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 4 OF _____

TWRS EIS
CALCULATION COVER SHEET

DISCIPLINE & TITLE WATER RESOURCES

ORIGINATOR STEVE CARBALLIERA DATE 3/19/96

REVISION NO.

OBJECTIVE PROVIDE MAXIMUM GROUNDWATER CONCENTRATIONS IN PCi/L

METHODOLOGY FOR EACH RADIOISOTOPE CONVERT mg/L TO PCi/L BY MULTIPLYING BY ITS SPECIFIC ACTIVITY

ASSUMPTIONS

(Continue on another sheet if necessary)

Steven J. Carballiera 2/16/

SIGNATURE/DATE

Stephen W. Billitt 20-MAR-96

CHECKED/DATE

1.7.2

CALCULATION & RESULTS
ATTACHED

PROJECTS/Common/HANFORD/
Sheet1 APPFNEW.XLS

Table F.3.1.1. Maximum Concentrations Calculated for the No Action Alternative										
Constituent	300 years (mg/L)	300 years (pCi/L)	500 years (mg/L)	500 years (pCi/L)	2,500 years (mg/L)	2,500 years (pCi/L)	5,000 years (mg/L)	5,000 years (pCi/L)	10,000 years (mg/L)	10,000 years (pCi/L)
Kd Group 1 (Kd = 0.0 mL/g)										
C-14	1.55E-05	6.90E+04	4.57E-06	2.03E+04	2.13E-09	9.48E+00	3.18E-11	1.42E-01	0	0.00E+00
I-129	2.50E-03	4.40E+02	3.21E-04	5.65E+01	6.51E-07	1.15E-01	1.31E-08	2.31E-03	1.10E-12	1.94E-07
Np-237	2.92E-03	2.06E+03	6.45E-04	4.54E+02	4.18E-07	2.94E-01	8.42E-09	5.93E-03	7.00E-13	4.93E-07
Np-238	0	0.00E+00	0	0.00E+00	0	0.00E+00	0	0.00E+00	0	0.00E+00
Rh-106	0	0.00E+00	0	0.00E+00	0	0.00E+00	0	0.00E+00	0	0.00E+00
Rn-219	0	0.00E+00	0	0.00E+00	0	0.00E+00	0	0.00E+00	0	0.00E+00
Rn-222	0	0.00E+00	0	0.00E+00	0	0.00E+00	0	0.00E+00	0	0.00E+00
Ru-106	0	0.00E+00	0	0.00E+00	0	0.00E+00	0	0.00E+00	0	0.00E+00
Sb-126m	0	0.00E+00	0	0.00E+00	0	0.00E+00	0	0.00E+00	0	0.00E+00
Se-79	4.64E-04	3.23E+04	3.45E-04	2.40E+04	9.18E-08	6.39E+00	1.80E-09	1.25E-01	1.00E-13	6.96E-06
Tc-99	1.87E-02	3.16E+05	7.45E-03	1.26E+05	8.02E-06	1.36E+02	1.58E-07	2.67E+00	1.34E-11	2.26E-04
U-233	3.91E-08	3.77E-01	2.61E-08	2.52E-01	4.70E-12	4.53E-05	1.00E-13	9.64E-07	0	0.00E+00
U-234	1.93E-06	1.20E+01	2.84E-07	1.77E+00	1.91E-10	1.19E-03	3.80E-12	2.37E-05	0	0.00E+00
U-235	8.03E-01	1.73E+03	9.30E-02	2.01E+02	3.55E-05	7.67E-02	7.15E-07	1.54E-03	6.15E-11	1.33E-07
U-236	8.48E-07	5.48E-02	1.21E-07	7.82E-03	1.69E-10	1.09E-05	3.40E-12	2.20E-07	0	0.00E+00
U-238	1.23E+02	4.13E+04	1.42E+01	4.77E+03	5.04E-03	1.69E+00	1.02E-04	3.43E-02	0	0.00E+00
Ag+	1.23E-02		7.77E-03		9.07E-07		1.76E-08		1.50E-12	
As+5	8.92E-03		5.54E-03		3.15E-06		6.12E-08		5.20E-12	
B+3	1.09E-02		6.50E-03		6.68E-06		1.30E-07		1.11E-11	
Be+2	6.14E-04		4.09E-04		0		0		0	
Cl-	5.52E+00		1.23E+00		1.31E-03		2.56E-05		2.19E-09	
CO3-2	1.69E+02		1.94E+01		4.22E-03		8.51E-05		7.31E-09	
Cr+3	2.72E+00		3.80E-01		8.38E-07		1.69E-08		1.50E-12	
CrO4-2	6.60E-01		9.20E-02		1.48E-03		2.91E-05		2.49E-09	
F-	3.44E+01		4.67E+00		9.31E-04		1.87E-05		1.60E-09	
Fe(CN)6-4	1.90E+00		1.45E+00		3.58E-05		7.21E-07		6.20E-11	
Hg+	5.00E-02		6.04E-03		6.29E-06		1.27E-07		1.09E-11	
K+	3.40E+00		2.52E+00		5.87E-04		1.14E-05		9.74E-10	
Li+	2.12E-04		1.33E-04		8.76E-08		1.70E-09		1.00E-13	
Mo+6	3.72E-02		2.43E-02		1.33E-05		2.59E-07		2.21E-11	
Na+	3.63E+03		4.46E+02		5.86E-01		1.18E-02		1.01E-06	
NO2-	4.25E+02		4.96E+01		2.48E-02		4.98E-04		4.27E-08	
NO3-	6.62E+03		8.22E+02		1.21E+00		2.43E-02		2.09E-06	
OH-	1.27E+02		1.79E+01		6.02E-02		1.21E-03		1.04E-07	
SiO3-2	1.35E+02		1.57E+01		6.39E-03		1.29E-04		1.11E-08	
SO4-2	1.53E+02		1.77E+01		7.15E-03		1.44E-04		1.23E-08	
UO2+2	2.10E-01		1.42E-01		7.00E-13		0		0	
V+5	1.51E-03		1.12E-03		2.14E-07		4.16E-09		4.00E-13	
W+4	8.01E-01		9.67E-02		1.01E-04		2.03-06		1.74E-10	
Kd Group 2 (Kd = 1.0 mL/g)										
Bi-210	---		---		0	0.00E+00	0	0.00E+00	0	0.00E+00
Ni-63	---		---		5.81E-06	3.42E+05	1.73E-06	1.02E+05	5.58E-08	3.28E+03
Pa-231	---		---		8.20E-09	3.87E-01	5.67E-10	2.68E-02	3.79E-11	1.79E-03
Pa-233	---		---		1.73E-11	3.58E+02	0	0.00E+00	1.00E-13	2.07E+00
Pa-234m	---		---		0	0.00E+00	0	0.00E+00	0	0.00E+00
Po-211	---		---		0	0.00E+00	0	0.00E+00	0	0.00E+00
Bi+3	---		---		6.86E+00		4.70E-01		3.40E-02	
Ca+2	---		---		2.04E-01		6.48E-02		1.88E-03	
Cd+2	---		---		3.72E-02		3.81E-03		2.14E-04	
Cu+2	---		---		2.21E-03		3.88E-04		1.55E-05	
Fe+3	---		---		7.14E+00		5.11E-01		3.77E-02	
Mg+2	---		---		2.63E-02		5.36E-03		2.04E-04	
Ni+2	---		---		2.13E-01		8.37E-02		2.31E-03	

