101 1.3E-03

---- POPULATION DATA ----

Population for Chronic Waterborne Release at the following Times A.D.:

Time	Population
1990.	2.9E+05
2100.	3.9E+05
2200.	4.3E+05
2300.	4.7E+05
2990.	1.3E+06
11900.	4.9E+06

Lifetime Effective Cumulative Dose Equivalent as a Function of Time

Period	Year	Dose
until	until	
34	4300.	6.80E+00
35	4370.	1.55E+01
36	4440.	2.44E+01
37	4510.	3.34E+01
38	4580.	4.25E+01
39	4650.	5.18E+01
40	4720.	6.12E+01
41	4790.	7.07E+01
42	4860.	8.04E+01
43	4930.	9.02E+01
44	5000.	1.00E+02
45	5070.	1.10E+02
46	5140.	1.20E+02
47	5210.	1.31E+02
48	5280.	1.41E+02
49	5350.	1.52E+02
50	5420.	1.63E+02
51	5490.	1.74E+02
52	5560.	1.85E+02
53	5630.	1.96E+02
54	5700.	2.07E+02
55	5770.	2.19E+02
56	5840.	2.30E+02
57	5910.	2.42E+02
58	5980.	2.54E+02
59	6050.	2.66E+02
60	6120.	2.78E+02
61	6190.	2.90E+02
62	6260.	3.03E+02

63	6330.	3.15E+02
64	6400.	3.28E+02
65	6470.	3.41E+02
66	6540.	3.54E+02
67	6610.	3.67E+02
68	6680.	3.80E+02
69	6750.	3.94E+02
70	6820.	4.07E+02
71	6890.	4.21E+02
72	6960.	4.35E+02
73	7030.	4.48E+02
74	7100.	4.63E+02
75	7170.	4.77E+02

Lifetime Effective Cumulative Dose Equivalent as a Function of Time

Period	Year	Dose
76	7240.	4.91E+02
77	7310.	5.06E+02
78	7380.	5.20E+02
79	7450.	5.35E+02
80	7520.	5.50E+02
81	7590.	5.65E+02
82	7660.	5.80E+02
83	7730.	5.95E+02
84	7800.	6.11E+02
85	7870.	6.26E+02
86	7940.	6.42E+02
87	8010.	6.58E+02
88	8080.	6.74E+02
89	8150.	6.90E+02
90	8220.	7.06E+02
91	8290.	7.23E+02
92	8360.	7.39E+02
93	8430.	7.56E+02
94	8500.	7.73E+02
95	8570.	7.90E+02
96	8640.	8.07E+02
97	8710.	8.24E+02
98	8780.	8.41E+02
99	8850.	8.59E+02
100	8920.	8.77E+02
101	8990.	8.94E+02
102	9060.	8.96E+02
until	until	
144	12000.	8.96E+02

Dose in units of person-rem;
that is the cumulative population dose received by the local population over 10,000 years with an assumed 70-yr individual lifetime.

Cumulative Population Dose Equivalent by Radionuclide

Radio-nuclide	Effective Dose Equivalent	Annual External Dose	Effective Dose Equivalent	Percent Of Total Dose
C 14	4.5E+01	2.1E-03	4.5E+01	5
TC 99	5.0E+02	3.1E-04	5.0E+02	55
I 129	1.0E+01	3.2E-05	1.0E+01	1
U 238	1.5E+02	3.2E-05	1.5E+02	17
TH 234	1.6E-02	2.1E-02	3.7E-02	0
PA 234	5.4E-05	3.3E-03	3.3E-03	0
NP 237	2.0E+02	9.8E-04	2.0E+02	21
PA 233	2.0E-03	2.3E-02	2.5E-02	0

Dose in units of person-rem;
that is the cumulative population dose received by the local population
with an assumed 70-yr individual lifetime.

Maximum Dose Increment Received By Population
In Year 9060 (70-yr Time Period Number No: 101)

Organ	Cumulative Dose Equivalent	Weighting Factors	Weighted Cumulative Dose Equivalent
Gonads	2.7E+00	2.5E-01	6.7E-01
Breast	2.1E+00	1.5E-01	3.1E-01
R Marrow	1.2E+01	1.2E-01	1.5E+00
Lung	2.1E+00	1.2E-01	2.5E-01
Thyroid	3.3E+01	3.0E-02	1.0E+00
Bone Sur	1.3E+02	3.0E-02	3.9E+00
Stomach	1.1E+02	6.0E-02	6.8E+00
LL Int.	2.2E+01	6.0E-02	1.3E+00
Kidneys	2.0E+01	6.0E-02	1.2E+00
UL Int.	8.6E+00	6.0E-02	5.1E-01
Liver	5.2E+00	6.0E-02	3.1E-01

Cumulative Effective Dose Equivalent 1.8E+01
External Dose 1.0E-03

Lifetime Effective Cumulative
Dose Equivalent 1.8E+01

Dose in units of person-rem;
that is the cumulative population dose received by the local population
with an assumed 70-yr individual lifetime.

Maximum Dose Increment Received By Individual (rem)
In Year 9060 (70-yr Time Period Number No: 101)

Radio-nuclide	Effective Dose Equivalent	Annual External Dose	Effective Dose Equivalent	Percent Of Total Dose
C 14	2.4E-07	1.1E-11	2.4E-07	5
TC 99	2.7E-06	1.6E-12	2.7E-06	55
I 129	5.4E-08	1.7E-13	5.4E-08	1
U 238	8.2E-07	1.7E-13	8.2E-07	17
TH 234	8.6E-11	1.1E-10	2.0E-10	0
PA 234	2.9E-13	1.8E-11	1.8E-11	0
NP 237	1.0E-06	5.2E-12	1.0E-06	21
PA 233	1.0E-11	1.2E-10	1.3E-10	0

4.814×10^{-6}

Population Internal Dose To Organ by Radionuclide
In Year 9060 (70-yr Time Period Number No: 101)

Radionuclide	Lung	Stomach	S Int.	UL Int.	LL Int.	Bone	Su R	Marro	Testes
C 14	9.2E-01	9.2E-01	9.2E-01	9.2E-01	9.2E-01	1.1E+00	1.1E+00	9.2E-01	
TC 99	1.0E+00	1.1E+02	2.0E+00	6.8E+00	1.8E+01	1.2E+00	1.2E+00	1.0E+00	
I 129	4.5E-04	6.2E-04	3.9E-04	3.9E-04	3.9E-04	5.3E-04	5.8E-04	3.6E-04	
U 238	1.2E-01	1.6E-01	2.3E-01	8.0E-01	2.3E+00	4.1E+01	2.8E+00	1.1E-01	
TH 234	2.4E-06	8.8E-05	2.1E-04	1.3E-03	3.8E-03	1.8E-06	1.5E-06	2.0E-07	
PA 234	2.8E-08	1.4E-06	2.8E-06	5.8E-06	4.8E-06	5.0E-08	1.4E-07	4.3E-08	
NP 237	5.4E-04	5.0E-03	1.2E-02	6.6E-02	2.0E-01	8.8E+01	7.1E+00	6.0E-01	
PA 233	1.7E-07	1.1E-05	3.2E-05	1.4E-04	4.1E-04	4.0E-06	2.8E-06	8.5E-07	
Total internal	2.1E+00	1.1E+02	3.2E+00	8.6E+00	2.2E+01	1.3E+02	1.2E+01	2.7E+00	

Radionuclide	Ovaries	Muscle	Thyroid	Kidneys	Liver
C 14	9.2E-01	9.2E-01	9.2E-01	0.0E+00	0.0E+00
TC 99	1.0E+00	1.0E+00	2.6E+01	0.0E+00	1.4E+00
I 129	3.9E-04	9.4E-04	6.7E+00	0.0E+00	0.0E+00
U 238	1.2E-01	1.1E-01	1.2E-01	2.0E+01	0.0E+00
TH 234	2.5E-06	2.9E-07	2.6E-08	0.0E+00	3.5E-07
PA 234	6.0E-07	9.1E-08	3.3E-09	1.5E-07	1.1E-07
NP 237	6.0E-01	4.8E-04	3.6E-04	0.0E+00	3.8E+00
PA 233	1.0E-05	1.1E-06	2.0E-08	1.4E-06	9.6E-07
Total internal	2.7E+00	2.1E+00	3.3E+01	2.0E+01	5.2E+00

opulation Air Submersion and External Incremental Dose by Radionuclide
In Year 9060 (70-yr Time Period Number No: 101)

Radionuclide	Air Submer-sion	External
C 14	5.2E-11	4.1E-05
TC 99	5.0E-12	6.1E-06
I 129	1.0E-12	6.3E-07
U 238	1.0E-12	6.3E-07
TH 234	1.7E-10	4.2E-04
PA 234	2.4E-11	6.5E-05
NP 237	3.8E-12	1.9E-05
PA 233	6.1E-11	4.6E-04
Total external	3.1E-10	1.0E-03

Dose in units of person-rem;
that is the cumulative population dose received by the local population with an assumed 70-yr individual lifetime.

Population Internal Dose To Organ by Exposure Pathway

In Year 9060 (70-yr Time Period Number No: 101)

Pathway	Lung	Stomach	S Int.	UL Int.	LL Int.	Bone	Su R	Marro	Testes
Inhalation	8.3E-03	2.1E-05	1.8E-05	1.8E-05	2.0E-05	3.6E-03	3.0E-04	4.4E-05	
Ingestion (Terr)	1.4E+00	1.1E+02	2.4E+00	7.5E+00	2.0E+01	6.6E+01	6.4E+00	1.7E+00	
Ingestion (Aqua)	5.7E-01	6.3E-01	5.7E-01	6.1E-01	7.0E-01	3.7E+01	3.6E+00	8.1E-01	
Drinking Water	9.9E-02	2.2E+00	1.6E-01	4.6E-01	1.2E+00	2.9E+01	2.2E+00	2.0E-01	
Total internal	2.1E+00	1.1E+02	3.2E+00	8.6E+00	2.2E+01	1.3E+02	1.2E+01	2.7E+00	

Pathway	Ovaries	Muscle	Thyroid	Kidneys	Liver
Inhalation	4.4E-05	1.8E-05	1.9E-05	1.4E-05	1.6E-04
Ingestion (Terr)	1.7E+00	1.4E+00	3.2E+01	1.3E+01	3.0E+00
Ingestion (Aqua)	8.1E-01	5.7E-01	5.9E-01	3.5E-01	1.6E+00
Drinking Water	2.0E-01	9.9E-02	1.2E+00	7.1E+00	6.6E-01
Total internal	2.7E+00	2.1E+00	3.3E+01	2.0E+01	5.2E+00

Dose in units of person-rem;
that is the cumulative population dose received by the local population
with an assumed 70-yr individual lifetime.

```
DITTY Long-Term Surface Water Release TWRS-EIS (Ex Situ No Sepa.)
  5
C 14
I 129
NP237
TC99
U 238
 &INPUT IWAT=1, IPATH=2, LUW=1, IPOPL=2,
  CFLO=120000.,
  RM=1.0, TZ=1990., TZR=0.,
  PL1(1)=294830.,391538.,431210.,469891.,1273208.,4932964.,
  TL(1)=1990., 2100.,2200.,2300.,2990.,11900.,
  NTL=6,
  USAGE(1)=0.3,0.,0.,0.,438.,17.,17.,
  CONSUM(1)=15.,276.,20.,230.,40.,30.,8.5,
  EXTIM=2920.,MOPYR=6, RIRR=150.,
  GRWP(1)=90.,90.,90.,30.,3*90.,
  YELD(1)=1.5,4.,0.84,1.3,3*0.84,
 &END
  5
C 14      5
1990.  0.0
4244.  0.0
4245.  0.0183
8995.  0.0183
8996.  0.0
I 129     5
1990.  0.0
4244.  0.0
4245.  0.0001
8995.  0.0001
8996.  0.0
NP237     5
1990.  0.0
4244.  0.0
4245.  0.00023
8995.  0.00023
8996.  0.0
TC99      5
1990.  0.0
4244.  0.0
4245.  0.1126
8995.  0.1126
8996.  0.0
U 238     5
```

1990.	0.0
4244.	0.0
4245.	0.0064
8995.	0.0064
8996.	0.0

DITTY Dose Calculation Program
(GENII Version 1.485 3-Dec-90)

Integrated population dose calculated for chronic liquid release
Release from time 1990. A.D. onward for 10,000 years
Case title: DITTY Long-Term Surface Water Release TWRS-EIS (Ex Situ No Sepa.)
Executed on: 06/21/96 at 07:03:13.0 Page 1

---- DATA LIBRARIES USED ----------(File)-----

Master Radionuclide Data: (2)
Radionuclide Master Library - Long Times (23-July-93 PDR)
Food Concentration Ratios: (8)
PNL Food Transfer Factor Library (by Z, Changed NP&U LF 6/18/96 AMN)
Fresh Water Bioaccumulation Factors: (9)
Bioaccumulation Factor Library - (30-Aug-88) RAP
External Exposure D.F.'s: (10)
External Dose Factors for GENII in person Sv/yr per Bq/X (8-May-90 RAP)
Inhalation/Ingestion D.F.'s: (30)
Worst-Case Solubilities, DITTY Internal Dose Factors (Sv/Bq) (23-Jul-93 PDR)
Waterborne Release Data: (31)
DITTY.IN

---- MASTER RADIONUCLIDE CONTROL LIST ----------
C 14 TC99 I 129 U 238 TH234 PA234 NP237
PA233

---- TERRESTRIAL/AQUATIC PATHWAY DATA FOR AN AVERAGE INDIVIDUAL

Pathway	Growing Period (days)	Yield (kg/m2)	Consumption (kg/yr)	Pathway	Usage (kg or hr/yr)
LEAFY VEG	9.0E+01	1.5E+00	1.5E+01	FISH	3.0E-01
OTHER VEG	9.0E+01	4.0E+00	2.8E+02	CRUSTACEA	0.0E+00
EGGS	9.0E+01	8.4E-01	2.0E+01	MOLLUSES	0.0E+00
MILK	3.0E+01	1.3E+00	2.3E+02	PLANTS	0.0E+00
BEEF	9.0E+01	8.4E-01	4.0E+01	DRINKING WATER	4.4E+02
PORK	9.0E+01	8.4E-01	3.0E+01	SEDIMENT EXPOSU	1.7E+01
POULTRY	9.0E+01	8.4E-01	8.5E+00	SWIMMING TIME	1.7E+01

External Exposure Time: 2.92E+03 hr/yr

---- LIQUID RELEASE PARAMETERS ----------

River Flow Rate, (ft3/sec) : 1.2E+05 Months/Year Irrigated : 6.0E+00
Reconcentration Ratio : 1.0E+00 Irrigation Rate
Mixing Ratio : 1.0E+00 (liters/m2/month) : 1.5E+02

Input Prepared By: _____ Date: _____

Input Checked By: _____ Date: _____

DITTY Dose Calculation Program
(GENII Version 1.485 3-Dec-90)

Integrated population dose calculated for chronic liquid release
Release from time 1990. A.D. onward for 10,000 years
Case title: DITTY Long-Term Surface Water Release TWRS-EIS (Ex Situ No Sepa.)
Executed on: 06/21/96 at 07:03:13.0 Page 2