Table F.3.2.1. Maximum Contaminant Concentration Calculated for the Long Term Management Alternative										
Constituent	300 years		500 years		2,500		5,000		10,000	
	(mg/L)		(mg/L)		years		years		years	
					(mg/L)		(mg/L)		(mg/L)	
Kd										
Group 1										
(Kd = 0.0										
mL/g)										
C-14	3.15E-06	1.40E+04	3.96E-06	1.76E+04	2.13E-09	9.48E+00	3.18E-11	1.42E-01	0	0.00E+00
I-129	4.09E-04	7.20E+01	3.21E-04	5.65E+01	6.51E-07	1.15E-01	1.31E-08	2.31E-03	1.10E-12	1.94E-07
Np-237	2.92E-03	2.06E+03	6.45E-04	4.54E+02	4.19E-07	2.95E-01	8.46E-09	5.96E-03	7.00E-13	4.93E-07
Np-238	0	0.00E+00	0	0.00E+00	0	0.00E+00	0	0.00E+00	0	0.00E+00
Rh-106	0	0.00E+00	0	0.00E+00	0	0.00E+00	0	0.00E+00	0	0.00E+00
Rn-219	0	0.00E+00	0	0.00E+00	0	0.00E+00	0	0.00E+00	0	0.00E+00
Rn-222	0	0.00E+00	0	0.00E+00	0	0.00E+00	0	0.00E+00	0	0.00E+00
Ru-106	0	0.00E+00	0	0.00E+00	0	0.00E+00	0	0.00E+00	0	0.00E+00
Sb-126m	0	0.00E+00	0	0.00E+00	0	0.00E+00	0	0.00E+00	0	0.00E+00
Se-79	2.12E-04	1.48E+04	3.45E-04	2.40E+04	9.18E-08	6.39E+00	1.80E-09	1.25E-01	1.00E-13	6.96E-06
Tc-99	5.40E-03	9.13E+04	6.48E-03	1.10E+05	8.44E-06	1.43E+02	1.71E-07	2.89E+00	1.45E-11	2.45E-04
U-233	1.53E-08	1.47E-01	2.89E-08	2.79E-01	4.70E-12	4.53E-05	1.00E-13	9.64E-07	0	0.00E+00
U-234	3.82E-05	2.38E+02	3.20E-05	2.00E+02	1.91E-10	1.19E-03	3.80E-12	2.37E-05	0	0.00E+00
U-235	1.20E-01	2.59E+02	9.30E-02	2.01E+02	5.28E-06	1.14E-02	1.06E-07	2.29E-04	6.33E-11	1.37E-07
U-236	1.36E-07	8.79E-03	1.27E-07	8.20E-03	2.52E-11	1.63E-06	5.00E-13	3.23E-08	0	0.00E+00
U-237	0	0.00E+00	0	0.00E+00	0	0.00E+00	0	0.00E+00	0	0.00E+00
U-238	1.83E+01	6.15E+03	1.42E+01	4.77E+03	7.50E-04	2.52E-01	1.51E-05	5.07E-03	9.00E-09	3.02E-06
Ag+	8.52E-03		9.19E-03		1.02E-06		2.11E-08		1.80E-12	
As+5	6.19E-03		6.37E-03		3.54E-06		7.32E-08		6.30E-12	
B+3	7.73E-03		6.84E-03		7.52E-06		1.55E-07		1.34E-11	
Be+2	4.39E-04		4.84E-04		0		0		0	
Cl-	1.41E+00		1.27E+00		1.46E-03		3.01E-05		2.59E-09	
CO3-2	2.50E+01		1.94E+01		4.22E-03		8.51E-05		7.31E-09	
Cr+3	5.87E-01		4.45E-01		8.39E-07		1.69E-08		1.50E-12	
CrO4-2	1.10E-01		9.20E-02		1.60E-03		3.27E-05		2.82E-09	
F-	5.10E+00		4.04E+00		9.49E-04		1.92E-07		1.65E-09	
Fe(CN)6-4	8.73E-01		1.49E+00		5.32E-06		1.07E-07		6.39E-11	
Hg+	3.06E-04		3.30E-04		0		0		0	
K+	2.38E+00		2.69E+00		6.60E-04		1.36E-05		1.18E-09	
Li+	1.47E-04		1.50E-04		9.86E-08		2.04E-09		2.00E-13	
Mo+6	2.69E-02		2.81E-02		1.50E-05		3.10E-07		2.67E-11	
Na+	5.70E+02		4.44E+02		5.90E-01		1.19E-02		1.03E-06	
NO2-	6.38E+01		4.94E+01		2.53E-02		5.12E-04		4.41E-08	
NO3-	1.05E+03		8.21E+02		1.21E+00		2.44E-02		2.10E-06	
OH-	2.26E+01		1.79E+01		6.02E-02		1.21E-03		1.04E-07	
SiO3-2	2.02E+01		1.56E+01		6.40E-03		1.29E-04		1.11E-08	
SO4-2	2.28E+01		1.77E+01		7.23E-03		1.46E-04		1.26E-08	
UO2+2	1.26E-01		1.49E-01		3.80E-12		0		0	
V+5	1.06E-03		1.20E-03		2.41E-07		4.98E-09		4.00E-13	
W+4	3.92E-03		4.22E-03		2.00E-13		0		0	
Kd										
Group 2										
(Kd = 1.0										
mL/g)										
Bi-210	---		---		0	0.00E+00	0	0.00E+00	0	0.00E+00
Ni-63	---		---		2.00E-13	1.18E-02	0	0.00E+00	0	0.00E+00
Pa-231	---		---		8.20E-09	3.87E-01	5.67E-10	2.68E-02	3.79E-11	1.79E-03
Pa-233	---		---		0	0.00E+00	0	0.00E+00	0	0.00E+00
Pa-234m	---		---		0	0.00E+00	0	0.00E+00	0	0.00E+00
Po-211	---		---		0	0.00E+00	0	0.00E+00	0	0.00E+00
Bi+3	---		---		6.86E+00		4.70E-01		3.40E-02	
Ca+2	---		---		2.04E-01		6.48E-02		1.88E-03	
Cd+2	---		---		3.72E-02		3.81E-03		2.14E-04	
Cu+2	---		---		6.00E-06		1.24E-07		1.07E-11	
Fe+3	---		---		7.14E+00		5.11E-01		3.77E-02	
Mg+2	---		---		2.63E-02		5.36E-03		2.04E-04	
Ni+2	---		---		2.13E-01		8.37E-02		2.31E-03	

Table.3.3.1. Maximum Concentrations Calculated for the In Situ Fill and Cap Alternative						
	2500	2500	5,000	5,000	10,000	10,000
	years	years	years	years	years	years
	(mg/L)	(pCi/L)	(mg/L)	(pCi/L)	(mg/L)	(pCi/L)
C-14	1.40E-12	6.23E-03	2.99E-07	1.33E+03	1.93E-08	8.59E+01
I-129	9.82E-11	1.73E-05	4.74E-05	8.34E+00	1.46E-05	2.57E+00
Rn-219	0	0.00E+00	0	0.00E+00	0	0.00E+00
Rn-222	0	0.00E+00	0	0.00E+00	0	0.00E+00
Ru-106	0	0.00E+00	1.00E-13	3.34E-01	0	0.00E+00
Sb-126m	0	0.00E+00	0	0.00E+00	0	0.00E+00
Se-79	1.35E-11	9.40E-04	6.51E-06	4.53E+02	1.91E-06	1.33E+02
Tc-99	2.72E-09	4.60E-02	8.70E-04	1.47E+04	1.03E-04	1.74E+03
U-233	0	0.00E+00	5.84E-10	5.63E-03	1.03E-10	9.93E-04
U-234	1.00E-13	6.24E-07	3.70E-08	2.31E-01	4.41E-09	2.75E-02
U-235	2.02E-08	4.36E-05	1.57E-02	3.39E+01	1.61E-03	3.48E+00
U-236	1.00E-13	6.46E-09	1.62E-08	1.05E-03	3.81E-09	2.46E-04
U-237	0	0.00E+00	0	0.00E+00	0	0.00E+00
U-238	3.00E-06	1.01E-03	2.40E+00	8.06E+02	2.44E-01	8.20E+01
Ag+	5.40E-10		5.53E-04		1.68E-07	
As+5	6.70E-11		3.00E-04		5.79E-07	
B+3	1.72E-10		4.12E-04		1.23E-06	
Be+2	5.76E-11		3.61E-05		7.80E-09	
Cl	1.41E-07		1.09E-01		9.95E-03	
CO3-2	1.47E-06		3.31E+00		3.19E-01	
Cr+3	2.20E-11		8.83E-05		1.86E-05	
CrO4-2	7.22E-10		6.19E-02		1.21E-02	
F-	5.96E-06		6.75E-01		6.44E-02	
Fe(CN)6-4	1.16E-06		1.93E-01		1.14E-03	
Hg+	2.40E-12		1.61E-05		6.68E-09	
K+	9.74E-07		3.47E-01		1.08E-04	
Li+	0		6.63E-06		1.61E-08	
Mo+6	2.06E-09		1.73E-03		2.45E-06	
Na+	4.43E-05		7.00E+01		1.24E+01	
NO2-	3.66E-06		8.31E+00		8.64E-01	
NO3-	3.17E-05		1.27E+02		2.68E+01	
Np-237	2.02E-10	1.42E-04	6.87E-05	4.84E+01	9.19E-06	6.47E+00
Np-238	0	0.00E+00	0	0.00E+00	0	0.00E+00
OH-	1.94E-05		2.34E+00		1.35E+00	
Rh-106	0		0		0	
SO4-2	2.43E-06		2.98E+00		3.04E-01	
SO4-2	2.43E-06		2.98E+00		3.04E-01	
UO2+2	6.95E-08		2.27E-02		3.46E-07	
V+5	4.28E-10		1.54E-04		3.94E-08	
W+4	0		2.00E-04		8.67E-08	

Table F.3.4.1 Maximum Concentrations in Groundwater Calculated for the In Situ Vitrification Alt						
			5,000	5,000	10,000	10,000
Constituents			years	years	years	years
			(mg/L)	(pCi/L)	(mg/L)	(pCi/L)
Tc2O7			1.72E-06	2.91E+01	2.21E-06	3.73E+01
U-233			1.40E-12	1.35E-05	1.80E-12	1.74E-05
U-234			3.92E-11	2.45E-04	4.99E-11	3.11E-04
U-235			1.25E-05	2.70E-02	1.61E-05	3.48E-02
U-236			4.51E-11	2.91E-06	5.82E-11	3.76E-06
U-238			1.84E-03	6.18E-01	2.37E-03	7.96E-01
Ag2O			1.90E-06		2.45E-06	
As2O5			1.42E-06		1.83E-06	
B2O3			4.86E-06		6.27E-06	
BeO			1.01E-07		1.31E-07	
Cr2O3			7.11E-05		9.18E-05	
Li2O			3.38E-08		4.36E-08	
Na2O			7.39E-02		9.54E-02	
MoO3			6.31E-06		8.14E-06	
NpO2			1.63E-07		2.10E-07	
V2O5			2.78E-07		3.59E-07	
WO2			5.63E-07		7.26E-07	
WO3			1.12E-06		1.45E-06	

Table F.3.5.1. Maximum Concentrations Calculated for the Ex Situ Intermediate Seperations Alte						
	2,500	2,500	5,000	5,000	10,000	10,000
Constituent	years	years	years	years	years	years
	(mg/L)	(pCi/L)	(mg/L)	(pCi/L)	(mg/L)	(pCi/L)
C-14	3.42E-10	1.52E+00	6.80E-09	3.03E+01	2.00E-13	8.90E-04
I-129	5.32E-08	9.36E-03	2.01E-06	3.54E-01	1.21E-10	2.13E-05
Rn-219	0	0.00E+00	0	0.00E+00	0	0.00E+00
Rn-222	0	0.00E+00	0	0.00E+00	0	0.00E+00
Ru-106	0	0.00E+00	0	0.00E+00	0	0.00E+00
Sb-126	0	0.00E+00	0	0.00E+00	0	0.00E+00
Se-79	7.49E-09	5.21E-01	2.75E-07	1.91E+01	1.71E-11	1.19E-03
Tc-99	3.78E-07	6.39E+00	1.50E-05	2.54E+02	1.55E-09	2.62E-02
U-233	7.00E-13	6.75E-06	2.32E-11	2.24E-04	0	0.00E+00
U-234	2.45E-11	1.53E-04	1.42E-09	8.86E-03	0	0.00E+00
U-235	7.44E-06	1.61E-02	0.00058249	1.26E+00	7.16E-09	1.55E-05
U-236	4.57E-11	2.95E-06	6.63E-10	4.28E-05		0.00E+00
U-237	0	0.00E+00	0	0.00E+00	0	0.00E+00
U-238	1.11E-03	3.73E-01	8.90E-02	2.99E+01	1.02E-06	3.43E-04
Ag+	3.24E-10		1.94E-05		1.72E-10	
As+5	4.02E-11		1.39E-05		5.95E-10	
B+3	1.03E-10		1.82E-05		1.26E-09	
Be+2	3.46E-11		9.15E-07		0	
Cl-	1.71E-05		0.00405731		2.50E-07	
CrO4-2	2.57E-06		3.16E-03		2.87E-07	
F-	1.80E-03		2.47E-02		1.86E-07	
Fe(CN)6-4	4.47E-04		4.27E-03		7.22E-09	
Hg+	1.50E-12		7.64E-07		0	
Li+	0		3.29E-07		1.66E-11	
Na+	1.61E-03		2.78E+00		1.18E-04	
NO2-	2.10E-03		3.10E-01		4.96E-06	
NO3-	2.18E-02		5.13E+00		2.43E-04	
SO4-2	0.00907481		0.110655		1.44E-06	
UO2+2	4.23E-08		8.93E-05		0	
V+5	2.57E-10		1.23E-06		4.05E-11	
W+6	0		9.90E-06		0	
Np-237	7.19E-08	5.06E-02	2.22E-06	1.56E+00	8.42E-11	5.93E-05
Np-238	0	0.00E+00	0	0.00E+00	0	0.00E+00
Rh-106	0	0.00E+00	0	0.00E+00	0	0.00E+00
CO3-2	6.66E-04		1.21E-01		8.51E-07	
Cr+3	1.52E-08		3.56E-06		1.69E-10	
K+	5.83E-07		2.68E-03		1.11E-07	
Mo+6	1.24E-09		5.51E-05		2.52E-09	
OH-	6.53E-03		1.14E-01		1.22E-05	
SO4-2	9.07E-04		1.11E-01		1.44E-06	

Table F.3.5.2 Maximum Concentrations Calculated for the LAW Vaults - Intermediate Seperatio						
			5,000	5,000	10,000	10,000
Constituent			years	years	years	years
			(mg/L)	(pCi/L)	(mg/L)	(pCi/L)
Tc-99			4.56E-06	7.71E+01	1.23E-05	2.08E+02
U-233			2.00E-13	1.93E-06	6.00E-13	5.78E-06
U-234			6.60E-12	4.12E-05	1.76E-11	1.10E-04
U-235			2.06E-06	4.45E-03	5.56E-06	1.20E-02
U-236			7.60E-12	4.91E-07	2.05E-11	1.32E-06
U-238			3.09E-04	1.04E-01	8.35E-04	2.81E-01
Ag2O			1.19E-06		3.23E-06	
As2O5			2.80E-06		7.57E-06	
B2O3			5.46E-06		1.48E-05	
BeO			2.98E-07		8.06E-07	
Cr2O3			3.52E-06		9.51E-06	
Li-2O			2.11E-08		5.71E-08	
MoO3			1.77E-05		4.79E-05	
Na2O			2.66E-01		7.19E-01	
NpO2			5.33E-08		1.44E-07	
V2O5			2.27E-07		6.13E-07	
WO2			1.22E-10		3.29E-10	
WO3			3.66E-06		9.89E-06	

Table F.3.8.1 Maximum Concentration Calculated in Groundwater for the Ex Situ/In Situ Combin						
Constituent	2,500 years (mg/L)	2,500 years (pCi/L)	5,000 years (mg/L)	5,000 years (pCi/L)	10,000 years (mg/L)	10,000 years (pCi/L)
C-14	2.3E-10	1.02E+00	6.71E-10	2.99E+00	0.00E+00	0.00E+00
I-129	3.91E-08	6.88E-03	0.000000118	2.08E-02	1.08E-11	1.90E-06
Np-237	5.23E-08	3.68E-02	9.63E-08	6.78E-02	6.20E-12	4.36E-06
Np-238	0	0.00E+00	0	0.00E+00	0	0.00E+00
Rh-106	0	0.00E+00	0	0.00E+00	0	0.00E+00
Rn-219	0	0.00E+00	0	0.00E+00	0	0.00E+00
Rn-222	0	0.00E+00	0	0.00E+00	0	0.00E+00
Ru-106	0	0.00E+00	0	0.00E+00	0	0.00E+00
Sb-126m	0	0.00E+00	0	0.00E+00	0	0.00E+00
Se-79	5.49E-09	3.82E-01	1.59E-08	1.11E+00	1.40E-12	9.74E-05
Tc-99	2.78E-07	4.70E+00	0.000000815	1.38E+01	7.55E-11	1.28E-03
U-233	4E-13	3.86E-06	1.6E-12	1.54E-05	0.00E+00	0.00E+00
U-234	1.01E-11	6.30E-05	9.16E-11	5.72E-04	0.00E+00	0.00E+00
U-235	3.36E-06	7.26E-03	2.59E-05	5.59E-02	5.02E-10	1.08E-06
U-236	1.71E-11	1.10E-06	1.74E-10	1.12E-05	0.00E+00	0.00E+00
U-237	0	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
U-238	4.99E-04	1.68E-01	3.95E-03	1.33E+00	7.20E-08	2.42E-05
Cl-	6.63E-06		1.20E-04		1.99E-09	
CO3 -2	3.70E-04		4.22E-03		6.97E-08	
Cr+3	7.72E-09		1.35E-07		8.50E-12	
CrO4 -2	7.90E-07		5.23E-05		4.91E-09	
F-	7.15E-04		7.25E-03		1.05E-08	
Fe(CN)6	1.75E-04		1.33E-04		3.52E-10	
Hg+	2.94E-07		2.91E-06		1.05E-10	
Na+	7.30E-03		1.02E-01		5.42E-06	
NO2 -	1.33E-03		1.23E-02		2.76E-07	
NO3 -	1.11E-02		1.95E-01		1.23E-05	
OH -	2.39E-03		2.43E-02		5.45E-07	
SiO3 -2	2.95E-04		3.42E-03		2.27E-08	
SO4 -2	4.05E-04		3.94E-03		1.01E-07	
W+4	4.72E-06		4.67E-05		1.68E-09	