---- WATER RELEASE OF EACH RADIONCLIDE PER 70-YR PERIOD (Ci) ----------

Radio-nuclide	Period/ Activity	Period/ Activity	Period/ Activity	Period/ Activity	Period/ Activity
C 14	33 1.0E+00	34 1.3E+00	35 1.3E+00	36 1.3E+00	37 1.3E+00
	38 1.3E+00	39 1.3E+00	40 1.3E+00	41 1.3E+00	42 1.3E+00
	43 1.3E+00	44 1.3E+00	45 1.3E+00	46 1.3E+00	47 1.3E+00
	48 1.3E+00	49 1.3E+00	50 1.3E+00	51 1.3E+00	52 1.3E+00
	53 1.3E+00	54 1.3E+00	55 1.3E+00	56 1.3E+00	57 1.3E+00
	58 1.3E+00	59 1.3E+00	60 1.3E+00	61 1.3E+00	62 1.3E+00
	63 1.3E+00	64 1.3E+00	65 1.3E+00	66 1.3E+00	67 1.3E+00
	68 1.3E+00	69 1.3E+00	70 1.3E+00	71 1.3E+00	72 1.3E+00
	73 1.3E+00	74 1.3E+00	75 1.3E+00	76 1.3E+00	77 1.3E+00
	78 1.3E+00	79 1.3E+00	80 1.3E+00	81 1.3E+00	82 1.3E+00
	83 1.3E+00	84 1.3E+00	85 1.3E+00	86 1.3E+00	87 1.3E+00
	88 1.3E+00	89 1.3E+00	90 1.3E+00	91 1.3E+00	92 1.3E+00
	93 1.3E+00	94 1.3E+00	95 1.3E+00	96 1.3E+00	97 1.3E+00
	98 1.3E+00	99 1.3E+00	100 1.3E+00	101 1.0E-01	
TC99	33 6.2E+00	34 7.9E+00	35 7.9E+00	36 7.9E+00	37 7.9E+00
	38 7.9E+00	39 7.9E+00	40 7.9E+00	41 7.9E+00	42 7.9E+00
	43 7.9E+00	44 7.9E+00	45 7.9E+00	46 7.9E+00	47 7.9E+00
	48 7.9E+00	49 7.9E+00	50 7.9E+00	51 7.9E+00	52 7.9E+00
	53 7.9E+00	54 7.9E+00	55 7.9E+00	56 7.9E+00	57 7.9E+00
	58 7.9E+00	59 7.9E+00	60 7.9E+00	61 7.9E+00	62 7.9E+00
	63 7.9E+00	64 7.9E+00	65 7.9E+00	66 7.9E+00	67 7.9E+00
	68 7.9E+00	69 7.9E+00	70 7.9E+00	71 7.9E+00	72 7.9E+00
	73 7.9E+00	74 7.9E+00	75 7.9E+00	76 7.9E+00	77 7.9E+00
	78 7.9E+00	79 7.9E+00	80 7.9E+00	81 7.9E+00	82 7.9E+00
	83 7.9E+00	84 7.9E+00	85 7.9E+00	86 7.9E+00	87 7.9E+00
	88 7.9E+00	89 7.9E+00	90 7.9E+00	91 7.9E+00	92 7.9E+00
	93 7.9E+00	94 7.9E+00	95 7.9E+00	96 7.9E+00	97 7.9E+00
	98 7.9E+00	99 7.9E+00	100 7.9E+00	101 6.2E-01	
I 129	33 5.5E-03	34 7.0E-03	35 7.0E-03	36 7.0E-03	37 7.0E-03
	38 7.0E-03	39 7.0E-03	40 7.0E-03	41 7.0E-03	42 7.0E-03

43 7.0E-03 44 7.0E-03 45 7.0E-03 46 7.0E-03 47 7.0E-03
48 7.0E-03 49 7.0E-03 50 7.0E-03 51 7.0E-03 52 7.0E-03
53 7.0E-03 54 7.0E-03 55 7.0E-03 56 7.0E-03 57 7.0E-03
58 7.0E-03 59 7.0E-03 60 7.0E-03 61 7.0E-03 62 7.0E-03
63 7.0E-03 64 7.0E-03 65 7.0E-03 66 7.0E-03 67 7.0E-03
68 7.0E-03 69 7.0E-03 70 7.0E-03 71 7.0E-03 72 7.0E-03
73 7.0E-03 74 7.0E-03 75 7.0E-03 76 7.0E-03 77 7.0E-03
78 7.0E-03 79 7.0E-03 80 7.0E-03 81 7.0E-03 82 7.0E-03
83 7.0E-03 84 7.0E-03 85 7.0E-03 86 7.0E-03 87 7.0E-03
88 7.0E-03 89 7.0E-03 90 7.0E-03 91 7.0E-03 92 7.0E-03
93 7.0E-03 94 7.0E-03 95 7.0E-03 96 7.0E-03 97 7.0E-03
98 7.0E-03 99 7.0E-03 100 7.0E-03 101 5.5E-04

U 238 33 3.6E-01 34 4.5E-01 35 4.5E-01 36 4.5E-01 37 4.5E-01
38 4.5E-01 39 4.5E-01 40 4.5E-01 41 4.5E-01 42 4.5E-01
43 4.5E-01 44 4.5E-01 45 4.5E-01 46 4.5E-01 47 4.5E-01
48 4.5E-01 49 4.5E-01 50 4.5E-01 51 4.5E-01 52 4.5E-01
53 4.5E-01 54 4.5E-01 55 4.5E-01 56 4.5E-01 57 4.5E-01
58 4.5E-01 59 4.5E-01 60 4.5E-01 61 4.5E-01 62 4.5E-01
63 4.5E-01 64 4.5E-01 65 4.5E-01 66 4.5E-01 67 4.5E-01
68 4.5E-01 69 4.5E-01 70 4.5E-01 71 4.5E-01 72 4.5E-01
73 4.5E-01 74 4.5E-01 75 4.5E-01 76 4.5E-01 77 4.5E-01
78 4.5E-01 79 4.5E-01 80 4.5E-01 81 4.5E-01 82 4.5E-01
83 4.5E-01 84 4.5E-01 85 4.5E-01 86 4.5E-01 87 4.5E-01
88 4.5E-01 89 4.5E-01 90 4.5E-01 91 4.5E-01 92 4.5E-01
93 4.5E-01 94 4.5E-01 95 4.5E-01 96 4.5E-01 97 4.5E-01
98 4.5E-01 99 4.5E-01 100 4.5E-01 101 3.5E-02

NP237 33 1.3E-02 34 1.6E-02 35 1.6E-02 36 1.6E-02 37 1.6E-02
38 1.6E-02 39 1.6E-02 40 1.6E-02 41 1.6E-02 42 1.6E-02
43 1.6E-02 44 1.6E-02 45 1.6E-02 46 1.6E-02 47 1.6E-02
48 1.6E-02 49 1.6E-02 50 1.6E-02 51 1.6E-02 52 1.6E-02
53 1.6E-02 54 1.6E-02 55 1.6E-02 56 1.6E-02 57 1.6E-02
58 1.6E-02 59 1.6E-02 60 1.6E-02 61 1.6E-02 62 1.6E-02
63 1.6E-02 64 1.6E-02 65 1.6E-02 66 1.6E-02 67 1.6E-02
68 1.6E-02 69 1.6E-02 70 1.6E-02 71 1.6E-02 72 1.6E-02
73 1.6E-02 74 1.6E-02 75 1.6E-02 76 1.6E-02 77 1.6E-02
78 1.6E-02 79 1.6E-02 80 1.6E-02 81 1.6E-02 82 1.6E-02
83 1.6E-02 84 1.6E-02 85 1.6E-02 86 1.6E-02 87 1.6E-02
88 1.6E-02 89 1.6E-02 90 1.6E-02 91 1.6E-02 92 1.6E-02
93 1.6E-02 94 1.6E-02 95 1.6E-02 96 1.6E-02 97 1.6E-02
98 1.6E-02 99 1.6E-02 100 1.6E-02 101 1.3E-03

---- POPULATION DATA ----

Population for Chronic Waterborne Release at the following Times A.D.:

Time	Population
1990.	2.9E+05
2100.	3.9E+05
2200.	4.3E+05
2300.	4.7E+05
2990.	1.3E+06
11900.	4.9E+06

Lifetime Effective Cumulative Dose Equivalent as a Function of Time

Period	Year	Dose
until	until	
34	4300.	6.80E+00
35	4370.	1.55E+01
36	4440.	2.44E+01
37	4510.	3.34E+01
38	4580.	4.25E+01
39	4650.	5.18E+01
40	4720.	6.12E+01
41	4790.	7.07E+01
42	4860.	8.04E+01
43	4930.	9.02E+01
44	5000.	1.00E+02
45	5070.	1.10E+02
46	5140.	1.20E+02
47	5210.	1.31E+02
48	5280.	1.41E+02
49	5350.	1.52E+02
50	5420.	1.63E+02
51	5490.	1.74E+02
52	5560.	1.85E+02
53	5630.	1.96E+02
54	5700.	2.07E+02
55	5770.	2.19E+02
56	5840.	2.30E+02
57	5910.	2.42E+02
58	5980.	2.54E+02
59	6050.	2.66E+02
60	6120.	2.78E+02
61	6190.	2.90E+02
62	6260.	3.03E+02

63	6330.	3.15E+02
64	6400.	3.28E+02
65	6470.	3.41E+02
66	6540.	3.54E+02
67	6610.	3.67E+02
68	6680.	3.80E+02
69	6750.	3.94E+02
70	6820.	4.07E+02
71	6890.	4.21E+02
72	6960.	4.35E+02
73	7030.	4.48E+02
74	7100.	4.63E+02
75	7170.	4.77E+02

Lifetime Effective Cumulative Dose Equivalent as a Function of Time

Period	Year	Dose
76	7240.	4.91E+02
77	7310.	5.06E+02
78	7380.	5.20E+02
79	7450.	5.35E+02
80	7520.	5.50E+02
81	7590.	5.65E+02
82	7660.	5.80E+02
83	7730.	5.95E+02
84	7800.	6.11E+02
85	7870.	6.26E+02
86	7940.	6.42E+02
87	8010.	6.58E+02
88	8080.	6.74E+02
89	8150.	6.90E+02
90	8220.	7.06E+02
91	8290.	7.23E+02
92	8360.	7.39E+02
93	8430.	7.56E+02
94	8500.	7.73E+02
95	8570.	7.90E+02
96	8640.	8.07E+02
97	8710.	8.24E+02
98	8780.	8.41E+02
99	8850.	8.59E+02
100	8920.	8.77E+02
101	8990.	8.94E+02
102	9060.	8.96E+02
until	until	
144	12000.	8.96E+02

Dose in units of person-rem;
that is the cumulative population dose received by the local population over 10,000 years with an assumed 70-yr individual lifetime.

Cumulative Population Dose Equivalent by Radionuclide

Radio-nuclide	Effective Dose Equivalent	Annual External Dose	Effective Dose Equivalent	Percent Of Total Dose
C 14	4.5E+01	2.1E-03	4.5E+01	5
TC 99	5.0E+02	3.1E-04	5.0E+02	55
I 129	1.0E+01	3.2E-05	1.0E+01	1
U 238	1.5E+02	3.2E-05	1.5E+02	17
TH 234	1.6E-02	2.1E-02	3.7E-02	0
PA 234	5.4E-05	3.3E-03	3.3E-03	0
NP 237	2.0E+02	9.8E-04	2.0E+02	21
PA 233	2.0E-03	2.3E-02	2.5E-02	0

Dose in units of person-rem;
that is the cumulative population dose received by the local population
with an assumed 70-yr individual lifetime.

Maximum Dose Increment Received By Population
In Year 9060 (70-yr Time Period Number No: 101)

Organ	Cumulative Dose Equivalent	Weighting Factors	Weighted Cumulative Dose Equivalent
Gonads	2.7E+00	2.5E-01	6.7E-01
Breast	2.1E+00	1.5E-01	3.1E-01
R Marrow	1.2E+01	1.2E-01	1.5E+00
Lung	2.1E+00	1.2E-01	2.5E-01
Thyroid	3.3E+01	3.0E-02	1.0E+00
Bone Sur	1.3E+02	3.0E-02	3.9E+00
Stomach	1.1E+02	6.0E-02	6.8E+00
LL Int.	2.2E+01	6.0E-02	1.3E+00
Kidneys	2.0E+01	6.0E-02	1.2E+00
UL Int.	8.6E+00	6.0E-02	5.1E-01
Liver	5.2E+00	6.0E-02	3.1E-01

Cumulative Effective Dose Equivalent 1.8E+01
External Dose 1.0E-03

Lifetime Effective Cumulative
Dose Equivalent 1.8E+01

Dose in units of person-rem;
that is the cumulative population dose received by the local population
with an assumed 70-yr individual lifetime.

Maximum Dose Increment Received By Individual (rem)
In Year 9060 (70-yr Time Period Number No: 101)

Radio-nuclide	Effective Dose Equivalent	Annual External Dose	Effective Dose Equivalent	Percent Of Total Dose
C 14	2.4E-07	1.1E-11	2.4E-07	5
TC 99	2.7E-06	1.6E-12	2.7E-06	55
I 129	5.4E-08	1.7E-13	5.4E-08	1
U 238	8.2E-07	1.7E-13	8.2E-07	17
TH 234	8.6E-11	1.1E-10	2.0E-10	0
PA 234	2.9E-13	1.8E-11	1.8E-11	0
NP 237	1.0E-06	5.2E-12	1.0E-06	21
PA 233	1.0E-11	1.2E-10	1.3E-10	0

4.814×10^{-6}

Population Internal Dose To Organ by Radionuclide
In Year 9060 (70-yr Time Period Number No: 101)

Radionuclide	Lung	Stomach S Int.	UL Int.	LL Int.	Bone Su	R Marro	Testes
C 14	9.2E-01	9.2E-01	9.2E-01	9.2E-01	9.2E-01	1.1E+00	1.1E+00	9.2E-01
TC 99	1.0E+00	1.1E+02	2.0E+00	6.8E+00	1.8E+01	1.2E+00	1.2E+00	1.0E+00
I 129	4.5E-04	6.2E-04	3.9E-04	3.9E-04	3.9E-04	5.3E-04	5.8E-04	3.6E-04
U 238	1.2E-01	1.6E-01	2.3E-01	8.0E-01	2.3E+00	4.1E+01	2.8E+00	1.1E-01
TH 234	2.4E-06	8.8E-05	2.1E-04	1.3E-03	3.8E-03	1.8E-06	1.5E-06	2.0E-07
PA 234	2.8E-08	1.4E-06	2.8E-06	5.8E-06	4.8E-06	5.0E-08	1.4E-07	4.3E-08
NP 237	5.4E-04	5.0E-03	1.2E-02	6.6E-02	2.0E-01	8.8E+01	7.1E+00	6.0E-01
PA 233	1.7E-07	1.1E-05	3.2E-05	1.4E-04	4.1E-04	4.0E-06	2.8E-06	8.5E-07
Total internal	2.1E+00	1.1E+02	3.2E+00	8.6E+00	2.2E+01	1.3E+02	1.2E+01	2.7E+00

Radionuclide	Ovaries	Muscle	Thyroid	Kidneys	Liver
C 14	9.2E-01	9.2E-01	9.2E-01	0.0E+00	0.0E+00
TC 99	1.0E+00	1.0E+00	2.6E+01	0.0E+00	1.4E+00
I 129	3.9E-04	9.4E-04	6.7E+00	0.0E+00	0.0E+00
U 238	1.2E-01	1.1E-01	1.2E-01	2.0E+01	0.0E+00
TH 234	2.5E-06	2.9E-07	2.6E-08	0.0E+00	3.5E-07
PA 234	6.0E-07	9.1E-08	3.3E-09	1.5E-07	1.1E-07
NP 237	6.0E-01	4.8E-04	3.6E-04	0.0E+00	3.8E+00
PA 233	1.0E-05	1.1E-06	2.0E-08	1.4E-06	9.6E-07
Total internal	2.7E+00	2.1E+00	3.3E+01	2.0E+01	5.2E+00

Population Air Submersion and External Incremental Dose by Radionuclide
In Year 9060 (70-yr Time Period Number No: 101)

Radionuclide	Air Submer-sion	External
C 14	5.2E-11	4.1E-05
TC 99	5.0E-12	6.1E-06
I 129	1.0E-12	6.3E-07
U 238	1.0E-12	6.3E-07
TH 234	1.7E-10	4.2E-04
PA 234	2.4E-11	6.5E-05
NP 237	3.8E-12	1.9E-05
PA 233	6.1E-11	4.6E-04
Total external	3.1E-10	1.0E-03

Dose in units of person-rem;
that is the cumulative population dose received by the local population with an assumed 70-yr individual lifetime.