Table F.3.8.2 Maximum Concentration Calculated in Groundwater for the Ex Situ/In Situ Combin						
	2,500 years	2,500 years	5,000 years	5,000 years	10,000 years	10,000 years
Constituent	(mg/L)	(pCi/L)	(mg/L)	(pCi/L)	(mg/L)	(pCi/L)
C-14	1E-13	4.45E-04	5.89E-08	2.62E+02	1.45E-09	6.45E+00
I-129	9.5E-12	1.67E-06	2.16E-05	3.80E+00	1.07E-06	1.88E-01
Np-237	1.48E-11	1.04E-05	2.47E-05	1.74E+01	1.26E-06	8.87E-01
Np-238	0	0.00E+00	0	0.00E+00	0	0.00E+00
Rh-106	0	0.00E+00	0	0.00E+00	0	0.00E+00
Rn-219	0	0.00E+00	0	0.00E+00	0	0.00E+00
Rn-222	0	0.00E+00	0	0.00E+00	0	0.00E+00
Ru-106	0	0.00E+00	0	0.00E+00	0	0.00E+00
Sb-126m	0	0.00E+00	0	0.00E+00	0	0.00E+00
Se-79	1.3E-12	9.05E-05	0.00000298	2.07E+02	1.38E-07	9.60E+00
Tc-99	1.21E-10	2.04E-03	1.64E-04	2.77E+03	7.49E-06	1.27E+02
U-233	0	0.00E+00	4.96E-10	4.78E-03	4.06E-11	3.91E-04
U-234	0	0.00E+00	1.33E-08	8.30E-02	1.32E-09	8.24E-03
U-235	1.04E-09	2.25E-06	2.03E-03	4.38E+00	1.47E-04	3.18E-01
U-236	0	0.00E+00	2.18E-09	1.41E-04	6.99E-10	4.52E-05
U-237	0	0.00E+00	0	0.00E+00	0	0.00E+00
U-238	1.49E-07	5.01E-05	3.07E-01	1.03E+02	1.99E-02	6.69E+00
Ag+	1.1E-10		2.80E-03	0.00E+00	3.59E-08	0.00E+00
As+5	4.11E-11		4.92E-04		1.25E-07	
B+3	1.05E-10		1.91E-03		4.07E-08	
Be+2	3.45E-11		9.49E-06		1.00E-13	
Cl-	5.19E-08		8.49E-02		5.69E-04	
CO3 -2	1.51E-06		1.94E+00		6.18E-03	
Cr+3	9.4E-12		5.44E-05		6.38E-06	
CrO4 -2	1.84E-08		2.60E-02		4.82E-03	
F-	5.63E-07		2.99E-01		3.68E-03	
Fe(CN)6	1.86E-07		5.64E-02		2.93E-04	
Hg+	3.52E-10		1.03E-03		8.35E-06	
K+	3.19E-07		3.20E-02		5.09E-06	
Li+	0		1.37E-05		3.48E-09	
Mo+6	8.81E-10		3.33E-04		2.62E-08	
Na+	9.14E-06		4.38E+01		4.54E+00	
NO2 -	1.71E-06		3.15E+00		1.02E-01	
NO3 -	1.35E-05		7.83E+01		9.19E+00	
OH -	1.42E-06		2.84E+00		5.38E-01	
SiO3 -2	9.51E-08		1.45E+00		9.01E-02	
SO4 -2	4.31E-07		1.92E+00		1.65E-02	
UO2 +2	4.17E-08		8.61E-03		4.56E-11	
V+5	2.63E-10		3.35E-05		8.50E-09	
W+4	5.65E-09		1.74E-02		1.34E-04	

Table F.3.8.3 Maximum Concentration Calculated in Groundwater f				
Constituent	5,000 years	5,000 years	10.000 years	10.000 years
	(mg/L)	(pCi/L)	(mg/L)	(pCi/L)
Tc-99	2.34E-06	3.95E+01	6.30E-06	1.06E+02
U-233	1.00E-13	9.64E-07	3.00E-13	2.89E-06
U-234	3.40E-12	2.12E-05	9.00E-12	5.62E-05
U-235	1.05E-06	2.27E-03	9.00E-12	1.94E-08
U-236	3.90E-12	2.52E-07	1.05E-11	6.78E-07
U-238	1.58E-04	5.31E-02	4.28E-04	1.44E-01
Ag+	6.12E-07		1.65E-06	
As+5	1.43E-06		3.88E-06	
B+	2.80E-06		7.56E-06	
Be+2	1.53E-07		4.13E-07	
Cr+3	1.80E-06		4.87E-06	
K+	4.11E-07		1.11E-06	
Li+	1.08E-08		2.92E-08	
Mo+6	9.08E-06		2.46E-05	
Na+	1.36E-01		3.68E-01	
NpO2	2.73E-08		7.39E-08	
SiO3 -2	1.20E-01		5.40E-01	
V+	1.16E-07		3.14E-07	
WO3	1.87E-06		5.07E-06	
WO2	6.23E-11		1.69E-10	

Table F.3.9.1 Maximum Concentrations Calculated for the Phased Implementation Total Alternati						
Constituent	2,500 years	2,500 years	5,000 years	5,000 years	10,000 years	10,000 years
	(mg/L)	(pCi/L)	(mg/L)	(pCi/L)	(mg/L)	(pCi/L)
C-14	3.42E-10	1.52E+00	6.80E-09	3.03E+01	2.00E-13	8.90E-04
I-129	5.32E-08	9.36E-03	2.01E-06	3.54E-01	1.21E-10	2.13E-05
Rn-219	0	0.00E+00	0	0.00E+00	0	0.00E+00
Rn-222	0	0.00E+00	0	0.00E+00	0	0.00E+00
Ru-106	0	0.00E+00	0	0.00E+00	0	0.00E+00
Sb-126	0	0.00E+00	0	0.00E+00	0	0.00E+00
Se-79	7.49E-09	5.21E-01	2.75E-07	1.91E+01	1.71E-11	1.19E-03
Tc-99	3.78E-07	6.39E+00	1.50E-05	2.54E+02	1.55E-09	2.62E-02
U-233	7.00E-13	6.75E-06	2.32E-11	2.24E-04	0	0.00E+00
U-234	2.45E-11	1.53E-04	1.42E-09	8.86E-03	0	0.00E+00
U-235	7.44E-06	1.61E-02	5.82E-04	1.26E+00	7.16E-09	1.55E-05
U-236	4.57E-11	2.95E-06	6.63E-10	4.28E-05	0	0.00E+00
U-237	0	0.00E+00	0	0.00E+00	0	0.00E+00
U-238	1.11E-03	3.73E-01	8.90E-01	2.99E+02	1.02E-06	3.43E-04
Ag+	3.24E-10		1.94E-05		1.72E-10	
As+5	4.02E-11		1.39E-05		5.95E-10	
B+3	1.03E-10		1.82E-05		1.26E-09	
Be+2	3.46E-11		9.15E-07		0	
Cl-	1.71E-05		4.06E-03		2.50E-07	
CrO4-2	2.57E-06		3.16E-03		2.87E-07	
F-	1.80E-03		2.47E-02		1.86E-07	
Fe(CN)6-	4.47E-04		4.27E-03		7.22E-09	
Hg+	1.50E-12		7.64E-07		0	
Li+	0		3.29E-07		1.66E-11	
Na+	1.62E-02		2.78E+00		1.18E-04	
NO2	2.11E-03		3.09E-01		4.96E-06	
NO3	2.19E-02		5.13E+00		2.44E-04	
SO4-2	9.07E-04		1.11E-01		1.44E-06	
UO2+2	4.23E-08		8.93E-05		0	
V+5	2.57E-10		1.23E-06		4.05E-11	
W+6	0		9.90E-06		0	
	0		0		0	
Np-237	7.19E-08	5.06E-02	2.22E-06	1.56E+00	8.42E-11	5.93E-05
Np-238	0	0.00E+00	0	0.00E+00	0	0.00E+00
Rh-106	0	0.00E+00	0	0.00E+00	0	0.00E+00
CO3-2	6.66E-04		1.21E-01		8.51E-07	
Cr+3	1.52E-08		3.56E-06		1.69E-10	
K+	5.85E-07		2.68E-03		1.11E-07	
Mo+6	1.24E-09		5.51E-05		2.52E-09	
OH-	6.53E-03		1.14E-01		1.22E-05	
SO4-2	9.07E-04		1.11E-01		1.44E-06	

Table F.3.9.2 Maximum Concentration Calculated for the LAW Vaults - Phased Im					
Constituent	5,000 years	5,000 years	10,000 years	10,000 years	
	(mg/L)	(pCi/L)	(mg/L)	(pCi/L)	
Tc-99	4.56E-06	7.71E+01	1.23E-05	2.08E+02	
U-233	2.00E-13	1.93E-06	6.00E-13	5.78E-06	
U-234	6.60E-12	4.12E-05	1.76E-11	1.10E-04	
U-235	2.06E-06	4.45E-03	5.56E-06	1.20E-02	
U-236	7.60E-12	4.91E-07	2.05E-11	1.32E-06	
U-238	3.09E-04	1.04E-01	8.35E-04	2.81E-01	
Ag2O	1.19E-06		3.23E-06		
As2O5	2.80E-06		7.57E-06		
B2O3	5.46E-06		1.48E-05		
BeO	2.98E-07		8.06E-07		
Cr2O3	3.52E-06		9.51E-06		
Li-2O	2.11E-08		5.71E-08		
MoO3	1.77E-05		4.79E-05		
Na2O	2.66E-01		7.19E-01		
NpO2	5.33E-08		1.44E-07		
V2O5	2.27E-07		6.13E-07		
WO2	1.22E-10		3.29E-10		
WO3	3.66E-06		9.89E-06		

TWRS EIS
CALCULATION COVER SHEET

DISCIPLINE & TITLE Groundwater - U.S. Ecology source terms for cumulative impacts.

ORIGINATOR P. BRAMSON DATE 3/15/96

REVISION NO. _____

OBJECTIVE Estimate groundwater contamination levels after closure of the U S Ecology SWBG site

METHODOLOGY Reviewed and adopted preliminary draft information that is currently the subject of negotiation with state regulators

ASSUMPTIONS 1) Assume closure in the year 2068. 2) Assume the ongoing negotiations results in the draft preliminary data being approved by the state. 3) Assume that these concentrations combine (add with) other sources.