DITTY Dose Calculation Program
(GENII Version 1.485 3-Dec-90)

Integrated population dose calculated for chronic liquid release
Release from time 1990. A.D. onward for 10,000 years
Case title: DITTY Long-Term Surface Water Release TWRS-EIS (Ex Situ No Sepa.)
Executed on: 06/21/96 at 07:03:13.0 Page 10

Population Internal Dose To Organ by Exposure Pathway

In Year 9060 (70-yr Time Period Number No: 101)

Pathway	Lung	Stomach	S Int.	UL Int.	LL Int.	Bone	Su R	Marro	Testes
Inhalation	8.3E-03	2.1E-05	1.8E-05	1.8E-05	2.0E-05	3.6E-03	3.0E-04	4.4E-05	
Ingestion (Terr)	1.4E+00	1.1E+02	2.4E+00	7.5E+00	2.0E+01	6.6E+01	6.4E+00	1.7E+00	
Ingestion (Aqua)	5.7E-01	6.3E-01	5.7E-01	6.1E-01	7.0E-01	3.7E+01	3.6E+00	8.1E-01	
Drinking Water	9.9E-02	2.2E+00	1.6E-01	4.6E-01	1.2E+00	2.9E+01	2.2E+00	2.0E-01	
Total internal	2.1E+00	1.1E+02	3.2E+00	8.6E+00	2.2E+01	1.3E+02	1.2E+01	2.7E+00	

Pathway	Ovaries	Muscle	Thyroid	Kidneys	Liver
Inhalation	4.4E-05	1.8E-05	1.9E-05	1.4E-05	1.6E-04
Ingestion (Terr)	1.7E+00	1.4E+00	3.2E+01	1.3E+01	3.0E+00
Ingestion (Aqua)	8.1E-01	5.7E-01	5.9E-01	3.5E-01	1.6E+00
Drinking Water	2.0E-01	9.9E-02	1.2E+00	7.1E+00	6.6E-01
Total internal	2.7E+00	2.1E+00	3.3E+01	2.0E+01	5.2E+00

Dose in units of person-rem;
that is the cumulative population dose received by the local population
with an assumed 70-yr individual lifetime.

TWRS EIS
CALCULATION COVER SHEET

DISCIPLINE & TITLE RISK ASSESSMENT, LEAD RISK ASSESSOR

ORIGINATOR ALEX NAZARALI DATE 6-20-96

REVISION NO. _____

OBJECTIVE REVISE RISK RESULT FOR THE COLUMBIA RIVER USERS.

METHODOLOGY USE COMPUTER CODE DITTY

ASSUMPTIONS PER INPUT/OUTPUT PRINTOUT.

(Continue on another sheet if necessary)

6/20/96
SIGNATURE/DATE

6/21/96
CHECKED/DATE

CALCULATION & RESULTS
ATTACHED

JACOBS\FORMS\CALCVR.SHT

To	Marc Nelson
From	Alex Nazarali
Date	June 21, 1996
Subject	Cumulative Risk to the Columbia River User Local Population over 10,000 Years

The cumulative risk to the Columbia River user in the TWRS Draft EIS (Appendix D, Table D.5.14.3 and Volume One, Table 5.11.6) was calculated based on the unit dose factors generated by the DITTY computer code and published in Appendix F of the Disposal of Hanford Defense High-Level, Transuranic, and Tank Wastes Final Environmental Impact Statement (HDW-EIS).

The DITTY code has undergone significant modifications since the HDW-EIS was published. The new version of the DITTY code uses ICRP Publications 26 and 30 (ICRP 1977; ICRP 1979) instead of ICRP Publication 2 (ICRP 1959).

The new version of the DITTY code was run to estimate the cumulative dose for the TWRS Final EIS. The input/output of the DITTY code for each alternative and the new table that summarizes the cumulative dose and risk to the Columbia River users over 10,000 years are enclosed. The enclosed table will replace Tables D.5.14.3 and 5.11.6.

Note: The Ftrans.dat file in the DITTY code, which is the PNL food transport factors library was modified by Alex Nazarali on 6/16/96 for the new runs. In this modification, the leaching factors for neptunium and uranium changed from 3.3E-03 and 1.3E-03 respectively to 0.8. This change makes the leaching factors of neptunium and uranium consistent with carbon, iodine, and technetium. These five constituents are transported from the tanks to the receptors with the same transport properties. The leaching factors were different in the DITTY code, which should be the same for our analysis.

Table D.5.14.3 Estimated Fatality, Population Dose (person-rem), and Maximum Incremental Dose (mrem) for the Columbia River User over 10,000 Years for all Alternatives

Alternative	**Total Fatality in 10,000 years**	**Cumulative Population Dose[1] (Person-rem)**	**Maximum Incremental Dose in mrem (Year Received)**
No Action	2.7	5460	0.82 (2900)
Long-Term Management	2.2	4400	0.75 (2830)
In Situ Fill and Cap	25.4	50800	0.15 (12000)
In Situ Vitrification	1.00E-06	0.002	0
Ex Situ Intermediate Separation	0.5	896	0.005 (9060)
Ex Situ No Separation	0.5	896	0.005 (9060)
Ex Situ Extensive Separation	0.5	896	0.005 (9060)
Ex Situ/In Situ Combination	2.2	4420	0.02 (12000)
Phased Implementation	0.5	896	0.005 (9060)

1 The ICRP Publication 60 dose to risk conversion factor of 5.0E-04 cancer fatality per rem is used.

```
DITTY Long-Term Surface Water Release TWRS-EIS (No Action)
   5
C 14
I 129
NP237
TC99
U 238
 &INPUT IWAT=1, IPATH=2, LUW=1, IPOPL=2,
  CFLO=120000.,
  RM=1.0, TZ=1990., TZR=0.,
  PL1(1)=294830.,391538.,431210.,469891.,1273208.,4932964.,
  TL(1)=1990., 2100.,2200.,2300.,2990.,11900.,
  NTL=6,
  USAGE(1)=0.3,0.,0.,0.,438.,17.,17.,
  CONSUM(1)=15.,276.,20.,230.,40.,30.,8.5,
  EXTIM=2920.,MOPYR=6, RIRR=150.,
  GRWP(1)=90.,90.,90.,30.,3*90.,
  YELD(1)=1.5,4.,0.84,1.3,3*0.84,
 &END
   5
C 14        5
1990.   0.0
2219.   0.0
2220.   8.0125
2845.   8.0125
2846.   0.0
I 129       5
1990.   0.0
2219.   0.0
2220.   0.0256
2845.   0.0256
2846.   0.0
NP237       5
1990.   0.0
2219.   0.0
2220.   0.106
2845.   0.106
2846.   0.0
TC99        5
1990.   0.0
2219.   0.0
2220.   49.68
2845.   49.68
2846.   0.0
U 238       5
```

1990.	0.0
2219.	0.0
2220.	0.7696
2845.	0.7696
2846.	0.0

DITTY Dose Calculation Program
(GENII Version 1.485 3-Dec-90)

Integrated population dose calculated for chronic liquid release
Release from time 1990. A.D. onward for 10,000 years
Case title: DITTY Long-Term Surface Water Release TWRS-EIS (No Action)
Executed on: 06/18/96 at 10:54:15.6 Page 1

---- DATA LIBRARIES USED ----------(File)-----

Master Radionuclide Data: (2)
Radionuclide Master Library - Long Times (23-July-93 PDR)
Food Concentration Ratios: (8)
PNL Food Transfer Factor Library (by Z, Changed NP&U LF 6/18/96 AMN)
Fresh Water Bioaccumulation Factors: (9)
Bioaccumulation Factor Library - (30-Aug-88) RAP
External Exposure D.F.'s: (10)
External Dose Factors for GENII in person Sv/yr per Bq/X (8-May-90 RAP)
Inhalation/Ingestion D.F.'s: (30)
Worst-Case Solubilities, DITTY Internal Dose Factors (Sv/Bq) (23-Jul-93 PDR)
Waterborne Release Data: (31)
DITTY.IN

---- MASTER RADIONUCLIDE CONTROL LIST ----------
C 14 TC99 I 129 U 238 TH234 PA234 NP237
PA233

---- TERRESTRIAL/AQUATIC PATHWAY DATA FOR AN AVERAGE INDIVIDUAL

Pathway	Growing Period (days)	Yield (kg/m2)	Consumption (kg/yr)	Pathway	Usage (kg or hr/yr)
LEAFY VEG	9.0E+01	1.5E+00	1.5E+01	FISH	3.0E-01
OTHER VEG	9.0E+01	4.0E+00	2.8E+02	CRUSTACEA	0.0E+00
EGGS	9.0E+01	8.4E-01	2.0E+01	MOLLUSES	0.0E+00
MILK	3.0E+01	1.3E+00	2.3E+02	PLANTS	0.0E+00
BEEF	9.0E+01	8.4E-01	4.0E+01	DRINKING WATER	4.4E+02
PORK	9.0E+01	8.4E-01	3.0E+01	SEDIMENT EXPOSU	1.7E+01
POULTRY	9.0E+01	8.4E-01	8.5E+00	SWIMMING TIME	1.7E+01

External Exposure Time: 2.92E+03 hr/yr

---- LIQUID RELEASE PARAMETERS ----------

River Flow Rate, (ft3/sec) : 1.2E+05 Months/Year Irrigated : 6.0E+00
Reconcentration Ratio : 1.0E+00 Irrigation Rate
Mixing Ratio : 1.0E+00 (liters/m2/month) : 1.5E+02

Input Prepared By: _____ Date: _____

Input Checked By: _____ Date: _____

DITTY Dose Calculation Program
(GENII Version 1.485 3-Dec-90)

Integrated population dose calculated for chronic liquid release
Release from time 1990. A.D. onward for 10,000 years
Case title: DITTY Long-Term Surface Water Release TWRS-EIS (No Action)
Executed on: 06/18/96 at 10:54:15.6 Page 2

---- WATER RELEASE OF EACH RADIONCLIDE PER 70-YR PERIOD (Ci) ----------

Radio-nuclide	Period/ Activity	Period/ Activity	Period/ Activity	Period/ Activity	Period/ Activity
C 14	4 6.3E-01	5 8.8E-01	6 8.8E-01	7 8.8E-01	8 8.8E-01
	9 8.8E-01	10 8.8E-01	11 8.8E-01	12 8.8E-01	13 2.0E-01
TC99	4 4.9E+02	5 6.8E+02	6 6.8E+02	7 6.8E+02	8 6.8E+02
	9 6.8E+02	10 6.8E+02	11 6.8E+02	12 6.8E+02	13 1.5E+02
I 129	4 1.3E+00	5 1.8E+00	6 1.8E+00	7 1.8E+00	8 1.8E+00
	9 1.8E+00	10 1.8E+00	11 1.8E+00	12 1.8E+00	13 4.0E-01
U 238	4 3.9E+01	5 5.4E+01	6 5.4E+01	7 5.4E+01	8 5.4E+01
	9 5.4E+01	10 5.4E+01	11 5.4E+01	12 5.4E+01	13 1.2E+01
NP237	4 5.4E+00	5 7.4E+00	6 7.4E+00	7 7.4E+00	8 7.4E+00
	9 7.4E+00	10 7.4E+00	11 7.4E+00	12 7.4E+00	13 1.6E+00

---- POPULATION DATA ----

Population for Chronic Waterborne Release at the following Times A.D.:

Time	Population
1990.	2.9E+05
2100.	3.9E+05
2200.	4.3E+05
2300.	4.7E+05
2990.	1.3E+06
11900.	4.9E+06

DITTY Dose Calculation Program
(GENII Version 1.485 3-Dec-90)

Integrated population dose calculated for chronic liquid release
Release from time 1990. A.D. onward for 10,000 years
Case title: DITTY Long-Term Surface Water Release TWRS-EIS (No Action)
Executed on: 06/18/96 at 10:54:15.6 Page 4

Lifetime Effective Cumulative Dose Equivalent as a Function of Time

Period	Year	Dose
until	until	
5	2270.	2.63E+02
6	2340.	6.52E+02
7	2410.	1.11E+03
8	2480.	1.63E+03
9	2550.	2.22E+03
10	2620.	2.88E+03
11	2690.	3.60E+03
12	2760.	4.39E+03
13	2830.	5.25E+03
14	2900.	5.46E+03
until	until	
144	12000.	5.46E+03

Dose in units of person-rem;
that is the cumulative population dose received by the local population over 10,000 years with an assumed 70-yr individual lifetime.

DITTY Dose Calculation Program
(GENII Version 1.485 3-Dec-90)

Integrated population dose calculated for chronic liquid release
Release from time 1990. A.D. onward for 10,000 years
Case title: DITTY Long-Term Surface Water Release TWRS-EIS (No Action)
Executed on: 06/18/96 at 10:54:15.6

Cumulative Population Dose Equivalent by Radionuclide

Radio-nuclide	Effective Dose Equivalent	Annual External Dose	Effective Dose Equivalent	Percent Of Total Dose
C 14	1.1E+00	5.0E-05	1.1E+00	0
TC 99	1.5E+03	9.3E-04	1.5E+03	27
I 129	9.2E+01	2.9E-04	9.2E+01	1
U 238	6.6E+02	1.4E-04	6.6E+02	12
TH 234	6.9E-02	9.0E-02	1.6E-01	0
PA 234	2.3E-04	1.4E-02	1.4E-02	0
NP 237	3.2E+03	1.6E-02	3.2E+03	58
PA 233	3.2E-02	3.8E-01	4.1E-01	0

Dose in units of person-rem;
that is the cumulative population dose received by the local population
with an assumed 70-yr individual lifetime.

Maximum Dose Increment Received By Population
In Year 2900 (70-yr Time Period Number No: 13)

Organ	Cumulative Dose Equivalent	Weighting Factors	Weighted Cumulative Dose Equivalent
Gonads	1.1E+02	2.5E-01	2.7E+01
Breast	2.9E+01	1.5E-01	4.3E+00
R Marrow	1.0E+03	1.2E-01	1.3E+02
Lung	2.9E+01	1.2E-01	3.5E+00
Thyroid	1.1E+03	3.0E-02	3.3E+01
Bone Sur	1.3E+04	3.0E-02	3.8E+02
Stomach	2.7E+03	6.0E-02	1.6E+02
Kidneys	6.9E+02	6.0E-02	4.1E+01
LL Int.	5.5E+02	6.0E-02	3.3E+01
Liver	5.3E+02	6.0E-02	3.2E+01
UL Int.	2.0E+02	6.0E-02	1.2E+01

Cumulative Effective Dose Equivalent 8.6E+02
External Dose 7.9E-02

Lifetime Effective Cumulative
Dose Equivalent 8.6E+02

Dose in units of person-rem;
that is the cumulative population dose received by the local population
with an assumed 70-yr individual lifetime.

Maximum Dose Increment Received By Individual (rem)
In Year 2900 (70-yr Time Period Number No: 13)

Radio-nuclide	Effective Dose Equivalent	Annual External Dose	Effective Dose Equivalent	Percent Of Total Dose
C 14	1.6E-07	7.5E-12	1.6E-07	0
TC 99	2.3E-04	1.4E-10	2.3E-04	27
I 129	1.4E-05	4.4E-11	1.4E-05	1
U 238	9.9E-05	2.0E-11	9.9E-05	12
TH 234	1.0E-08	1.4E-08	2.4E-08	0
PA 234	3.5E-11	2.1E-09	2.1E-09	0
NP 237	4.8E-04	2.4E-09	4.8E-04	58
PA 233	4.8E-09	5.7E-08	6.2E-08	0

8.232E-4

Population Internal Dose To Organ by Radionuclide
In Year 2900 (70-yr Time Period Number No: 13)

Radionuclide	Lung	Stomach S Int.	UL Int.	LL Int.	Bone Su	R Marro	Testes
C 14	1.8E-01	1.8E-01	1.8E-01	1.8E-01	1.8E-01	2.2E-01	2.2E-01	1.8E-01
TC 99	2.5E+01	2.7E+03	4.9E+01	1.6E+02	4.4E+02	2.9E+01	2.9E+01	2.5E+01
I 129	3.2E-02	4.5E-02	2.8E-02	2.8E-02	2.8E-02	3.8E-02	4.2E-02	2.6E-02
U 238	4.0E+00	5.4E+00	7.8E+00	2.7E+01	7.8E+01	1.4E+03	9.3E+01	3.7E+00
TH 234	8.0E-05	3.0E-03	7.2E-03	4.3E-02	1.3E-01	6.0E-05	5.1E-05	6.8E-06
PA 234	9.4E-07	4.6E-05	9.4E-05	2.0E-04	1.6E-04	1.7E-06	4.8E-06	1.4E-06
NP 237	7.0E-02	6.5E-01	1.6E+00	8.5E+00	2.6E+01	1.1E+04	9.2E+02	7.8E+01
PA 233	2.2E-05	1.5E-03	4.1E-03	1.8E-02	5.3E-02	5.1E-04	3.6E-04	1.1E-04
Total internal	2.9E+01	2.7E+03	5.8E+01	2.0E+02	5.5E+02	1.3E+04	1.0E+03	1.1E+02

Radionuclide	Ovaries	Muscle	Thyroid	Kidneys	Liver
C 14	1.8E-01	1.8E-01	1.8E-01	0.0E+00	0.0E+00
TC 99	2.5E+01	2.5E+01	6.2E+02	0.0E+00	3.4E+01
I 129	2.8E-02	6.7E-02	4.8E+02	0.0E+00	0.0E+00
U 238	3.9E+00	3.7E+00	3.9E+00	6.9E+02	0.0E+00
TH 234	8.5E-05	9.8E-06	8.7E-07	0.0E+00	1.2E-05
PA 234	2.0E-05	3.1E-06	1.1E-07	5.1E-06	3.7E-06
NP 237	7.8E+01	6.2E-02	4.6E-02	0.0E+00	5.0E+02
PA 233	1.3E-03	1.4E-04	2.6E-06	1.8E-04	1.2E-04
Total internal	1.1E+02	2.9E+01	1.1E+03	6.9E+02	5.3E+02

Population Air Submersion and External Incremental Dose by Radionuclide
In Year 2900 (70-yr Time Period Number No: 13)

Radionuclide	Air Submer-sion	External
C 14	9.9E-12	7.9E-06
TC 99	1.2E-10	1.5E-04
I 129	7.5E-11	4.6E-05
U 238	3.5E-11	2.1E-05
TH 234	5.6E-09	1.4E-02
PA 234	8.0E-10	2.2E-03
NP 237	4.9E-10	2.5E-03
PA 233	7.9E-09	6.0E-02
Tot l external	1.5E-08	7.9E-02

Dose in units of person-rem;
that is the cumulative population dose received by the local population with an assumed 70-yr individual lifetime.

Population Internal Dose To Organ by Exposure Pathway

In Year 2900 (70-yr Time Period Number No: 13)

Pathway	Lung	Stomach	S Int.	UL Int.	LL Int.	Bone	Su R	Marro	Testes
Inhalation	2.8E-01	8.0E-05	1.3E-05	3.4E-05	8.4E-05	4.6E-01	3.6E-02	3.4E-03	
Ingestion (Terr)	2.7E+01	2.7E+03	5.3E+01	1.8E+02	4.9E+02	5.8E+03	4.8E+02	6.0E+01	
Ingestion (Aqua)	2.1E-01	2.0E+00	9.0E-01	4.1E+00	1.2E+01	4.6E+03	3.8E+02	3.2E+01	
Drinking Water	1.8E+00	5.3E+01	3.9E+00	1.4E+01	4.0E+01	2.4E+03	1.9E+02	1.5E+01	
Total internal	2.9E+01	2.7E+03	5.8E+01	2.0E+02	5.5E+02	1.3E+04	1.0E+03	1.1E+02	

Pathway	Ovaries	Muscle	Thyroid	Kidneys	Liver
Inhalation	3.4E-03	9.6E-06	8.1E-05	4.7E-04	2.0E-02
Ingestion (Terr)	6.0E+01	2.7E+01	1.0E+03	4.4E+02	2.5E+02
Ingestion (Aqua)	3.2E+01	2.1E-01	9.6E-01	1.2E+01	2.0E+02
Drinking Water	1.5E+01	1.8E+00	6.2E+01	2.4E+02	8.3E+01
Total internal	1.1E+02	2.9E+01	1.1E+03	6.9E+02	5.3E+02

Dose in units of person-rem;
that is the cumulative population dose received by the local population
with an assumed 70-yr individual lifetime.

```
DITTY Long-Term Surface Water Release TWRS-EIS (Long Term Management)
  5
C 14
I 129
NP237
TC99
U 238
 &INPUT IWAT=1, IPATH=2, LUW=1, IPOPL=2,
  CFLO=120000.,
  RM=1.0, TZ=1990., TZR=0.,
  PL1(1)=294830.,391538.,431210.,469891.,1273208.,4932964.,
  TL(1)=1990., 2100.,2200.,2300.,2990.,11900.,
  NTL=6,
  USAGE(1)=0.3,0.,0.,0.,438.,17.,17.,
  CONSUM(1)=15.,276.,20.,230.,40.,30.,8.5,
  EXTIM=2920.,MOPYR=6, RIRR=150.,
  GRWP(1)=90.,90.,90.,30.,3*90.,
  YELD(1)=1.5,4.,0.84,1.3,3*0.84,
 &END
  5
C 14       5
1990.   0.0
2219.   0.0
2220.   8.7092
2795.   8.7092
2796.   0.0
I 129      5
1990.   0.0
2219.   0.0
2220.   0.0278
2795.   0.0278
2796.   0.0
NP237      5
1990.   0.0
2219.   0.0
2220.   0.1151
2795.   0.1151
2796.   0.0
TC99       5
1990.   0.0
2219.   0.0
2220.   54.00
2795.   54.00
2796.   0.0
U 238      5
```

1990.	0.0
2219.	0.0
2220.	0.8365
2795.	0.8365
2796.	0.0

DITTY Dose Calculation Program
(GENII Version 1.485 3-Dec-90)

Integrated population dose calculated for chronic liquid release
Release from time 1990. A.D. onward for 10,000 years
Case title: DITTY Long-Term Surface Water Release TWRS-EIS (Long Term Management)
Executed on: 06/18/96 at 10:54:24.7 Page 1

---- DATA LIBRARIES USED ----------(File)-----

Master Radionuclide Data: (2)
Radionuclide Master Library - Long Times (23-July-93 PDR)
Food Concentration Ratios: (8)
PNL Food Transfer Factor Library (by Z, Changed NP&U LF 6/18/96 AMN)
Fresh Water Bioaccumulation Factors: (9)
Bioaccumulation Factor Library - (30-Aug-88) RAP
External Exposure D.F.'s: (10)
External Dose Factors for GENII in person Sv/yr per Bq/X (8-May-90 RAP)
Inhalation/Ingestion D.F.'s: (30)
Worst-Case Solubilities, DITTY Internal Dose Factors (Sv/Bq) (23-Jul-93 PDR)
Waterborne Release Data: (31)
DITTY.IN

---- MASTER RADIONUCLIDE CONTROL LIST ----------
C 14 TC99 I 129 U 238 TH234 PA234 NP237
PA233

---- TERRESTRIAL/AQUATIC PATHWAY DATA FOR AN AVERAGE INDIVIDUAL

Pathway	Growing Period (days)	Yield (kg/m2)	Consumption (kg/yr)	Pathway	Usage (kg or hr/yr)
LEAFY VEG	9.0E+01	1.5E+00	1.5E+01	FISH	3.0E-01
OTHER VEG	9.0E+01	4.0E+00	2.8E+02	CRUSTACEA	0.0E+00
EGGS	9.0E+01	8.4E-01	2.0E+01	MOLLUSES	0.0E+00
MILK	3.0E+01	1.3E+00	2.3E+02	PLANTS	0.0E+00
BEEF	9.0E+01	8.4E-01	4.0E+01	DRINKING WATER	4.4E+02
PORK	9.0E+01	8.4E-01	3.0E+01	SEDIMENT EXPOSU	1.7E+01
POULTRY	9.0E+01	8.4E-01	8.5E+00	SWIMMING TIME	1.7E+01

External Exposure Time: 2.92E+03 hr/yr

---- LIQUID RELEASE PARAMETERS ----------

River Flow Rate, (ft3/sec) : 1.2E+05 Months/Year Irrigated : 6.0E+00
Reconcentration Ratio : 1.0E+00 Irrigation Rate
Mixing Ratio : 1.0E+00 (liters/m2/month) : 1.5E+02

Input Prepared By: _____ Date: _____

Input Checked By: _____ Date: _____

DITTY Dose Calculation Program
(GENII Version 1.485 3-Dec-90)

Integrated population dose calculated for chronic liquid release
Release from time 1990. A.D. onward for 10,000 years
Case title: DITTY Long-Term Surface Water Release TWRS-EIS (Long Term Management)
Executed on: 06/18/96 at 10:54:24.7 Page 2

---- WATER RELEASE OF EACH RADIONCLIDE PER 70-YR PERIOD (Ci) ----------

Radio-nuclide	Period/ Activity	Period/ Activity	Period/ Activity	Period/ Activity	Period/ Activity
C 14	4 3.6E+01	5 5.0E+01	6 5.0E+01	7 5.0E+01	8 5.0E+01
	9 5.0E+01	10 5.0E+01	11 5.0E+01	12 2.5E+01	
TC99	4 2.0E+02	5 2.8E+02	6 2.8E+02	7 2.8E+02	8 2.8E+02
	9 2.8E+02	10 2.8E+02	11 2.8E+02	12 1.4E+02	
I 129	4 1.4E+00	5 1.9E+00	6 1.9E+00	7 1.9E+00	8 1.9E+00
	9 1.9E+00	10 1.9E+00	11 1.9E+00	12 9.9E-01	
U 238	4 4.2E+01	5 5.9E+01	6 5.9E+01	7 5.9E+01	8 5.9E+01
	9 5.9E+01	10 5.9E+01	11 5.9E+01	12 3.0E+01	
NP237	4 5.8E+00	5 8.1E+00	6 8.1E+00	7 8.1E+00	8 8.1E+00
	9 8.1E+00	10 8.1E+00	11 8.1E+00	12 4.1E+00	

DITTY Dose Calculation Program
(GENII Version 1.485 3-Dec-90)

Integrated population dose calculated for chronic liquid release
Release from time 1990. A.D. onward for 10,000 years
Case title: DITTY Long-Term Surface Water Release TWRS-EIS (Long Term Management)
Executed on: 06/18/96 at 10:54:24.7 Page 3

---- POPULATION DATA ----------

Population for Chronic Waterborne Release at the following Times A.D.:

Time	Population
1990.	2.9E+05
2100.	3.9E+05
2200.	4.3E+05
2300.	4.7E+05
2990.	1.3E+06
11900.	4.9E+06

DITTY Dose Calculation Program
(GENII Version 1.485 3-Dec-90)

Integrated population dose calculated for chronic liquid release
Release from time 1990. A.D. onward for 10,000 years
Case title: DITTY Long-Term Surface Water Release TWRS-EIS (Long Term Management)
Executed on: 06/18/96 at 10:54:24.7

Lifetime Effective Cumulative Dose Equivalent as a Function of Time

Period	Year	Dose
until	until	
5	2270.	2.39E+02
6	2340.	5.94E+02
7	2410.	1.01E+03
8	2480.	1.49E+03
9	2550.	2.02E+03
10	2620.	2.62E+03
11	2690.	3.28E+03
12	2760.	4.00E+03
13	2830.	4.40E+03
until	until	
144	12000.	4.40E+03

Dose in units of person-rem;
that is the cumulative population dose received by the local population
over 10,000 years with an assumed 70-yr individual lifetime.

DITTY Dose Calculation Program
(GENII Version 1.485 3-Dec-90)

Integrated population dose calculated for chronic liquid release
Release from time 1990. A.D. onward for 10,000 years
Case title: DITTY Long-Term Surface Water Release TWRS-EIS (Long Term Management)
Executed on: 06/18/96 at 10:54:24.7

Cumulative Population Dose Equivalent by Radionuclide

Radio-nuclide	Effective Dose Equivalent	Annual External Dose	Effective Dose Equivalent	Percent Of Total Dose
C 14	5.5E+01	2.5E-03	5.5E+01	1
TC 99	5.6E+02	3.4E-04	5.6E+02	12
I 129	8.8E+01	2.8E-04	8.8E+01	2
U 238	6.3E+02	1.3E-04	6.3E+02	14
TH 234	6.7E-02	8.7E-02	1.5E-01	0
PA 234	2.2E-04	1.3E-02	1.4E-02	0
NP 237	3.1E+03	1.5E-02	3.1E+03	69
PA 233	3.1E-02	3.6E-01	4.0E-01	0

Dose in units of person-rem;
that is the cumulative population dose received by the local population
with an assumed 70-yr individual lifetime.

Maximum Dose Increment Received By Population
In Year 2830 (70-yr Time Period Number No: 12)

Organ	Cumulative Dose Equivalent	Weighting Factors	Weighted Cumulative Dose Equivalent
Gonads	1.0E+02	2.5E-01	2.5E+01
Breast	2.3E+01	1.5E-01	3.4E+00
R Marrow	1.0E+03	1.2E-01	1.2E+02
Lung	2.3E+01	1.2E-01	2.7E+00
Thyroid	7.3E+02	3.0E-02	2.2E+01
Bone Sur	1.3E+04	3.0E-02	3.8E+02
Stomach	1.0E+03	6.0E-02	6.3E+01
Kidneys	6.9E+02	6.0E-02	4.1E+01
Liver	5.1E+02	6.0E-02	3.1E+01
LL Int.	2.8E+02	6.0E-02	1.7E+01
UL Int.	1.1E+02	6.0E-02	6.4E+00

Cumulative Effective Dose Equivalent 7.2E+02
External Dose 7.9E-02

Lifetime Effective Cumulative
Dose Equivalent 7.2E+02

Dose in units of person-rem;
that is the cumulative population dose received by the local population
with an assumed 70-yr individual lifetime.

DITTY Dose Calculation Program
(GENII Version 1.485 3-Dec-90)

Integrated population dose calculated for chronic liquid release
Release from time 1990. A.D. onward for 10,000 years
Case title: DITTY Long-Term Surface Water Release TWRS-EIS (Long Term Management)
Executed on: 06/18/96 at 10:54:24.7 Page 7

Maximum Dose Increment Received By Individual (rem)
In Year 2830 (70-yr Time Period Number No: 12)

Radio-nuclide	Effective Dose Equivalent	Annual External Dose	Effective Dose Equivalent	Percent Of Total Dose
C 14	9.3E-06	4.3E-10	9.3E-06	1
TC 99	9.5E-05	5.8E-11	9.5E-05	12
I 129	1.5E-05	4.7E-11	1.5E-05	2
U 238	1.1E-04	2.2E-11	1.1E-04	14
TH 234	1.1E-08	1.5E-08	2.6E-08	0
PA 234	3.8E-11	2.3E-09	2.3E-09	0
NP 237	5.2E-04	2.6E-09	5.2E-04	69
PA 233	5.2E-09	6.2E-08	6.7E-08	0

7.494E-4

Population Internal Dose To Organ by Radionuclide
In Year 2830 (70-yr Time Period Number No: 12)

Radionuclide	Lung	Stomach S Int.	UL Int.	LL Int.	Bone Su	R Marro	Testes
C 14	9.2E+00	9.2E+00	9.2E+00	9.2E+00	9.2E+00	1.1E+01	1.1E+01	9.2E+00
TC 99	9.5E+00	1.0E+03	1.9E+01	6.2E+01	1.7E+02	1.1E+01	1.1E+01	9.5E+00
I 129	3.2E-02	4.5E-02	2.8E-02	2.8E-02	2.8E-02	3.9E-02	4.2E-02	2.6E-02
U 238	4.0E+00	5.4E+00	7.9E+00	2.7E+01	7.9E+01	1.4E+03	9.3E+01	3.7E+00
TH 234	8.1E-05	3.0E-03	7.3E-03	4.3E-02	1.3E-01	6.0E-05	5.1E-05	6.8E-06
PA 234	9.4E-07	4.6E-05	9.4E-05	2.0E-04	1.6E-04	1.7E-06	4.9E-06	1.4E-06
NP 237	7.0E-02	6.5E-01	1.6E+00	8.5E+00	2.6E+01	1.1E+04	9.2E+02	7.8E+01
PA 233	2.2E-05	1.5E-03	4.1E-03	1.8E-02	5.3E-02	5.1E-04	3.6E-04	1.1E-04
Total internal	2.3E+01	1.0E+03	3.7E+01	1.1E+02	2.8E+02	1.3E+04	1.0E+03	1.0E+02

Radionuclide	Ovaries	Muscle	Thyroid	Kidneys	Liver
C 14	9.2E+00	9.2E+00	9.2E+00	0.0E+00	0.0E+00
TC 99	9.5E+00	9.5E+00	2.4E+02	0.0E+00	1.3E+01
I 129	2.8E-02	6.7E-02	4.8E+02	0.0E+00	0.0E+00
U 238	3.9E+00	3.7E+00	3.9E+00	6.9E+02	0.0E+00
TH 234	8.5E-05	9.8E-06	8.7E-07	0.0E+00	1.2E-05
PA 234	2.0E-05	3.1E-06	1.1E-07	5.1E-06	3.7E-06
NP 237	7.8E+01	6.3E-02	4.6E-02	0.0E+00	5.0E+02
PA 233	1.3E-03	1.4E-04	2.6E-06	1.8E-04	1.2E-04
Total internal	1.0E+02	2.3E+01	7.3E+02	6.9E+02	5.1E+02

Population Air Submersion and External Incremental Dose by Radionuclide
In Year 2830 (70-yr Time Period Number No: 12)

Radionuclide	Air Submer-sion	External
C 14	5.2E-10	4.1E-04
TC 99	4.6E-11	5.6E-05
I 129	7.5E-11	4.6E-05
U 238	3.5E-11	2.1E-05
TH 234	5.6E-09	1.4E-02
PA 234	8.0E-10	2.2E-03
NP 237	4.9E-10	2.5E-03
PA 233	8.0E-09	6.0E-02
Total external	1.6E-08	7.9E-02

Dose in units of person-rem;
that is the cumulative population dose received by the local population with an assumed 70-yr individual lifetime.