(Continue on another sheet if necessary)

P. Bramson 3/15/96
SIGNATURE/DATE

A.J.L. Nyquist 3/15/96
CHECKED/DATE

CALCULATION & RESULTS
ATTACHED

JACOBS\FORMS\CALCVR.SHT

Facsimile Cover Sheet

To: Phil Bramson
Company:
Phone:
Fax:

From: Art Palmer
Company: American Ecology
Office Phone: 423-220-5230
Pager: 800-360-0579
Fax: 423-220-5245

Date: 2/29/96
Pages including this cover page: 6

Comments:

Source Term and Well Concentrations
These are very conservative. Pls call w/ quest.
Thanks

Art Palmer

Table 3.1

Radionuclide Source Term

Isotope	Half-Life (years)	Activity (Curies) (1)
Am-241	458	464.3
C-14	5.73E+03	3880.7
Cd-113	1.3E+15	2.94
Cl-36	3.08E+05	34.5
Hf-182*	9.00E6	1.56
I-129	1.70E+07	5.77
In-115	6.00E14	2.99
K-40	1.26E-09	4.7
Nb-94	2.00E+04	0.94
Ni-59	8.00E+04	187.91
Ni-63	92	35,426.5
Pu-238	86.4	11,442.99
Pu-239	2.44E+04	12,945.7*
Pu-240	6.60E+03	included with Pu-239
Pu-241	13.2	NA
Pu-242	3.79E5	240.48
Ra-226	1.60E+03	207.6
Sr-90	27.7	35,334.4
Tc-99	2.12E+05	65.6
Th-232	1.41E+10	636.5
U-238	4.51E+09	10,938.24

Notes:

* Combines total activity for Pu-239 and Pu-240; use Pu-239 half-life
(1) Includes activity through 1993 and predicted future activity (1994-2063)

Table 3.7

Estimated Concentrations at Hypothetical Well (pCi/L)

INPUT FOR RWELL1.OUT

RICH1.DAT (K=1000 FT/D, INFIL = 0.2 IN/YR, DEPTH = 265 FT, POR = 0.30)

Isotope	TRANSS RICH1.OUT (pCi/L)	Dilution Factor	Well Conc. (pCi/L)	Conversion Factor	PRESTO Input (Ci/cu. m)	Status for PRESTO
Am-241	7.29E-120	0.0004	2.9E-123	1.00E-09	2.9E-132	Ignore
C-14	13515.1	0.0004	5.40604	1.00E-09	5.41E-09	Retain
Cl-36	16.9191	0.0004	0.006768	1.00E-09	6.77E-12	Ignore
I-129	16.8499	0.0004	0.00674	1.00E-09	6.74E-12	Retain
K-40	22.7167	0.0004	0.009087	1.00E-09	9.09E-12	Retain
Nb-94	6.85E-12	0.0004	2.74E-15	1.00E-09	2.74E-24	Retain
Ni-59	0.211916	0.0004	8.48E-05	1.00E-09	8.48E-14	Retain
Ni-63	9.11E-92	0.0004	3.64E-95	1.00E-09	3.6E-104	Ignore
Pu-238	1.09E-79	0.0004	4.38E-83	1.00E-09	4.38E-92	Ignore
Pu-239	3.57054	0.0004	0.001428	1.00E-09	1.43E-12	Retain
Pu-242	40.7807	0.0004	0.016312	1.00E-09	1.63E-11	Retain
Ra-226	3.11E-31	0.0004	1.24E-34	1.00E-09	1.24E-43	Retain
Sr-90	8.02E-10	0.0004	3.21E-13	1.00E-09	3.21E-22	Retain
Tc-99	8,251.5	0.0004	3.301	1.00E-09	3.30E-09	Retain
Th-232	373.686	0.0004	0.149474	1.00E-09	1.49E-10	Retain
U-238	852.955	0.0004	0.341182	1.00E-09	3.41E-10	Retain

Note:

Isotopes less than 1E-50 pCi/L were ignored
Dose rates for Cl-36 were not calculated by PRESTO-II, but were instead calculated by hand

Environmental Science & Engineering, Inc.

A CH2M HILL Company

FACSIMILE

DATE: 3/5/96 TIME:

TO: Phil Brownson FROM: Phil Rogers

FAX#: JOB#: 8946001-6-0200

SUBJECT:

Number of Pages
(Including this Cover Sheet)
2

ADDITIONAL MESSAGE:

Cummulative Impact Predicted Concentrations

If you have any questions, please call us immediately at (303) 790-0770.

2 Inverness Drive East, Suite 201 Englewood, CO 80112 Phone (303) 790-0770 Fax (303) 790-1411

	Tc-99 pCi/L (years)	I-129 pCi/L (years)	C-14 pCi/L (years)	U-238 pCi/L (years)	Nitrate Metric Tonnes (years)
Predicted Maximum Groundwater Concentration U.S. Ecology Site And Time of Peak	3.301	6.74E-03	5.41	3.4E-01	pCi/L
Predicted Maximum Groundwater Concentrations for the ERDF	7.376185	0.000978	223.092	0.171233	pCi/L
Peak Arrival Time	(1445 yrs))	(1445 yrs)	(1445 yrs)	(1445 yrs)	
Dose Conv. Factor (mrem/pCi)	1.3E-06	2.8E-04	2.1E-06	2.4E-04	
Max GW Dose (mrem/yr)	0.007	0.0002	0.342	0.03	
Predicted Maximum Groundwater Concentrations for the I.I.W Burial in 200W Peak Arrival Time					
Category 1 (no cap)					
Max GW Dose (mrem/yr)	2.5E-03	1.4E-02	1.3E-04	3.6E-04	
Max GW concentration (pCi/L)	2.6E+00	6.8E-02	8.5E-02	2.1E-03	pCi/L
	(123yrs)	(123yrs)	(123yrs)	(123yrs)	
Category 3 (cap)					
Max GW Dose (mrem/yr)	1.6	1.7E-01	5.2	20	
Max GW concentration (pCi/L)	1685.985	0.831703	3392.042	114.1553	pCi/L
Time to Peak (years)	(1000)	(1000)	(1000)	(1000)	
MCL	900	1	2000		

TWRS EIS
CALCULATION COVER SHEET

DISCIPLINE & TITLE Alex Nazarali
Risk Assessment

ORIGINATOR Alex Nazarali DATE March 11, 1996

REVISION NO. 0

OBJECTIVE Recalculate the risk value, previously computed by RADTRAN 4, for exposures other than the uniform default values used in each of the alternatives. The uniform default values did not take into consideration the varying amounts of waste (curie [Ci]) transported per trip.

METHODOLOGY Recalculate the HLW transportation risk, from the Hanford Site to the geologic repository, to the worker and public based on the waste loading per trip as well as the total number of trips.

The first calculation of risk for the worker and public, and corresponding trips are listed in the following table.

Table 1 - Calculation of Risk with Original Number of Trips

Alternative	Number of Trips	Risk	
		Worker	Public
Ex Situ No Separations (Vitrification)	2140	2.38	0.143
Ex Situ No Separations (Calcination)	1030	1.18	0.706
Ex Situ Intermediate	25	0.298	0.0181

A change in the waste loading was requested (SUGGEST A REFERENCE HERE) and is being incorporated in the EIS. In this change, the inventory of waste (total curie of waste) is the same but more trips are involved. The numbers of trips have been changed to 14,700 for Ex Situ No Separations Vitrification and 4150 for the Ex Situ No Separations Calcination alternatives, and 30 for the Ex Situ Intermediate Separations alternative.

The RADTRAN 4 model was used for the trip number and the resultant risks were 25.7, 4.76, and 1.46 for the worker; and 1.54, 0.285, and 0.0878 for the public for Ex Situ No Separations Vitrification, Ex Situ No Separations Calcination and Ex Situ Intermediate Separations alternatives, respectively.

The second calculation of risk for the worker and public, and the increased number of trips are listed in the following table.

Table 2 - Calculation of Risk with Increased Trips

Alternative	Number of Trips	Risk	
		Worker	Public
Ex Situ No Separations (Vitrification)	14700	25.7	1.54
Ex Situ No Separations (Calcination)	4150	4.76	0.285
Ex Situ Intermediate	30	1.46	0.0878

Note: Risk was calculated based on the number of trips without consideration of the waste loading per trip.

Table 3 - Variance between Calculation of Risk with Original and Increased Trips

Alternative	Worker Pop LCF (Previous LCF)	Public LCF (Previous LCF)	Worker - Difference	Public - Difference
No Separations (Vitrification)	25.7 (2.38)	1.54 (0.143)	+ 23.32	+ 1.397
No Separations (Calcination)	4.76 (1.18)	0.285 (0.706)	+ 3.58	- 0.421
Ex Situ Intermediate Separations with Cs, Sr	1.46 (0.298)	0.0878 (0.0181)	+ 1.162	+ 0.0697
Ex Situ Intermediate Separations without Cs, Sr	1.46 (0.298)	0.0878 (0.0181)	+ 1.162	+ 0.0697

The increase in the number of fatalities calculated in the preceding table was due to the increase in the number of trips without a corresponding adjustment in the default value being made for the content of the shipments. The same curies (Ci) of waste are transported under both cases, but the case with more trips will have less exposure per trip because of dilution of the waste with more glass materials. For example:

1) If a total of 100 curies is transported in 5 trips, the content of the shipment would be 100/5 = 20 curies per shipment;

2) If a total of 100 curies is transported in 10 trips, the content of the shipment would be 100/10 = 10 curies per shipment.