DITTY Dose Calculation Program
(GENII Version 1.485 3-Dec-90)

Integrated population dose calculated for chronic liquid release
Release from time 1990. A.D. onward for 10,000 years
Case title: DITTY Long-Term Surface Water Release TWRS-EIS (Long Term Management)
Executed on: 06/18/96 at 10:54:24.7 Page 9

Population Internal Dose To Organ by Exposure Pathway

In Year 2830 (70-yr Time Period Number No: 12)

Pathway	Lung	Stomach S Int.	UL Int.	LL Int.	Bone Su	R Marro	Testes
Inhalation	2.8E-01	2.1E-04	1.9E-04	2.1E-04	2.5E-04	4.6E-01	3.6E-02	3.5E-03
Ingestion (Terr)	1.5E+01	1.0E+03	2.7E+01	8.5E+01	2.3E+02	5.8E+03	4.7E+02	4.8E+01
Ingestion (Aqua)	5.8E+00	6.6E+00	6.4E+00	9.6E+00	1.8E+01	4.6E+03	3.8E+02	3.7E+01
Drinking Water	1.9E+00	2.2E+01	3.8E+00	1.2E+01	3.5E+01	2.4E+03	1.9E+02	1.5E+01
Total internal	2.3E+01	1.0E+03	3.7E+01	1.1E+02	2.8E+02	1.3E+04	1.0E+03	1.0E+02

Pathway	Ovaries	Muscle	Thyroid	Kidneys	Liver
Inhalation	3.5E-03	1.8E-04	2.4E-04	4.7E-04	2.0E-02
Ingestion (Terr)	4.9E+01	1.5E+01	6.7E+02	4 4E+02	2.3E+02
Ingestion (Aqua)	3.7E+01	5.8E+00	6.3E+00	1.2E+01	2.0E+02
Drinking Water	1.5E+01	1.9E+00	5.5E+01	2.4E+02	8.3E+01
Total internal	1.0E+02	2.3E+01	7.3E+02	6.9E+02	5.1E+02

Dose in units of person-rem;
that is the cumulative population dose received by the local population
with an assumed 70-yr individual lifetime.

```
DITTY Long-Term Surface Water Release TWRS-EIS (In Situ Fill & Cap)
   5
C 14
I 129
NP237
TC99
U 238
 &INPUT IWAT=1, IPATH=2, LUW=1, IPOPL=2,
  CFLO=120000.,
  RM=1.0, TZ=1990., TZR=0.,
  PL1(1)=294830.,391538.,431210.,469891.,1273208.,4932964.,
  TL(1)=1990., 2100.,2200.,2300.,2990.,11900.,
  NTL=6,
  USAGE(1)=0.3,0.,0.,0.,438.,17.,17.,
  CONSUM(1)=15.,276.,20.,230.,40.,30.,8.5,
  EXTIM=2920.,MOPYR=6, RIRR=150.,
  GRWP(1)=90.,90.,90.,30.,3*90.,
  YELD(1)=1.5,4.,0.84,1.3,3*0.84,
 &END
   5
C 14        5
 1990.   0.0
 4994.   0.0
 4995.   0.3518
11995.   0.3518
11996.   0.0
I 129       5
 1990.   0.0
 4994.   0.0
 4995.   0.0021
11995.   0.0021
11996.   0.0
NP237       5
 1990.   0.0
 4994.   0.0
 4995.   0.0085
11995.   0.0085
11996.   0.0
TC99        5
 1990.   0.0
 4994.   0.0
 4995.   3.929
11995.   3.929
11996.   0.0
U 238       5
```

1990.	0.0
4994.	0.0
4995.	0.0619
11995.	0.0619
11996.	0.0

DITTY Dose Calculation Program
(GENII Version 1.485 3-Dec-90)

Integrated population dose calculated for chronic liquid release
Release from time 1990. A.D. onward for 10,000 years
Case title: DITTY Long-Term Surface Water Release TWRS-EIS (In Situ Fill & Cap)
Executed on: 06/18/96 at 10:54:36.0 Page 1

---- DATA LIBRARIES USED ----------(File)-----

Master Radionuclide Data: (2)
Radionuclide Master Library - Long Times (23-July-93 PDR)
Food Concentration Ratios: (8)
PNL Food Transfer Factor Library (by Z, Changed NP&U LF 6/18/96 AMN)
Fresh Water Bioaccumulation Factors: (9)
Bioaccumulation Factor Library - (30-Aug-88) RAP
External Exposure D.F.'s: (10)
External Dose Factors for GENII in person Sv/yr per Bq/X (8-May-90 RAP)
Inhalation/Ingestion D.F.'s: (30)
Worst-Case Solubilities, DITTY Internal Dose Factors (Sv/Bq) (23-Jul-93 PDR)
Waterborne Release Data: (31)
DITTY.IN

---- MASTER RADIONUCLIDE CONTROL LIST ----------
C 14 TC99 I 129 U 238 TH234 PA234 NP237
PA233

---- TERRESTRIAL/AQUATIC PATHWAY DATA FOR AN AVERAGE INDIVIDUAL

Pathway	Growing Period (days)	Yield (kg/m2)	Consumption (kg/yr)	Pathway	Usage (kg or hr/yr)
LEAFY VEG	9.0E+01	1.5E+00	1.5E+01	FISH	3.0E-01
OTHER VEG	9.0E+01	4.0E+00	2.8E+02	CRUSTACEA	0.0E+00
EGGS	9.0E+01	8.4E-01	2.0E+01	MOLLUSES	0.0E+00
MILK	3.0E+01	1.3E+00	2.3E+02	PLANTS	0.0E+00
BEEF	9.0E+01	8.4E-01	4.0E+01	DRINKING WATER	4.4E+02
PORK	9.0E+01	8.4E-01	3.0E+01	SEDIMENT EXPOSU	1.7E+01
POULTRY	9.0E+01	8.4E-01	8.5E+00	SWIMMING TIME	1.7E+01

External Exposure Time: 2.92E+03 hr/yr

---- LIQUID RELEASE PARAMETERS ----------

River Flow Rate, (ft3/sec) : 1.2E+05 Months/Year Irrigated : 6.0E+00
Reconcentration Ratio : 1.0E+00 Irrigation Rate
Mixing Ratio : 1.0E+00 (liters/m2/month) : 1.5E+02

Input Prepared By: _____ Date: _____

Input Checked By: _____ Date: _____

DITTY Dose Calculation Program
(GENII Version 1.485 3-Dec-90)

Integrated population dose calculated for chronic liquid release
Release from time 1990. A.D. onward for 10,000 years
Case title: DITTY Long-Term Surface Water Release TWRS-EIS (In Situ Fill & Cap)
Executed on: 06/18/96 at 10:54:36.0 Page 2

---- WATER RELEASE OF EACH RADIONCLIDE PER 70-YR PERIOD (Ci) ----------

Radio-nuclide	Period/ Activity	Period/ Activity	Period/ Activity	Period/ Activity	Period/ Activity
C 14	43 1.9E+00	44 2.5E+01	45 2.5E+01	46 2.5E+01	47 2.5E+01
	48 2.5E+01	49 2.5E+01	50 2.5E+01	51 2.5E+01	52 2.5E+01
	53 2.5E+01	54 2.5E+01	55 2.5E+01	56 2.5E+01	57 2.5E+01
	58 2.5E+01	59 2.5E+01	60 2.5E+01	61 2.5E+01	62 2.5E+01
	63 2.5E+01	64 2.5E+01	65 2.5E+01	66 2.5E+01	67 2.5E+01
	68 2.5E+01	69 2.5E+01	70 2.5E+01	71 2.5E+01	72 2.5E+01
	73 2.5E+01	74 2.5E+01	75 2.5E+01	76 2.5E+01	77 2.5E+01
	78 2.5E+01	79 2.5E+01	80 2.5E+01	81 2.5E+01	82 2.5E+01
	83 2.5E+01	84 2.5E+01	85 2.5E+01	86 2.5E+01	87 2.5E+01
	88 2.5E+01	89 2.5E+01	90 2.5E+01	91 2.5E+01	92 2.5E+01
	93 .5E+01	94 2.5E+01	95 2.5E+01	96 2.5E+01	97 2.5E+01
	98 2.5E+01	99 2.5E+01	100 2.5E+01	101 2.5E+01	102 2.5E+01
	103 2.5E+01	104 2.5E+01	105 2.5E+01	106 2.5E+01	107 2.5E+01
	108 2.5E+01	109 2.5E+01	110 2.5E+01	111 2.5E+01	112 2.5E+01
	113 2.5E+01	114 2.5E+01	115 2.5E+01	116 2.5E+01	117 2.5E+01
	118 2.5E+01	119 2.5E+01	120 2.5E+01	121 2.5E+01	122 2.5E+01
	123 2.5E+01	124 2.5E+01	125 2.5E+01	126 2.5E+01	127 2.5E+01
	128 2.5E+01	129 2.5E+01	130 2.5E+01	131 2.5E+01	132 2.5E+01
	133 2.5E+01	134 2.5E+01	135 2.5E+01	136 2.5E+01	137 2.5E+01
	138 2.5E+01	139 2.5E+01	140 2.5E+01	141 2.5E+01	142 2.5E+01
	143 2.3E+01				
TC99	43 2.2E+01	44 2.8E+02	45 2.8E+02	46 2.8E+02	47 2.8E+02
	48 2.8E+02	49 2.8E+02	50 2.8E+02	51 2.8E+02	52 2.8E+02
	53 2.8E+02	54 2.8E+02	55 2.8E+02	56 2.8E+02	57 2.8E+02
	58 2.8E+02	59 2.8E+02	60 2.8E+02	61 2.8E+02	62 2.8E+02
	63 2.8E+02	64 2.8E+02	65 2.8E+02	66 2.8E+02	67 2.8E+02
	68 2.8E+02	69 2.8E+02	70 2.8E+02	71 2.8E+02	72 2.8E+02
	73 2.8E+02	74 2.8E+02	75 2.8E+02	76 2.8E+02	77 2.8E+02
	78 2.8E+02	79 2.8E+02	80 2.8E+02	81 2.8E+02	82 2.8E+02
	83 2.8E+02	84 2.8E+02	85 2.8E+02	86 2.8E+02	87 2.8E+02

88 2.8E+02 89 2.8E+02 90 2.8E+02 91 2.8E+02 92 2.8E+02
93 2.8E+02 94 2.8E+02 95 2.8E+02 96 2.8E+02 97 2.8E+02
98 2.8E+02 99 2.8E+02 100 2.8E+02 101 2.8E+02 102 2.8E+02
103 2.8E+02 104 2.8E+02 105 2.8E+02 106 2.8E+02 107 2.8E+02
108 2.8E+02 109 2.8E+02 110 2.8E+02 111 2.8E+02 112 2.8E+02
113 2.8E+02 114 2.8E+02 115 2.8E+02 116 2.8E+02 117 2.8E+02
118 2.8E+02 119 2.8E+02 120 2.8E+02 121 2.8E+02 122 2.8E+02
123 2.8E+02 124 2.8E+02 125 2.8E+02 126 2.8E+02 127 2.8E+02
128 2.8E+02 129 2.8E+02 130 2.8E+02 131 2.8E+02 132 2.8E+02
133 2.8E+02 134 2.8E+02 135 2.8E+02 136 2.8E+02 137 2.8E+02
138 2.8E+02 139 2.8E+02 140 2.8E+02 141 2.8E+02 142 2.8E+02
143 2.6E+02

I 129 43 1.2E-02 44 1.5E-01 45 1.5E-01 46 1.5E-01 47 1.5E-01
48 1.5E-01 49 1.5E-01 50 1.5E-01 51 1.5E-01 52 1.5E-01
53 1.5E-01 54 1.5E-01 55 1.5E-01 56 1.5E-01 57 1.5E-01
58 1.5E-01 59 1.5E-01 60 1.5E-01 61 1.5E-01 62 1.5E-01
63 1.5E-01 64 1.5E-01 65 1.5E-01 66 1.5E-01 67 1.5E-01
68 1.5E-01 69 1.5E-01 70 1.5E-01 71 1.5E-01 72 1.5E-01
73 1.5E-01 74 1.5E-01 75 1.5E-01 76 1.5E-01 77 1.5E-01
78 1.5E-01 79 1.5E-01 80 1.5E-01 81 1.5E-01 82 1.5E-01
83 1.5E-01 84 1.5E-01 85 1.5E-01 86 1.5E-01 87 1.5E-01
88 1.5E-01 89 1.5E-01 90 1.5E-01 91 1.5E-01 92 1.5E-01
93 1.5E-01 94 1.5E-01 95 1.5E-01 96 1.5E-01 97 1.5E-01
98 1.5E-01 99 1.5E-01 100 1.5E-01 101 1.5E-01 102 1.5E-01
103 1.5E-01 104 1.5E-01 105 1.5E-01 106 1.5E-01 107 1.5E-01
108 1.5E-01 109 1.5E-01 110 1.5E-01 111 1.5E-01 112 1.5E-01
113 1.5E-01 114 1.5E-01 115 1.5E-01 116 1.5E-01 117 1.5E-01
118 1.5E-01 119 1.5E-01 120 1.5E-01 121 1.5E-01 122 1.5E-01
123 1.5E-01 124 1.5E-01 125 1.5E-01 126 1.5E-01 127 1.5E-01
128 1.5E-01 129 1.5E-01 130 1.5E-01 131 1.5E-01 132 1.5E-01
133 1.5E-01 134 1.5E-01 135 1.5E-01 136 1.5E-01 137 1.5E-01
138 1.5E-01 139 1.5E-01 140 1.5E-01 141 1.5E-01 142 1.5E-01
143 1.4E-01

U 238 43 3.4E-01 44 4.3E+00 45 4.3E+00 46 4.3E+00 47 4.3E+00
48 4.3E+00 49 4.3E+00 50 4.3E+00 51 4.3E+00 52 4.3E+00
53 4.3E+00 54 4.3E+00 55 4.3E+00 56 4.3E+00 57 4.3E+00
58 4.3E+00 59 4.3E+00 60 4.3E+00 61 4.3E+00 62 4.3E+00
63 4.3E+00 64 4.3E+00 65 4.3E+00 66 4.3E+00 67 4.3E+00
68 4.3E+00 69 4.3E+00 70 4.3E+00 71 4.3E+00 72 4.3E+00
73 4.3E+00 74 4.3E+00 75 4.3E+00 76 4.3E+00 77 4.3E+00
78 4.3E+00 79 4.3E+00 80 4.3E+00 81 4.3E+00 82 4.3E+00
83 4.3E+00 84 4.3E+00 85 4.3E+00 86 4.3E+00 87 4.3E+00
88 4.3E+00 89 4.3E+00 90 4.3E+00 91 4.3E+00 92 4.3E+00
93 4.3E+00 94 4.3E+00 95 4.3E+00 96 4.3E+00 97 4.3E+00
98 4.3E+00 99 4.3E+00 100 4.3E+00 101 4.3E+00 102 4.3E+00