Assuming that the exposure from 20 curies per shipment and the exposure from 10 curies per shipment to be the same is not technically correct.

The risk result of the second case changes with the higher number of trips, and is reduced by the ratio of the number of trips as follows:

Ex Situ No Separation Vitrification
Worker 25.7 LCFs x 2140/14700 = 25.7 x (0.1456) = 3.74 LCFs
Public 1.54 LCFs x 2140/14700 = 1.54 x (0.1456) = 0.224 LCFs

Ex Situ No Separation Calcination
Worker 4.76 LCFs x 1030/4150 = 4.76 x (0.248) = 1.18 LCFs
Public 0.285 LCFs x 1030/4150 = 0.285 x (0.248) = 0.07 LCFs

Ex Situ Intermediate Separations
Worker 1.46 LCFs x 25/30 = 1.46 x (0.83) = 1.21 LCFs
Public 0.0878 LCFs x 25/30 = 0.088 x (0.83) = 0.073 LCFs

Table 4 - Calculation of Risk with Adjusted Ratio

Alternative	Adjusted Ratio Original # Trips / Increased Trips	Adjusted Risk - Risk from Table 2 x Adjusted Ratio	
		Worker	Public
Ex Situ No Separations (Vitrification)	2140/14700 = 0.1456	3.74	0.224
Ex Situ No Separations (Calcination)	1030/4150 = 0.248	1.18	0.07
Ex Situ Intermediate	25/30 = 0.83	1.21	0.073

Note: Risk was calculated based on the number of trips with consideration of the waste loading per trip.

Table 5 - Variance between Calculation of Risk with Increased Trips and Adjusted Ratio

Alternative	Worker Pop LCF (Previous LCF)	Public LCF (Previous LCF)	Worker - Difference	Public - Difference
No Separations (Vitrification)	3.74 (25.7)	0.224 (1.54)	- 21.96	- 1.316
No Separations (Calcination)	1.18 (4.76)	0.07 (0.285)	- 3.58	- 0.215
Ex Situ Intermediate Separations with Cs, Sr	1.21 (1.46)	0.073 (0.0878)	- 0.25	- 0.0148
Ex Situ Intermediate Separations without Cs, Sr	1.21 (1.46)	0.073 (0.0878)	- 0.25	- 0.0148

Attached are two RADTRAN 4 computer outputs. The first (Run A) is for the dose rate of 13.05 mrem/hr at 2 meters that results in an 8.47E-02 rem overall integrated dose. The second (Run B) is for 6.50 mrem/hr (half the value of Run A) that results in a total integrated dose of 3.93E-02.

$$13.05/6.50 = 8.47E\text{-}02/3.93E\text{-}02 = 2.008 \approx 2.155$$

This demonstrates the linear relationship between the dose rate and the total integrated dose.

ASSUMPTIONS The waste inventory (Ci of waste) is constant. The more trips, the less exposure per trip; and the less trips the more exposure per trip.

NOTE: RADTRAN 4 Results Trip # are changed and they are not per Jacobs request.

3/15/96
SIGNATURE/DATE

3/15/96
CHECKED/DATE

CALCULATION & RESULTS
ATTACHED

h:\users\lcrowlt-calcv.wpd

Run B


```
RRRR   AAA   DDDD   TTTTT  RRRR   AAA   N   N
R   R A   A  D   D    T    R   R A   A  NN  N
R   R A   A  D   D    T    R   R A   A  N N N
RRRR  A   A  D   D    T    RRRR  A   A  N  NN
R R   AAAAA  D   D    T    R R   AAAAA  N   N
R  R  A   A  D   D    T    R  R  A   A  N   N
R   R A   A  DDDD     T    R   R A   A  N   N
```

```
    4
4   4
4   4
44444
    4
    4
    4
```

RADTRAN 4.0.18 VERSION DATE: SEPTEMBER 24, 1995

MODE DESCRIPTIONS

NUMBER	NAME	CHARACTERIZATION
1	TRUCK	LONG HAUL VEHICLE
2	RAIL	COMMERCIAL TRAIN
3	BARGE	INLAND VESSEL
4	SHIP	OPEN SEA VESSEL
5	CARGO AIR	CARGO AIRCRAFT
6	PASS AIR	PASSENGER AIRCRAFT
7	P-VAN	PASSENGER VAN
8	CVAN-T	COMMERCIAL VAN
9	CVAN-R	COMMERCIAL VAN
10	CVAN-CA	COMMERCIAL VAN

ECHO CHECK

```
&& Edited Thu Feb 22 15:03:39 1996
&& _NOSEPVW.IN4_
TITLE _REDUCED_DOSE_RATE_CASE_
FORM UNIT
DIMEN 20 5 2 10 18
PARM 1 3 2 1 0
POPDEN     3.400    406.000   1959.100
PACKAGE
   LABGRP
       GRP1       GRP2
SHIPMENT
   LABISO
      AM241      AM243      CM244      CS137       NI63      NP237
      PU238      PU239      PU240      PU241      RU106      SM151
      SN126       SR90       TC99       U233       U234       U235
       U238       ZR93
NORMAL
   NMODE=2
       9.360E-01  5.500E-02  9.000E-03  6.437E+01  4.025E+01  2.416E+01
       5.000E+00  1.524E+02  2.000E+00  3.300E-02  1.000E+01  6.000E+01
       2.000E+00  1.000E+02  2.000E+01  4.000E+00  1.000E+02  1.000E+02
       3.000E+00  0.000E+00  1.000E+00  0.000E+00  1.000E+00  5.000E+00
       5.000E+00
ACCIDENT
   ARATMZ
       NMODE=2   6.620E-08    6.620E-08    6.620E-08
   SEVFRC
     NPOP=1
       NMODE=2
       9.94E-01  2.02E-03  3.34E-03  5.55E-04  1.71E-07
     NPOP=2
       NMODE=2
       9.94E-01  2.02E-03  3.34E-03  5.55E-04  1.71E-07
     NPOP=3
       NMODE=2
       9.94E-01  2.02E-03  3.34E-03  5.55E-04  1.71E-07
RELEASE
   RFRAC
     GROUP=1
       0.00E+00  0.00E+00  3.70E-05  3.70E-03  5.00E-02
     GROUP=2
       0.00E+00  0.00E+00  2.00E-06  2.00E-03  1.00E-03
   AERSOL
     DISP=2
       0.00E+00  0.00E+00  1.00E+00  1.00E+00  1.00E+00
     DISP=7
```

```
   0.00E+00  0.00E+00  1.00E+00  1.00E+00  1.00E+00
RESP
 DISP=2
   0.00E+00  0.00E+00  5.00E-02  5.00E-02  5.00E-02
 DISP=7
```

_REDUCED_DOSE_RATE_CASE_

```
        0.00E+00  0.00E+00  1.00E+00  1.00E+00  1.00E+00
DEFINE    U234
        8.93E+07  1.73E-03  2.43E-05  1.30E+08  2.60E+05  0.00E+00
        0.00E+00  1.00E-02  3.00E+00  8.20E+07  6.50E+04
DEFINE    NI63
        1.33E+05  1.71E-02  0.00E+00  3.00E+03  5.40E+02  0.00E+00
        0.00E+00  1.00E-02  2.00E+00  1.00E+05  5.30E+03
DEFINE   SN126
        3.65E+07  5.65E-02  7.70E-03  8.60E+04  1.70E+04  0.00E+00
        0.00E+00  1.00E-02  2.00E+00  4.10E+05  2.10E+05
DEFINE    ZR93
        5.59E+08  1.96E-02  0.00E+00  8.10E+04  1.60E+03  0.00E+00
        0.00E+00  1.00E-02  2.00E+00  4.50E+06  9.80E+04
EOF
ISOTOPES  2 146860     1.00    6.500   1.00   0.00  HLW
         AM241  7.08E-01      GRP2   2
         AM243  2.26E-04      GRP2   2
         CM244  8.04E-04      GRP2   2
         CS137  2.38E+02      GRP1   7
          NI63  1.83E+00      GRP2   2
         NP237  4.75E-04      GRP2   2
         PU238  7.35E-03      GRP2   2
         PU239  1.80E-01      GRP2   2
         PU240  4.56E-02      GRP2   2
         PU241  5.10E-01      GRP2   2
         RU106  2.58E-07      GRP1   7
         SM151  4.29E+00      GRP2   2
         SN126  4.27E-03      GRP2   2
          SR90  2.97E+02      GRP2   2
          TC99  2.19E-01      GRP2   2
          U233  8.24E-08      GRP2   2
          U234  1.44E-06      GRP2   2
          U235  1.40E-04      GRP2   2
          U238  3.28E-03      GRP2   2
          ZR93  2.68E-02      GRP2   2
DISTKM
          NMODE=2  2140.50
PKGSIZ
          HLW     5.00
EOF
```

_REDUCED_DOSE_RATE_CASE_

REGULATORY CHECKS

_REDUCED_DOSE_RATE_CASE_

CALCULATIONAL INFORMATION FOR MODE RAIL

FOR SEVERITY CATEGORY 4 AREA 1 HAS BEEN INTERDICTED.
THERE WILL BE NO 50 YEAR GROUNDSHINE DOSE AND NO INGESTION DOSE.

FOR SEVERITY CATEGORY 4 AREA 2 HAS BEEN INTERDICTED.
THERE WILL BE NO 50 YEAR GROUNDSHINE DOSE AND NO INGESTION DOSE.

FOR SEVERITY CATEGORY 4 AREA 3 HAS BEEN INTERDICTED.
THERE WILL BE NO 50 YEAR GROUNDSHINE DOSE AND NO INGESTION DOSE.

FOR SEVERITY CATEGORY 5 AREA 1 HAS BEEN INTERDICTED.
THERE WILL BE NO 50 YEAR GROUNDSHINE DOSE AND NO INGESTION DOSE.

FOR SEVERITY CATEGORY 5 AREA 2 HAS BEEN INTERDICTED.
THERE WILL BE NO 50 YEAR GROUNDSHINE DOSE AND NO INGESTION DOSE.

FOR SEVERITY CATEGORY 5 AREA 3 HAS BEEN INTERDICTED.
THERE WILL BE NO 50 YEAR GROUNDSHINE DOSE AND NO INGESTION DOSE.

FOR SEVERITY CATEGORY 5 AREA 4 HAS BEEN INTERDICTED.
THERE WILL BE NO 50 YEAR GROUNDSHINE DOSE AND NO INGESTION DOSE.

FOR SEVERITY CATEGORY 5 AREA 5 HAS BEEN INTERDICTED.
THERE WILL BE NO 50 YEAR GROUNDSHINE DOSE AND NO INGESTION DOSE.

FOR SEVERITY CATEGORY 5 AREA 6 HAS BEEN INTERDICTED.
THERE WILL BE NO 50 YEAR GROUNDSHINE DOSE AND NO INGESTION DOSE.

_REDUCED_DOSE_RATE_CASE_

INCIDENT-FREE SUMMARY
******** **** *******

INCIDENT-FREE POPULATION EXPOSURE IN PERSON-REM

	PASSENGR	CREW	HANDLERS	OFF LINK	ON LINK	STOPS	STORAGE	TOTALS
LINK 1	0.00E+00	3.20E+04	1.57E+04	2.50E+02	3.27E+01	1.26E+03	4.12E+02	4.97E+04
TOTALS:	0.00E+00	3.20E+04	1.57E+04	2.50E+02	3.27E+01	1.26E+03	4.12E+02	4.97E+04

MAXIMUM INDIVIDUAL IN-TRANSIT DOSE

LINK 1 3.93E-02 REM

_REDUCED_DOSE_RATE_CASE_

EXPECTED VALUES OF POPULATION RISK IN PERSON REM

HLW	GROUND	INHALED	RESUSPD	CLOUDSH	*INGESTION	TOTAL
AM241	1.41E-05	4.00E-04	1.82E-03	1.24E-10	0.00E+00	2.24E-03
AM243	8.03E-09	1.28E-07	5.83E-07	1.06E-13	0.00E+00	7.19E-07
CM244	4.24E-10	2.39E-07	1.03E-06	6.21E-16	0.00E+00	1.27E-06
CS137	1.13E-01	2.85E-04	1.26E-03	0.00E+00	0.00E+00	1.14E-01
NI63	1.91E-05	5.26E-09	2.39E-08	0.00E+00	0.00E+00	1.91E-05
NP237	1.04E-08	2.55E-07	1.16E-06	1.00E-13	0.00E+00	1.43E-06
PU238	7.13E-09	3.73E-06	1.68E-05	5.97E-15	0.00E+00	2.06E-05
PU239	9.12E-08	9.83E-05	4.49E-04	1.36E-13	0.00E+00	5.47E-04
PU240	5.01E-08	2.49E-05	1.14E-04	3.63E-14	0.00E+00	1.39E-04
PU241	3.49E-10	4.84E-06	2.06E-05	0.00E+00	0.00E+00	2.54E-05
RU106	3.52E-12	7.74E-12	1.77E-11	0.00E+00	0.00E+00	2.89E-11
SM151	3.09E-08	1.36E-07	6.12E-07	3.61E-14	0.00E+00	7.78E-07
SN126	1.54E-07	3.52E-10	1.61E-09	1.91E-12	0.00E+00	1.56E-07
SR90	0.00E+00	6.83E-04	3.01E-03	0.00E+00	0.00E+00	3.69E-03
TC99	0.00E+00	2.94E-09	1.34E-08	1.07E-15	0.00E+00	1.63E-08
U233	6.87E-14	1.89E-11	8.65E-11	1.82E-19	0.00E+00	1.05E-10
U234	1.59E-12	1.79E-10	8.18E-10	2.03E-18	0.00E+00	9.99E-10
U235	1.37E-08	2.95E-08	1.35E-07	1.98E-13	0.00E+00	1.78E-07
U238	2.84E-09	6.91E-07	3.14E-06	3.14E-15	0.00E+00	3.84E-06
ZR93	3.34E-07	2.08E-09	9.49E-09	0.00E+00	0.00E+00	3.46E-07
TOTALS:	1.13E-01	1.50E-03	6.70E-03	1.26E-10	0.00E+00	1.21E-01

* NOTE THAT INGESTION RISK IS A SOCIETAL RISK;
THE USER MAY WISH TO TREAT THIS VALUE SEPARATELY.

_REDUCED_DOSE_RATE_CASE_

EXPECTED RISK VALUES - OTHER

LINK	ECON $$	EARLY FATALITY
1	0.00E+00	0.00E+00
TOTAL	0.00E+00	0.00E+00

TOTAL EXPOSED POPULATION: INCIDENT-FREE

RAIL RURAL	1.09E+04	PERSONS
RAIL SUBURBAN	7.65E+04	PERSONS
RAIL URBAN	6.04E+04	PERSONS
TOTAL	1.48E+05	PERSONS

TOTAL EXPOSED POPULATION: ACCIDENT
(PERSONS UNDER PLUME FOOTPRINT FOR A SINGLE ACCIDENT)

RAIL RURAL	4.59E+03	PERSONS
RAIL SUBURBAN	5.48E+05	PERSONS
RAIL URBAN	2.64E+06	PERSONS

EOI
END OF RUN

TOTAL EXPOSED POPULATION: INCIDENT-FREE

RAIL RURAL	1.09E+04	PERSONS
RAIL SUBURBAN	7.65E+04	PERSONS
RAIL URBAN	6.04E+04	PERSONS
TOTAL	1.48E+05	PERSONS

TOTAL EXPOSED POPULATION: ACCIDENT
(PERSONS UNDER PLUME FOOTPRINT FOR A SINGLE ACCIDENT)

RAIL RURAL	4.59E+03	PERSONS
RAIL SUBURBAN	5.48E+05	PERSONS

RAIL URBAN 2.64E+06 PERSONS

EOI
END OF RUN

```
&& Edited Thu Feb 22 15:03:39 1996
&& _NOSEPVW.IN4_
TITLE _REDUCED_DOSE_RATE_CASE_
FORM UNIT
DIMEN 20 5 2 10 18
PARM 1 3 2 1 0
POPDEN     3.400    406.000   1959.100
PACKAGE
   LABGRP
       GRP1       GRP2
SHIPMENT
   LABISO
      AM241      AM243      CM244      CS137      NI63       NP237
      PU238      PU239      PU240      PU241      RU106      SM151
      SN126       SR90       TC99       U233       U234       U235
       U238       ZR93
NORMAL
   NMODE=2
       9.360E-01  5.500E-02  9.000E-03  6.437E+01  4.025E+01  2.416E+01
       5.000E+00  1.524E+02  2.000E+00  3.300E-02  1.000E+01  6.000E+01
       2.000E+00  1.000E+02  2.000E+01  4.000E+00  1.000E+02  1.000E+02
       3.000E+00  0.000E+00  1.000E+00  0.000E+00  1.000E+00  5.000E+00
       5.000E+00
ACCIDENT
   ARATMZ
       NMODE=2   6.620E-08    6.620E-08    6.620E-08
   SEVFRC
     NPOP=1
       NMODE=2
       9.94E-01  2.02E-03  3.34E-03  5.55E-04  1.71E-07
     NPOP=2
       NMODE=2
       9.94E-01  2.02E-03  3.34E-03  5.55E-04  1.71E-07
     NPOP=3
       NMODE=2
       9.94E-01  2.02E-03  3.34E-03  5.55E-04  1.71E-07
RELEASE
   RFRAC
     GROUP=1
       0.00E+00  0.00E+00  3.70E-05  3.70E-03  5.00E-02
     GROUP=2
       0.00E+00  0.00E+00  2.00E-06  2.00E-03  1.00E-03
   AERSOL
     DISP=2
       0.00E+00  0.00E+00  1.00E+00  1.00E+00  1.00E+00
     DISP=7
       0.00E+00  0.00E+00  1.00E+00  1.00E+00  1.00E+00
   RESP
     DISP=2
       0.00E+00  0.00E+00  5.00E-02  5.00E-02  5.00E-02
     DISP=7
       0.00E+00  0.00E+00  1.00E+00  1.00E+00  1.00E+00
DEFINE   U234
       8.93E+07  1.73E-03  2.43E-05  1.30E+08  2.60E+05  0.00E+00
```

```
      0.00E+00  1.00E-02  3.00E+00  8.20E+07  6.50E+04
DEFINE   NI63
      1.33E+05  1.71E-02  0.00E+00  3.00E+03  5.40E+02  0.00E+00
      0.00E+00  1.00E-02  2.00E+00  1.00E+05  5.30E+03
DEFINE  SN126
      3.65E+07  5.65E-02  7.70E-03  8.60E+04  1.70E+04  0.00E+00
      0.00E+00  1.00E-02  2.00E+00  4.10E+05  2.10E+05
DEFINE   ZR93
      5.59E+08  1.96E-02  0.00E+00  8.10E+04  1.60E+03  0.00E+00
      0.00E+00  1.00E-02  2.00E+00  4.50E+06  9.80E+04
EOF
ISOTOPES  2 146860     1.00    6.500   1.00   0.00  HLW
        AM241  7.08E-01      GRP2   2
        AM243  2.26E-04      GRP2   2
        CM244  8.04E-04      GRP2   2
        CS137  2.38E+02      GRP1   7
         NI63  1.83E+00      GRP2   2
        NP237  4.75E-04      GRP2   2
        PU238  7.35E-03      GRP2   2
        PU239  1.80E-01      GRP2   2
        PU240  4.56E-02      GRP2   2
        PU241  5.10E-01      GRP2   2
        RU106  2.58E-07      GRP1   7
        SM151  4.29E+00      GRP2   2
        SN126  4.27E-03      GRP2   2
         SR90  2.97E+02      GRP2   2
         TC99  2.19E-01      GRP2   2
         U233  8.24E-08      GRP2   2
         U234  1.44E-06      GRP2   2
         U235  1.40E-04      GRP2   2
         U238  3.28E-03      GRP2   2
         ZR93  2.68E-02      GRP2   2
DISTKM
        NMODE=2  2140.50
PKGSIZ
        HLW     5.00
EOF
EOI
```