103 4.3E+00 104 4.3E+00 105 4.3E+00 106 4.3E+00 107 4.3E+00
108 4.3E+00 109 4.3E+00 110 4.3E+00 111 4.3E+00 112 4.3E+00
113 4.3E+00 114 4.3E+00 115 4.3E+00 116 4.3E+00 117 4.3E+00
118 4.3E+00 119 4.3E+00 120 4.3E+00 121 4.3E+00 122 4.3E+00
123 4.3E+00 124 4.3E+00 125 4.3E+00 126 4.3E+00 127 4.3E+00
128 4.3E+00 129 4.3E+00 130 4.3E+00 131 4.3E+00 132 4.3E+00
133 4.3E+00 134 4.3E+00 135 4.3E+00 136 4.3E+00 137 4.3E+00
138 4.3E+00 139 4.3E+00 140 4.3E+00 141 4.3E+00 142 4.3E+00
143 4.1E+00

NP237 43 4.7E-02 44 6.0E-01 45 6.0E-01 46 6.0E-01 47 6.0E-01
48 6.0E-01 49 6.0E-01 50 6.0E-01 51 6.0E-01 52 6.0E-01
53 6.0E-01 54 6.0E-01 55 6.0E-01 56 6.0E-01 57 6.0E-01
58 6.0E-01 59 6.0E-01 60 6.0E-01 61 6.0E-01 62 6.0E-01
63 6.0E-01 64 6.0E-01 65 6.0E-01 66 6.0E-01 67 6.0E-01
68 6.0E-01 69 6.0E-01 70 6.0E-01 71 6.0E-01 72 6.0E-01
73 6.0E-01 74 6.0E-01 75 6.0E-01 76 6.0E-01 77 6.0E-01
78 6.0E-01 79 6.0E-01 80 6.0E-01 81 6.0E-01 82 6.0E-01
83 6.0E-01 84 6.0E-01 85 6.0E-01 86 6.0E-01 87 6.0E-01
88 6.0E-01 89 6.0E-01 90 6.0E-01 91 6.0E-01 92 6.0E-01
93 6.0E-01 94 6.0E-01 95 6.0E-01 96 6.0E-01 97 6.0E-01
98 6.0E-01 99 6.0E-01 100 6.0E-01 101 6.0E-01 102 6.0E-01
103 6.0E-01 104 6.0E-01 105 6.0E-01 106 6.0E-01 107 6.0E-01
108 6.0E-01 109 6.0E-01 110 6.0E-01 111 6.0E-01 112 6.0E-01
113 6.0E-01 114 6.0E-01 115 6.0E-01 116 6.0E-01 117 6.0E-01
118 6.0E-01 119 6.0E-01 120 6.0E-01 121 6.0E-01 122 6.0E-01
123 6.0E-01 124 6.0E-01 125 6.0E-01 126 6.0E-01 127 6.0E-01
128 6.0E-01 129 6.0E-01 130 6.0E-01 131 6.0E-01 132 6.0E-01
133 6.0E-01 134 6.0E-01 135 6.0E-01 136 6.0E-01 137 6.0E-01
138 6.0E-01 139 6.0E-01 140 6.0E-01 141 6.0E-01 142 6.0E-01
143 5.6E-01

DITTY Dose Calculation Program
(GENII Version 1.485 3-Dec-90)

Integrated population dose calculated for chronic liquid release
Release from time 1990. A.D. onward for 10,000 years
Case title: DITTY Long-Term Surface Water Release TWRS-EIS (In Situ Fill & Cap)
Executed on: 06/18/96 at 10:54:36.0 Page 3

---- POPULATION DATA ----------

Population for Chronic Waterborne Release at the following Times A.D.:

Time	Population
1990.	2.9E+05
2100.	3.9E+05
2200.	4.3E+05
2300.	4.7E+05
2990.	1.3E+06
11900.	4.9E+06

Lifetime Effective Cumulative Dose Equivalent as a Function of Time

Period	Year	Dose
until	until	
44	5000.	2.36E+01
45	5070.	3.27E+02
46	5140.	6.36E+02
47	5210.	9.48E+02
48	5280.	1.26E+03
49	5350.	1.58E+03
50	5420.	1.91E+03
51	5490.	2.24E+03
52	5560.	2.57E+03
53	5630.	2.91E+03
54	5700.	3.25E+03
55	5770.	3.59E+03
56	5840.	3.94E+03
57	5910.	4.30E+03
58	5980.	4.65E+03
59	6050.	5.02E+03
60	6120.	5.38E+03
61	6190.	5.75E+03
62	6260.	6.13E+03
63	6330.	6.51E+03
64	6400.	6.89E+03
65	6470.	7.27E+03
66	6540.	7.66E+03
67	6610.	8.06E+03
68	6680.	8.46E+03
69	6750.	8.86E+03
70	6820.	9.27E+03
71	6890.	9.68E+03
72	6960.	1.01E+04

73	7030.	1.05E+04
74	7100.	1.09E+04
75	7170.	1.14E+04
76	7240.	1.18E+04
77	7310.	1.22E+04
78	7380.	1.27E+04
79	7450.	1.31E+04
80	7520.	1.36E+04
81	7590.	1.40E+04
82	7660.	1.45E+04
83	7730.	1.49E+04
84	7800.	1.54E+04
85	7870.	1.59E+04

Lifetime Effective Cumulative Dose Equivalent as a Function of Time

Period	Year	Dose
86	7940.	1.63E+04
87	8010.	1.68E+04
88	8080.	1.73E+04
89	8150.	1.78E+04
90	8220.	1.83E+04
91	8290.	1.88E+04
92	8360.	1.93E+04
93	8430.	1.98E+04
94	8500.	2.03E+04
95	8570.	2.08E+04
96	8640.	2.13E+04
97	8710.	2.18E+04
98	8780.	2.24E+04
99	8850.	2.29E+04
100	8920.	2.34E+04
101	8990.	2.39E+04
102	9060.	2.45E+04
103	9130.	2.50E+04
104	9200.	2.56E+04
105	9270.	2.61E+04
106	9340.	2.67E+04
107	9410.	2.72E+04
108	9480.	2.78E+04
109	9550.	2.84E+04
110	9620.	2.90E+04
111	9690.	2.95E+04
112	9760.	3.01E+04
113	9830.	3.07E+04
114	9900.	3.13E+04
115	9970.	3.19E+04

116	10040.	3.25E+04
117	10110.	3.31E+04
118	10180.	3.37E+04
119	10250.	3.43E+04
120	10320.	3.49E+04
121	10390.	3.55E+04
122	10460.	3.61E+04
123	10530.	3.68E+04
124	10600.	3.74E+04
125	10670.	3.80E+04
126	10740.	3.87E+04
127	10810.	3.93E+04
128	10880.	4.00E+04
---	---	---

NO See Next page

DITTY Dose Calculation Program
(GENII Version 1.485 3-Dec-90)

Integrated population dose calculated for chronic liquid release
Release from time 1990. A.D. onward for 10,000 years
Case title: DITTY Long-Term Surface Water Release TWRS-EIS (In Situ Fill & Cap)
Executed on: 06/18/96 at 10:54:36.0

Lifetime Effective Cumulative Dose Equivalent as a Function of Time

Period	Year	Dose
129	10950.	4.06E+04
130	11020.	4.13E+04
131	11090.	4.19E+04
132	11160.	4.26E+04
133	11230.	4.33E+04
134	11300.	4.39E+04
135	11370.	4.46E+04
136	11440.	4.53E+04
137	11510.	4.60E+04
138	11580.	4.67E+04
139	11650.	4.74E+04
140	11720.	4.81E+04
141	11790.	4.88E+04
142	11860.	4.95E+04
143	11930.	5.02E+04
144	12000.	5.08E+04

Dose in units of person-rem;
that is the cumulative population dose received by the local population over 10,000 years with an assumed 70-yr individual lifetime.

DITTY Dose Calculation Program
(GENII Version 1.485 3-Dec-90)

Integrated population dose calculated for chronic liquid release
Release from time 1990. A.D. onward for 10,000 years
Case title: DITTY Long-Term Surface Water Release TWRS-EIS (In Situ Fill & Cap)
Executed on: 06/18/96 at 10:54:36.0 Page 7

Cumulative Population Dose Equivalent by Radionuclide

Radio-nuclide	Effective Dose Equivalent	Annual External Dose	Effective Dose Equivalent	Percent Of Total Dose
C 14	1.6E+03	7.5E-02	1.6E+03	3
TC 99	3.3E+04	2.0E-02	3.3E+04	64
I 129	4.0E+02	1.3E-03	4.0E+02	0
U 238	2.8E+03	5.8E-04	2.8E+03	5
TH 234	3.0E-01	3.8E-01	6.8E-01	0
PA 234	9.9E-04	6.0E-02	6.1E-02	0
NP 237	1.4E+04	6.8E-02	1.4E+04	26
PA 233	1.4E-01	1.6E+00	1.8E+00	0

Dose in units of person-rem;
that is the cumulative population dose received by the local population
with an assumed 70-yr individual lifetime.

Maximum Dose Increment Received By Population
In Year 12000 (70-yr Time Period Number No: 143)

Organ	Cumulative Dose Equivalent	Weighting Factors	Weighted Cumulative Dose Equivalent
Gonads	1.0E+02	2.5E-01	2.5E+01
Breast	7.2E+01	1.5E-01	1.1E+01
R Marrow	4.7E+02	1.2E-01	5.6E+01
Lung	7.2E+01	1.2E-01	8.7E+00
Thyroid	1.4E+03	3.0E-02	4.2E+01
Bone Sur	4.9E+03	3.0E-02	1.5E+02
Stomach	5.2E+03	6.0E-02	3.1E+02
LL Int.	9.1E+02	6.0E-02	5.4E+01
UL Int.	3.5E+02	6.0E-02	2.1E+01
Kidneys	2.6E+02	6.0E-02	1.6E+01
Liver	2.5E+02	6.0E-02	1.5E+01

Cumulative Effective Dose Equivalent 7.1E+02
External Dose 3.1E-02

Lifetime Effective Cumulative
Dose Equivalent 7.1E+02

Dose in units of person-rem;
that is the cumulative population dose received by the local population
with an assumed 70-yr individual lifetime.

Maximum Dose Increment Received By Individual (rem)
In Year 12000 (70-yr Time Period Number No: 143)

Radio-nuclide	Effective Dose Equivalent	Annual External Dose	Effective Dose Equivalent	Percent Of Total Dose
C 14	4.6E-06	2.1E-10	4.6E-06	3
TC 99	9.3E-05	5.7E-11	9.3E-05	64
I 129	1.1E-06	3.6E-12	1.1E-06	0
U 238	8.0E-06	1.6E-12	8.0E-06	5
TH 234	8.4E-10	1.1E-09	1.9E-09	0
PA 234	2.8E-12	1.7E-10	1.7E-10	0
NP 237	3.9E-05	1.9E-10	3.9E-05	26
PA 233	3.8E-10	4.6E-09	5.0E-09	0

1.457E-4

Population Internal Dose To Organ by Radionuclide
In Year 12000 (70-yr Time Period Number No: 143)

Radionuclide	Lung	Stomach	S Int.	UL Int.	LL Int.	Bone Su	R Marro	Testes
C 14	2.3E+01	2.3E+01	2.3E+01	2.3E+01	2.3E+01	2.9E+01	2.9E+01	2.3E+01
TC 99	4.8E+01	5.2E+03	9.3E+01	3.1E+02	8.4E+02	5.6E+01	5.6E+01	4.8E+01
I 129	1.2E-02	1.7E-02	1.1E-02	1.1E-02	1.1E-02	1.5E-02	1.6E-02	9.9E-03
U 238	1.5E+00	2.0E+00	3.0E+00	1.0E+01	3.0E+01	5.3E+02	3.5E+01	1.4E+00
TH 234	3.0E-05	1.1E-03	2.7E-03	1.6E-02	4.8E-02	2.3E-05	1.9E-05	2.6E-06
PA 234	3.6E-07	1.7E-05	3.5E-05	7.4E-05	6.1E-05	6.5E-07	1.8E-06	5.5E-07
NP 237	2.6E-02	2.5E-01	5.9E-01	3.2E+00	9.9E+00	4.3E+03	3.5E+02	3.0E+01
PA 233	8.3E-06	5.5E-04	1.5E-03	6.9E-03	2.0E-02	1.9E-04	1.4E-04	4.2E-05
Total internal	7.2E+01	5.2E+03	1.2E+02	3.5E+02	9.1E+02	4.9E+03	4.7E+02	1.0E+02

Radionuclide	Ovaries	Muscle	Thyroid	Kidneys	Liver
C 14	2.3E+01	2.3E+01	2.3E+01	0.0E+00	0.0E+00
TC 99	4.8E+01	4.8E+01	1.2E+03	0.0E+00	6.5E+01
I 129	1.1E-02	2.6E-02	1.9E+02	0.0E+00	0.0E+00
U 238	1.5E+00	1.4E+00	1.5E+00	2.6E+02	0.0E+00
TH 234	3.2E-05	3.7E-06	3.3E-07	0.0E+00	4.5E-06
PA 234	7.7E-06	1.2E-06	4.2E-08	1.9E-06	1.4E-06
NP 237	3.0E+01	2.4E-02	1.7E-02	0.0E+00	1.9E+02
PA 233	5.0E-04	5.3E-05	9.7E-07	6.6E-05	4.7E-05
Total internal	1.0E+02	7.2E+01	1.4E+03	2.6E+02	2.5E+02

Population Air Submersion and External Incremental Dose by Radionuclide
In Year 12000 (70-yr Time Period Number No: 143)

Radionuclide	Air Submer-sion	External
C 14	1.3E-09	1.0E-03
TC 99	2.3E-10	2.8E-04
I 129	2.9E-11	1.8E-05
U 238	1.3E-11	8.1E-06
TH 234	2.1E-09	5.4E-03
PA 234	3.0E-10	8.4E-04
NP 237	1.8E-10	9.5E-04
PA 233	3.0E-09	2.3E-02
Total external	7.2E-09	3.1E-02

Dose in units of person-rem;
that is the cumulative population dose received by the local population with an assumed 70-yr individual lifetime.

DITTY Dose Calculation Program
(GENII Version 1.485 3-Dec-90)

Integrated population dose calculated for chronic liquid release
Release from time 1990. A.D. onward for 10,000 years
Case title: DITTY Long-Term Surface Water Release TWRS-EIS (In Situ Fill & Cap)
Executed on: 06/18/96 at 10:54:36.0 Page 11

Population Internal Dose To Organ by Exposure Pathway

In Year 12000 (70-yr Time Period Number No: 143)

Pathway	Lung	Stomach	S Int.	UL Int.	LL Int.	Bone	Su R	Marro	Testes
Inhalation	1.1E-01	5.9E-04	4.5E-04	4.7E-04	4.9E-04	1.7E-01	1.4E-02	1.7E-03	
Ingestion (Terr)	5.6E+01	5.1E+03	1.0E+02	3.2E+02	8.6E+02	2.2E+03	2.4E+02	6.8E+01	
Ingestion (Aqua)	1.4E+01	1.7E+01	1.5E+01	1.6E+01	1.9E+01	1.8E+03	1.6E+02	2.6E+01	
Drinking Water	2.4E+00	1.0E+02	3.9E+00	1.1E+01	2.9E+01	9.0E+02	7.2E+01	7.3E+00	
Total internal	7.2E+01	5.2E+03	1.2E+02	3.5E+02	9.1E+02	4.9E+03	4.7E+02	1.0E+02	

Pathway	Ovaries	Muscle	Thyroid	Kidneys	Liver
Inhalation	1.7E-03	4.5E-04	5.0E-04	1.8E-04	7.6E-03
Ingestion (Terr)	6.8E+01	5.6E+01	1.3E+03	1.7E+02	1.4E+02
Ingestion (Aqua)	2.6E+01	1.4E+01	1.5E+01	4.4E+00	7.6E+01
Drinking Water	7.4E+00	2.4E+00	4.3E+01	9.0E+01	3.2E+01
Total internal	1.0E+02	7.2E+01	1.4E+03	2.6E+02	2.5E+02

Dose in units of person-rem;
that is the cumulative population dose received by the local population
with an assumed 70-yr individual lifetime.

```
DITTY Long-Term Surface Water Release TWRS-EIS (Ex Situ In Situ Combo)
   5
C 14
I 129
NP237
TC99
U 238
 &INPUT IWAT=1, IPATH=2, LUW=1, IPOPL=2,
  CFLO=120000.,
  RM=1.0, TZ=1990., TZR=0.,
  PL1(1)=294830.,391538.,431210.,469891.,1273208.,4932964.,
  TL(1)=1990., 2100.,2200.,2300.,2990.,11900.,
  NTL=6,
  USAGE(1)=0.3,0.,0.,0.,438.,17.,17.,
  CONSUM(1)=15.,276.,20.,230.,40.,30.,8.5,
  EXTIM=2920.,MOPYR=6, RIRR=150.,
  GRWP(1)=90.,90.,90.,30.,3*90.,
  YELD(1)=1.5,4.,0.84,1.3,3*0.84,
 &END
   5
C 14        5
 1990.   0.0
 4244.   0.0
 4245.   0.0199
11995.   0.0199
11996.   0.0
I 129       5
 1990.   0.0
 4244.   0.0
 4245.   0.0002
11995.   0.0002
11996.   0.0
NP237       5
 1990.   0.0
 4244.   0.0
 4245.   0.0006
11995.   0.0006
11996.   0.0
TC99        5
 1990.   0.0
 4244.   0.0
 4245.   0.3326
11995.   0.3326
11996.   0.0
U 238       5
```

1990.	0.0
4244.	0.0
4245.	0.0075
11995.	0.0075
11996.	0.0

DITTY Dose Calculation Program
(GENII Version 1.485 3-Dec-90)

Integrated population dose calculated for chronic liquid release
Release from time 1990. A.D. onward for 10,000 years
Case title: DITTY Long-Term Surface Water Release TWRS-EIS (Ex Situ In Situ Combo)
Executed on: 06/18/96 at 10:54:54.8 Page 1

---- DATA LIBRARIES USED ----------(File)-----

Master Radionuclide Data: (2)
Radionuclide Master Library - Long Times (23-July-93 PDR)
Food Concentration Ratios: (8)
PNL Food Transfer Factor Library (by Z, Changed NP&U LF 6/18/96 AMN)
Fresh Water Bioaccumulation Factors: (9)
Bioaccumulation Factor Library - (30-Aug-88) RAP
External Exposure D.F.'s: (10)
External Dose Factors for GENII in person Sv/yr per Bq/X (8-May-90 RAP)
Inhalation/Ingestion D.F.'s: (30)
Worst-Case Solubilities, DITTY Internal Dose Factors (Sv/Bq) (23-Jul-93 PDR)
Waterborne Release Data: (31)
DITTY.IN

---- MASTER RADIONUCLIDE CONTROL LIST ----------
C 14 TC99 I 129 U 238 TH234 PA234 NP237
PA233

---- TERRESTRIAL/AQUATIC PATHWAY DATA FOR AN AVERAGE INDIVIDUAL

Pathway	Growing Period (days)	Yield (kg/m2)	Consumption (kg/yr)	Pathway	Usage (kg or hr/yr)
LEAFY VEG	9.0E+01	1.5E+00	1.5E+01	FISH	3.0E-01
OTHER VEG	9.0E+01	4.0E+00	2.8E+02	CRUSTACEA	0.0E+00
EGGS	9.0E+01	8.4E-01	2.0E+01	MOLLUSES	0.0E+00
MILK	3.0E+01	1.3E+00	2.3E+02	PLANTS	0.0E+00
BEEF	9.0E+01	8.4E-01	4.0E+01	DRINKING WATER	4.4E+02
PORK	9.0E+01	8.4E-01	3.0E+01	SEDIMENT EXPOSU	1.7E+01
POULTRY	9.0E+01	8.4E-01	8.5E+00	SWIMMING TIME	1.7E+01

External Exposure Time: 2.92E+03 hr/yr

---- LIQUID RELEASE PARAMETERS ----------

River Flow Rate, (ft3/sec) : 1.2E+05 Months/Year Irrigated : 6.0E+00
Reconcentration Ratio : 1.0E+00 Irrigation Rate
Mixing Ratio : 1.0E+00 (liters/m2/month) : 1.5E+02

Input Prepared By: _____ Date: _____

Input Checked By: _____ Date: _____

DITTY Dose Calculation Program
(GENII Version 1.485 3-Dec-90)

Integrated population dose calculated for chronic liquid release
Release from time 1990. A.D. onward for 10,000 years
Case title: DITTY Long-Term Surface Water Release TWRS-EIS (Ex Situ In Situ Combo)
Executed on: 06/18/96 at 10:54:54.8 Page 2

---- WATER RELEASE OF EACH RADIONCLIDE PER 70-YR PERIOD (Ci) ----------

Radio-nuclide	Period/ Activity	Period/ Activity	Period/ Activity	Period/ Activity	Period/ Activity
C 14	33 1.1E+00	34 1.4E+00	35 1.4E+00	36 1.4E+00	37 1.4E+00
	38 1.4E+00	39 1.4E+00	40 1.4E+00	41 1.4E+00	42 1.4E+00
	43 1.4E+00	44 1.4E+00	45 1.4E+00	46 1.4E+00	47 1.4E+00
	48 1.4E+00	49 1.4E+00	50 1.4E+00	51 1.4E+00	52 1.4E+00
	53 1.4E+00	54 1.4E+00	55 1.4E+00	56 1.4E+00	57 1.4E+00
	58 1.4E+00	59 1.4E+00	60 1.4E+00	61 1.4E+00	62 1.4E+00
	63 1.4E+00	64 1.4E+00	65 1.4E+00	66 1.4E+00	67 1.4E+00
	68 1.4E+00	69 1.4E+00	70 1.4E+00	71 1.4E+00	72 1.4E+00
	73 1.4E+00	74 1.4E+00	75 1.4E+00	76 1.4E+00	77 1.4E+00
	78 1.4E+00	79 1.4E+00	80 1.4E+00	81 1.4E+00	82 1.4E+00
	83 1.4E+00	84 1.4E+00	85 1.4E+00	86 1.4E+00	87 1.4E+00
	88 1.4E+00	89 1.4E+00	90 1.4E+00	91 1.4E+00	92 1.4E+00
	93 1.4E+00	94 1.4E+00	95 1.4E+00	96 1.4E+00	97 1.4E+00
	98 1.4E+00	99 1.4E+00	100 1.4E+00	101 1.4E+00	102 1.4E+00
	103 1.4E+00	104 1.4E+00	105 1.4E+00	106 1.4E+00	107 1.4E+00
	108 1.4E+00	109 1.4E+00	110 1.4E+00	111 1.4E+00	112 1.4E+00
	113 1.4E+00	114 1.4E+00	115 1.4E+00	116 1.4E+00	117 1.4E+00
	118 1.4E+00	119 1.4E+00	120 1.4E+00	121 1.4E+00	122 1.4E+00
	123 1.4E+00	124 1.4E+00	125 1.4E+00	126 1.4E+00	127 1.4E+00
	128 1.4E+00	129 1.4E+00	130 1.4E+00	131 1.4E+00	132 1.4E+00
	133 1.4E+00	134 1.4E+00	135 1.4E+00	136 1.4E+00	137 1.4E+00
	138 1.4E+00	139 1.4E+00	140 1.4E+00	141 1.4E+00	142 1.4E+00
	143 1.3E+00				
TC99	33 1.8E+01	34 2.3E+01	35 2.3E+01	36 2.3E+01	37 2.3E+01
	38 2.3E+01	39 2.3E+01	40 2.3E+01	41 2.3E+01	42 2.3E+01
	43 2.3E+01	44 2.3E+01	45 2.3E+01	46 2.3E+01	47 2.3E+01
	48 2.3E+01	49 2.3E+01	50 2.3E+01	51 2.3E+01	52 2.3E+01
	53 2.3E+01	54 2.3E+01	55 2.3E+01	56 2.3E+01	57 2.3E+01
	58 2.3E+01	59 2.3E+01	60 2.3E+01	61 2.3E+01	62 2.3E+01
	63 2.3E+01	64 2.3E+01	65 2.3E+01	66 2.3E+01	67 2.3E+01

68 2.3E+01 69 2.3E+01 70 2.3E+01 71 2.3E+01 72 2.3E+01
73 2.3E+01 74 2.3E+01 75 2.3E+01 76 2.3E+01 77 2.3E+01
78 2.3E+01 79 2.3E+01 80 2.3E+01 81 2.3E+01 82 2.3E+01
83 2.3E+01 84 2.3E+01 85 2.3E+01 86 2.3E+01 87 2.3E+01
88 2.3E+01 89 2.3E+01 90 2.3E+01 91 2.3E+01 92 2.3E+01
93 2.3E+01 94 2.3E+01 95 2.3E+01 96 2.3E+01 97 2.3E+01
98 2.3E+01 99 2.3E+01 100 2.3E+01 101 2.3E+01 102 2.3E+01
103 2.3E+01 104 2.3E+01 105 2.3E+01 106 2.3E+01 107 2.3E+01
108 2.3E+01 109 2.3E+01 110 2.3E+01 111 2.3E+01 112 2.3E+01
113 2.3E+01 114 2.3E+01 115 2.3E+01 116 2.3E+01 117 2.3E+01
118 2.3E+01 119 2.3E+01 120 2.3E+01 121 2.3E+01 122 2.3E+01
123 2.3E+01 124 2.3E+01 125 2.3E+01 126 2.3E+01 127 2.3E+01
128 2.3E+01 129 2.3E+01 130 2.3E+01 131 2.3E+01 132 2.3E+01
133 2.3E+01 134 2.3E+01 135 2.3E+01 136 2.3E+01 137 2.3E+01
138 2.3E+01 139 2.3E+01 140 2.3E+01 141 2.3E+01 142 2.3E+01
143 2.2E+01

I 129 33 1.1E-02 34 1.4E-02 35 1.4E-02 36 1.4E-02 37 1.4E-02
38 1.4E-02 39 1.4E-02 40 1.4E-02 41 1.4E-02 42 1.4E-02
43 1.4E-02 44 1.4E-02 45 1.4E-02 46 1.4E-02 47 1.4E-02
48 1.4E-02 49 1.4E-02 50 1.4E-02 51 1.4E-02 52 1.4E-02
53 1.4E-02 54 1.4E-02 55 1.4E-02 56 1.4E-02 57 1.4E-02
58 1.4E-02 59 1.4E-02 60 1.4E-02 61 1.4E-02 62 1.4E-02
63 1.4E-02 64 1.4E-02 65 1.4E-02 66 1.4E-02 67 1.4E-02
68 1.4E-02 69 1.4E-02 70 1.4E-02 71 1.4E-02 72 1.4E-02
73 1.4E-02 74 1.4E-02 75 1.4E-02 76 1.4E-02 77 1.4E-02
78 1.4E-02 79 1.4E-02 80 1.4E-02 81 1.4E-02 82 1.4E-02
83 1.4E-02 84 1.4E-02 85 1.4E-02 86 1.4E-02 87 1.4E-02
88 1.4E-02 89 1.4E-02 90 1.4E-02 91 1.4E-02 92 1.4E-02
93 1.4E-02 94 1.4E-02 95 1.4E-02 96 1.4E-02 97 1.4E-02
98 1.4E-02 99 1.4E-02 100 1.4E-02 101 1.4E-02 102 1.4E-02
103 1.4E-02 104 1.4E-02 105 1.4E-02 106 1.4E-02 107 1.4E-02
108 1.4E-02 109 1.4E-02 110 1.4E-02 111 1.4E-02 112 1.4E-02
113 1.4E-02 114 1.4E-02 115 1.4E-02 116 1.4E-02 117 1.4E-02
118 1.4E-02 119 1.4E-02 120 1.4E-02 121 1.4E-02 122 1.4E-02
123 1.4E-02 124 1.4E-02 125 1.4E-02 126 1.4E-02 127 1.4E-02
128 1.4E-02 129 1.4E-02 130 1.4E-02 131 1.4E-02 132 1.4E-02
133 1.4E-02 134 1.4E-02 135 1.4E-02 136 1.4E-02 137 1.4E-02
138 1.4E-02 139 1.4E-02 140 1.4E-02 141 1.4E-02 142 1.4E-02
143 1.3E-02

U 238 33 4.2E-01 34 5.2E-01 35 5.2E-01 36 5.2E-01 37 5.2E-01
38 5.2E-01 39 5.2E-01 40 5.2E-01 41 5.2E-01 42 5.2E-01
43 5.2E-01 44 5.2E-01 45 5.2E-01 46 5.2E-01 47 5.2E-01
48 5.2E-01 49 5.2E-01 50 5.2E-01 51 5.2E-01 52 5.2E-01
53 5.2E-01 54 5.2E-01 55 5.2E-01 56 5.2E-01 57 5.2E-01
58 5.2E-01 59 5.2E-01 60 5.2E-01 61 5.2E-01 62 5.2E-01

63 5.2E-01 64 5.2E-01 65 5.2E-01 66 5.2E-01 67 5.2E-01
68 5.2E-01 69 5.2E-01 70 5.2E-01 71 5.2E-01 72 5.2E-01
73 5.2E-01 74 5.2E-01 75 5.2E-01 76 5.2E-01 77 5.2E-01
78 5.2E-01 79 5.2E-01 80 5.2E-01 81 5.2E-01 82 5.2E-01
83 5.2E-01 84 5.2E-01 85 5.2E-01 86 5.2E-01 87 5.2E-01
88 5.2E-01 89 5.2E-01 90 5.2E-01 91 5.2E-01 92 5.2E-01
93 5.2E-01 94 5.2E-01 95 5.2E-01 96 5.2E-01 97 5.2E-01
98 5.2E-01 99 5.2E-01 100 5.2E-01 101 5.2E-01 102 5.2E-01
103 5.2E-01 104 5.2E-01 105 5.2E-01 106 5.2E-01 107 5.2E-01
108 5.2E-01 109 5.2E-01 110 5.2E-01 111 5.2E-01 112 5.2E-01
113 5.2E-01 114 5.2E-01 115 5.2E-01 116 5.2E-01 117 5.2E-01
118 5.2E-01 119 5.2E-01 120 5.2E-01 121 5.2E-01 122 5.2E-01
123 5.2E-01 124 5.2E-01 125 5.2E-01 126 5.2E-01 127 5.2E-01
128 5.2E-01 129 5.2E-01 130 5.2E-01 131 5.2E-01 132 5.2E-01
133 5.2E-01 134 5.2E-01 135 5.2E-01 136 5.2E-01 137 5.2E-01
138 5.2E-01 139 5.2E-01 140 5.2E-01 141 5.2E-01 142 5.2E-01
143 4.9E-01

NP237 33 3.3E-02 34 4.2E-02 35 4.2E-02 36 4.2E-02 37 4.2E-02
38 4.2E-02 39 4.2E-02 40 4.2E-02 41 4.2E-02 42 4.2E-02
43 4.2E-02 44 4.2E-02 45 4.2E-02 46 4.2E-02 47 4.2E-02
48 4.2E-02 49 4.2E-02 50 4.2E-02 51 4.2E-02 52 4.2E-02
53 4.2E-02 54 4.2E-02 55 4.2E-02 56 4.2E-02 57 4.2E-02
58 4.2E-02 59 4.2E-02 60 4.2E-02 61 4.2E-02 62 4.2E-02
63 4.2E-02 64 4.2E-02 65 4.2E-02 66 4.2E-02 67 4.2E-02
68 4.2E-02 69 4.2E-02 70 4.2E-02 71 4.2E-02 72 4.2E-02
73 4.2E-02 74 4.2E-02 75 4.2E-02 76 4.2E-02 77 4.2E-02
78 4.2E-02 79 4.2E-02 80 4.2E-02 81 4.2E-02 82 4.2E-02
83 4.2E-02 84 4.2E-02 85 4.2E-02 86 4.2E-02 87 4.2E-02
88 4.2E-02 89 4.2E-02 90 4.2E-02 91 4.2E-02 92 4.2E-02
93 4.2E-02 94 4.2E-02 95 4.2E-02 96 4.2E-02 97 4.2E-02
98 4.2E-02 99 4.2E-02 100 4.2E-02 101 4.2E-02 102 4.2E-02
103 4.2E-02 104 4.2E-02 105 4.2E-02 106 4.2E-02 107 4.2E-02
108 4.2E-02 109 4.2E-02 110 4.2E-02 111 4.2E-02 112 4.2E-02
113 4.2E-02 114 4.2E-02 115 4.2E-02 116 4.2E-02 117 4.2E-02
118 4.2E-02 119 4.2E-02 120 4.2E-02 121 4.2E-02 122 4.2E-02
123 4.2E-02 124 4.2E-02 125 4.2E-02 126 4.2E-02 127 4.2E-02
128 4.2E-02 129 4.2E-02 130 4.2E-02 131 4.2E-02 132 4.2E-02
133 4.2E-02 134 4.2E-02 135 4.2E-02 136 4.2E-02 137 4.2E-02
138 4.2E-02 139 4.2E-02 140 4.2E-02 141 4.2E-02 142 4.2E-02
143 3.9E-02

DITTY Dose Calculation Program
(GENII Version 1.485 3-Dec-90)

Integrated population dose calculated for chronic liquid release
Release from time 1990. A.D. onward for 10,000 years
Case title: DITTY Long-Term Surface Water Release TWRS-EIS (Ex Situ In Situ Combo)
Executed on: 06/18/96 at 10:54:54.8 Page 3

---- POPULATION DATA ----------

Population for Chronic Waterborne Release at the following Times A.D.:

Time	Population
1990.	2.9E+05
2100.	3.9E+05
2200.	4.3E+05
2300.	4.7E+05
2990.	1.3E+06
11900.	4.9E+06

DITTY Dose Calculation Program
(GENII Version 1.485 3-Dec-90)

Integrated population dose calculated for chronic liquid release
Release from time 1990. A.D. onward for 10,000 years
Case title: DITTY Long-Term Surface Water Release TWRS-EIS (Ex Situ In Situ Combo)
Executed on: 06/18/96 at 10:54:54.8

Lifetime Effective Cumulative Dose Equivalent as a Function of Time

Period	Year	Dose
until	until	
34	4300.	1.68E+01
35	4370.	3.84E+01
36	4440.	6.03E+01
37	4510.	8.25E+01
38	4580.	1.05E+02
39	4650.	1.28E+02
40	4720.	1.51E+02
41	4790.	1.75E+02
42	4860.	1.99E+02
43	4930.	2.23E+02
44	5000.	2.48E+02
45	5070.	2.73E+02
46	5140.	2.98E+02
47	5210.	3.24E+02
48	5280.	3.50E+02
49	5350.	3.76E+02
50	5420.	4.03E+02
51	5490.	4.30E+02
52	5560.	4.57E+02
53	5630.	4.85E+02
54	5700.	5.13E+02
55	5770.	5.41E+02
56	5840.	5.70E+02
57	5910.	5.99E+02
58	5980.	6.28E+02
59	6050.	6.58E+02
60	6120.	6.88E+02
61	6190.	7.18E+02
62	6260.	7.49E+02

63	6330.	7.80E+02
64	6400.	8.11E+02
65	6470.	8.43E+02
66	6540.	8.75E+02
67	6610.	9.08E+02
68	6680.	9.41E+02
69	6750.	9.74E+02
70	6820.	1.01E+03
71	6890.	1.04E+03
72	6960.	1.08E+03
73	7030.	1.11E+03
74	7100.	1.14E+03
75	7170.	1.18E+03

Lifetime Effective Cumulative Dose Equivalent as a Function of Time

Period	Year	Dose
76	7240.	1.21E+03
77	7310.	1.25E+03
78	7380.	1.29E+03
79	7450.	1.32E+03
80	7520.	1.36E+03
81	7590.	1.40E+03
82	7660.	1.44E+03
83	7730.	1.47E+03
84	7800.	1.51E+03
85	7870.	1.55E+03
86	7940.	1.59E+03
87	8010.	1.63E+03
88	8080.	1.67E+03
89	8150.	1.71E+03
90	8220.	1.75E+03
91	8290.	1.79E+03
92	8360.	1.83E+03
93	8430.	1.87E+03
94	8500.	1.91E+03
95	8570.	1.95E+03
96	8640.	2.00E+03
97	8710.	2.04E+03
98	8780.	2.08E+03
99	8850.	2.12E+03
100	8920.	2.17E+03
101	8990.	2.21E+03
102	9060.	2.26E+03
103	9130.	2.30E+03
104	9200.	2.35E+03
105	9270.	2.39E+03

106	9340.	2.44E+03
107	9410.	2.48E+03
108	9480.	2.53E+03
109	9550.	2.58E+03
110	9620.	2.62E+03
111	9690.	2.67E+03
112	9760.	2.72E+03
113	9830.	2.77E+03
114	9900.	2.82E+03
115	9970.	2.86E+03
116	10040.	2.91E+03
117	10110.	2.96E+03
118	10180.	3.01E+03

Lifetime Effective Cumulative Dose Equivalent as a Function of Time

Period	Year	Dose
119	10250.	3.06E+03
120	10320.	3.11E+03
121	10390.	3.16E+03
122	10460.	3.21E+03
123	10530.	3.27E+03
124	10600.	3.32E+03
125	10670.	3.37E+03
126	10740.	3.42E+03
127	10810.	3.48E+03
128	10880.	3.53E+03
129	10950.	3.58E+03
130	11020.	3.64E+03
131	11090.	3.69E+03
132	11160.	3.74E+03
133	11230.	3.80E+03
134	11300.	3.85E+03
135	11370.	3.91E+03
136	11440.	3.97E+03
137	11510.	4.02E+03
138	11580.	4.08E+03
139	11650.	4.14E+03
140	11720.	4.19E+03
141	11790.	4.25E+03
142	11860.	4.31E+03
143	11930.	4.37E+03
144	12000.	4.42E+03

Dose in units of person-rem;

that is the cumulative population dose received by the local population over 10,000 years with an assumed 70-yr individual lifetime.

DITTY Dose Calculation Program
(GENII Version 1.485 3-Dec-90)

Integrated population dose calculated for chronic liquid release
Release from time 1990. A.D. onward for 10,000 years
Case title: DITTY Long-Term Surface Water Release TWRS-EIS (Ex Situ In Situ Combo)
Executed on: 06/18/96 at 10:54:54.8

Cumulative Population Dose Equivalent by Radionuclide

Radio-nuclide	Effective Dose Equivalent	Annual External Dose	Effective Dose Equivalent	Percent Of Total Dose
C 14	9.8E+01	4.5E-03	9.8E+01	2
TC 99	2.9E+03	1.8E-03	2.9E+03	66
I 129	4.0E+01	1.3E-04	4.0E+01	0
U 238	3.6E+02	7.4E-05	3.6E+02	8
TH 234	3.8E-02	4.9E-02	8.7E-02	0
PA 234	1.3E-04	7.7E-03	7.8E-03	0
NP 237	1.0E+03	5.1E-03	1.0E+03	23
PA 233	1.0E-02	1.2E-01	1.3E-01	0

Dose in units of person-rem;
that is the cumulative population dose received by the local population
with an assumed 70-yr individual lifetime.

Maximum Dose Increment Received By Population
In Year 12000 (70-yr Time Period Number No: 143)

Organ	Cumulative Dose Equivalent	Weighting Factors	Weighted Cumulative Dose Equivalent
Gonads	7.6E+00	2.5E-01	1.9E+00
Breast	5.5E+00	1.5E-01	8.3E-01
R Marrow	3.5E+01	1.2E-01	4.2E+00
Lung	5.5E+00	1.2E-01	6.6E-01
Thyroid	1.2E+02	3.0E-02	3.6E+00
Bone Sur	3.7E+02	3.0E-02	1.1E+01
Stomach	4.4E+02	6.0E-02	2.6E+01
LL Int.	7.7E+01	6.0E-02	4.6E+00
Kidneys	3.2E+01	6.0E-02	1.9E+00
UL Int.	2.9E+01	6.0E-02	1.8E+00
Liver	1.9E+01	6.0E-02	1.1E+00

Cumulative Effective Dose Equivalent 5.8E+01
External Dose 2.5E-03

Lifetime Effective Cumulative
Dose Equivalent 5.8E+01

Dose in units of person-rem;
that is the cumulative population dose received by the local population
with an assumed 70-yr individual lifetime.

Maximum Dose Increment Received By Individual (rem)
In Year 12000 (70-yr Time Period Number No: 43)

Radio-nuclide	Effective Dose Equivalent	Annual External Dose	Effective Dose Equivalent	Percent Of Total Dose
C 14	2.6E-07	1.2E-11	2.6E-07	2
TC 99	7.9E-06	4.8E-12	7.9E-06	66
I 129	1.1E-07	3.4E-13	1.1E-07	0
U 238	9.6E-07	2.0E-13	9.6E-07	8
TH 234	1.0E-10	1.3E-10	2.3E-10	0
PA 234	3.4E-13	2.1E-11	2.1E-11	0
NP 237	2.7E-06	1.4E-11	2.7E-06	23
PA 233	2.7E-11	3.2E-10	3.5E-10	0

1.193E-5

Population Internal Dose To Organ by Radionuclide
In Year 12000 (70-yr Time Period Number No: 143)

Radionuclide	Lung	Stomach S Int.	UL Int.	LL Int.	Bone Su	R Marro	Testes
C 14	1.3E+00	1.3E+00	1.3E+00	1.3E+00	1.3E+00	1.6E+00	1.6E+00	1.3E+00
TC 99	4.0E+00	4.4E+02	7.9E+00	2.7E+01	7.1E+01	4.8E+00	4.8E+00	4.0E+00
I 129	1.2E-03	1.7E-03	1.0E-03	1.0E-03	1.0E-03	1.4E-03	1.5E-03	9.4E-04
U 238	1.8E-01	2.5E-01	3.6E-01	1.2E+00	3.6E+00	6.4E+01	4.3E+00	1.7E-01
TH 234	3.7E-06	1.4E-04	3.3E-04	2.0E-03	5.9E-03	2.8E-06	2.4E-06	3.1E-07
PA 234	4.3E-08	2.1E-06	4.3E-06	9.0E-06	7.4E-06	7.8E-08	2.2E-07	6.6E-08
NP 237	1.9E-03	1.7E-02	4.2E-02	2.3E-01	7.0E-01	3.0E+02	2.5E+01	2.1E+00
PA 233	5.8E-07	3.9E-05	1.1E-04	4.9E-04	1.4E-03	1.4E-05	9.6E-06	2.9E-06
Total internal	5.5E+00	4.4E+02	9.6E+00	2.9E+01	7.7E+01	3.7E+02	3.5E+01	7.6E+00

Radionuclide	Ovaries	Muscle	Thyroid	Kidneys	Liver
C 14	1.3E+00	1.3E+00	1.3E+00	0.0E+00	0.0E+00
TC 99	4.0E+00	4.0E+00	1.0E+02	0.0E+00	5.5E+00
I 129	1.0E-03	2.5E-03	1.8E+01	0.0E+00	0.0E+00
U 238	1.8E-01	1.7E-01	1.8E-01	3.2E+01	0.0E+00
TH 234	3.9E-06	4.5E-07	4.0E-08	0.0E+00	5.5E-07
PA 234	9.4E-07	1.4E-07	5.1E-09	2.3E-07	1.7E-07
NP 237	2.1E+00	1.7E-03	1.2E-03	0.0E+00	1.3E+01
PA 233	3.5E-05	3.7E-06	6.9E-08	4.7E-06	3.3E-06
Total internal	7.6E+00	5.5E+00	1.2E+02	3.2E+01	1.9E+01

Population Air Submersion and External Incremental Dose by Radionuclide
In Year 12000 (70-yr Time Period Number No: 143)

Radionuclide	Air Submer-sion	External
C 14	7.4E-11	5.9E-05
TC 99	2.0E-11	2.4E-05
I 129	2.8E-12	1.7E-06
U 238	1.6E-12	9.8E-07
TH 234	2.6E-10	6.5E-04
PA 234	3.7E-11	1.0E-04
NP 237	1.3E-11	6.7E-05
PA 233	2.1E-10	1.6E-03
Total external	6.2E-10	2.5E-03

Dose in units of person-rem;
that is the cumulative population dose received by the local population with an assumed 70-yr individual lifetime.

Population Internal Dose To Organ by Exposure Pathway

In Year 12000 (70-yr Time Period Number No: 143)

Pathway	Lung	Stomach S Int.	UL Int.	LL Int.	Bone Su	R Marro	Testes
Inhalation	1.3E-02	3.7E-05	2.6E-05	2.7E-05	3.0E-05	1.2E-02	9.9E-04	1.2E-04
Ingestion (Terr)	4.5E+00	4.3E+02	8.4E+00	2.7E+01	7.3E+01	1.8E+02	1.9E+01	5.4E+00
Ingestion (Aqua)	8.2E-01	1.1E+00	8.4E-01	9.4E-01	1.2E+00	1.2E+02	1.1E+01	1.7E+00
Drinking Water	1.9E-01	8.5E+00	3.4E-01	1.0E+00	2.8E+00	7.3E+01	5.7E+00	5.4E-01
Total internal	5.5E+00	4.4E+02	9.6E+00	2.9E+01	7.7E+01	3.7E+02	3.5E+01	7.6E+00

Pathway	Ovaries	Muscle	Thyroid	Kidneys	Liver
Inhalation	1.2E-04	2.6E-05	3.0E-05	2.2E-05	5.4E-04
Ingestion (Terr)	5.4E+00	4.5E+00	1.2E+02	2.0E+01	1.1E+01
Ingestion (Aqua)	1.7E+00	8.2E-01	8.9E-01	5.4E-01	5.4E+00
Drinking Water	5.4E-01	2.0E-01	3.8E+00	1.1E+01	2.3E+00
Total internal	7.6E+00	5.5E+00	1.2E+02	3.2E+01	1.9E+01

Dose in units of person-rem;
that is the cumulative population dose received by the local population
with an assumed 70-yr individual lifetime.

```
DITTY Long-Term Surface Water Release TWRS-EIS (Ex Situ Exten. Sepa.)
  5
C 14
I 129
NP237
TC99
U 238
 &INPUT IWAT=1, IPATH=2, LUW=1, IPOPL=2,
  CFLO=120000.,
  RM=1.0, TZ=1990., TZR=0.,
  PL1(1)=294830.,391538.,431210.,469891.,1273208.,4932964.,
  TL(1)=1990., 2100.,2200.,2300.,2990.,11900.,
  NTL=6,
  USAGE(1)=0.3,0.,0.,0.,438.,17.,17.,
  CONSUM(1)=15.,276.,20.,230.,40.,30.,8.5,
  EXTIM=2920.,MOPYR=6, RIRR=150.,
  GRWP(1)=90.,90.,90.,30.,3*90.,
  YELD(1)=1.5,4.,0.84,1.3,3*0.84,
 &END
  5
C 14      5
1990.  0.0
4244.  0.0
4245.  0.0183
8995.  0.0183
8996.  0.0
I 129     5
1990.  0.0
4244.  0.0
4245.  0.0001
8995.  0.0001
8996.  0.0
NP237     5
1990.  0.0
4244.  0.0
4245.  0.00023
8995.  0.00023
8996.  0.0
TC99      5
1990.  0.0
4244.  0.0
4245.  0.1126
8995.  0.1126
8996.  0.0
U 238     5
```

1990.	0.0
4244.	0.0
4245.	0.0064
8995.	0.0064
8996.	0.0