Run A


```
RRRR    AAA   DDDD   TTTTT  RRRR    AAA   N   N
R   R  A   A  D   D    T    R   R  A   A  NN  N
R   R  A   A  D   D    T    R   R  A   A  N N N
RRRR   A   A  D   D    T    RRRR   A   A  N  NN
R R    AAAAA  D   D    T    R R    AAAAA  N   N
R  R   A   A  D   D    T    R  R   A   A  N   N
R   R  A   A  DDDD     T    R   R  A   A  N   N
```

```
    4
4   4
4   4
44444
    4
    4
    4
```

RADTRAN 4.0.18 VERSION DATE: SEPTEMBER 24, 1995

MODE DESCRIPTIONS

NUMBER	NAME	CHARACTERIZATION
1	TRUCK	LONG HAUL VEHICLE
2	RAIL	COMMERCIAL TRAIN
3	BARGE	INLAND VESSEL
4	SHIP	OPEN SEA VESSEL
5	CARGO AIR	CARGO AIRCRAFT
6	PASS AIR	PASSENGER AIRCRAFT
7	P-VAN	PASSENGER VAN
8	CVAN-T	COMMERCIAL VAN
9	CVAN-R	COMMERCIAL VAN
10	CVAN-CA	COMMERCIAL VAN

ECHO CHECK

```
&& Edited Thu Feb 22 14:57:21 1996
&& _NOSEPVW.IN4_
TITLE _NO_SEPARATIONS_VITRIFIED_WITHOUT_CS_AND_SR
FORM UNIT
DIMEN 20 5 2 10 18
PARM 1 3 2 1 0
POPDEN     3.400    406.000   1959.100
PACKAGE .
   LABGRP
       GRP1       GRP2
SHIPMENT
   LABISO
      AM241      AM243      CM244      CS137       NI63      NP237
      PU238      PU239      PU240      PU241      RU106      SM151
      SN126       SR90       TC99       U233       U234       U235
       U238       ZR93
NORMAL
   NMODE=2
       9.360E-01  5.500E-02  9.000E-03  6.437E+01  4.025E+01  2.416E+01
       5.000E+00  1.524E+02  2.000E+00  3.300E-02  1.000E+01  6.000E+01
       2.000E+00  1.000E+02  2.000E+01  4.000E+00  1.000E+02  1.000E+02
       3.000E+00  0.000E+00  1.000E+00  0.000E+00  1.000E+00  5.000E+00
       5.000E+00
ACCIDENT
   ARATMZ
       NMODE=2   6.620E-08    6.620E-08    6.620E-08
   SEVFRC
     NPOP=1
       NMODE=2
       9.94E-01  2.02E-03  3.34E-03  5.55E-04  1.71E-07
     NPOP=2
       NMODE=2
       9.94E-01  2.02E-03  3.34E-03  5.55E-04  1.71E-07
     NPOP=3
       NMODE=2
       9.94E-01  2.02E-03  3.34E-03  5.55E-04  1.71E-07
RELEASE
   RFRAC
     GROUP=1
       0.00E+00  0.00E+00  3.70E-05  3.70E-03  5.00E-02
     GROUP=2
       0.00E+00  0.00E+00  2.00E-06  2.00E-03  1.00E-03
   AERSOL
     DISP=2
       0.00E+00  0.00E+00  1.00E+00  1.00E+00  1.00E+00
     DISP=7
```

```
    0.00E+00  0.00E+00  1.00E+00  1.00E+00  1.00E+00
RESP
  DISP=2
    0.00E+00  0.00E+00  5.00E-02  5.00E-02  5.00E-02
  DISP=7
```

_NO_SEPARATIONS_VITRIFIED_WITHOUT_CS_AND_SR

```
      0.00E+00  0.00E+00  1.00E+00  1.00E+00  1.00E+00
DEFINE   U234
      8.93E+07  1.73E-03  2.43E-05  1.30E+08  2.60E+05  0.00E+00
      0.00E+00  1.00E-02  3.00E+00  8.20E+07  6.50E+04
DEFINE   NI63
      1.33E+05  1.71E-02  0.00E+00  3.00E+03  5.40E+02  0.00E+00
      0.00E+00  1.00E-02  2.00E+00  1.00E+05  5.30E+03
DEFINE  SN126
      3.65E+07  5.65E-02  7.70E-03  8.60E+04  1.70E+04  0.00E+00
      0.00E+00  1.00E-02  2.00E+00  4.10E+05  2.10E+05
DEFINE   ZR93
      5.59E+08  1.96E-02  0.00E+00  8.10E+04  1.60E+03  0.00E+00
      0.00E+00  1.00E-02  2.00E+00  4.50E+06  9.80E+04
EOF
ISOTOPES  2 146860     1.00   14.000   1.00   0.00  HLW
        AM241  7.08E-01      GRP2   2
        AM243  2.26E-04      GRP2   2
        CM244  8.04E-04      GRP2   2
        CS137  2.38E+02      GRP1   7
         NI63  1.83E+00      GRP2   2
        NP237  4.75E-04      GRP2   2
        PU238  7.35E-03      GRP2   2
        PU239  1.80E-01      GRP2   2
        PU240  4.56E-02      GRP2   2
        PU241  5.10E-01      GRP2   2
        RU106  2.58E-07      GRP1   7
        SM151  4.29E+00      GRP2   2
        SN126  4.27E-03      GRP2   2
         SR90  2.97E+02      GRP2   2
         TC99  2.19E-01      GRP2   2
         U233  8.24E-08      GRP2   2
         U234  1.44E-06      GRP2   2
         U235  1.40E-04      GRP2   2
         U238  3.28E-03      GRP2   2
         ZR93  2.68E-02      GRP2   2
DISTKM
        NMODE=2  2140.50
PKGSIZ
        HLW     5.00
EOF
```

_NO_SEPARATIONS_VITRIFIED_WITHOUT_CS_AND_SR

REGULATORY CHECKS

MODE 2 HAS BEEN REDESIGNATED AS EXCLUSIVE USE

FOR THE SHIPMENT OF HLW BY MODE 2
THE DOSE RATE AT 2 METERS COULD EXCEED 10 MR/HR
PPS*TI HAS BEEN RESET TO EQUAL 13.05

_NO_SEPARATIONS_VITRIFIED_WITHOUT_CS_AND_SR

CALCULATIONAL INFORMATION FOR MODE RAIL

FOR SEVERITY CATEGORY 4 AREA 1 HAS BEEN INTERDICTED.
THERE WILL BE NO 50 YEAR GROUNDSHINE DOSE AND NO INGESTION DOSE.

FOR SEVERITY CATEGORY 4 AREA 2 HAS BEEN INTERDICTED.
THERE WILL BE NO 50 YEAR GROUNDSHINE DOSE AND NO INGESTION DOSE.

FOR SEVERITY CATEGORY 4 AREA 3 HAS BEEN INTERDICTED.
THERE WILL BE NO 50 YEAR GROUNDSHINE DOSE AND NO INGESTION DOSE.

FOR SEVERITY CATEGORY 5 AREA 1 HAS BEEN INTERDICTED.
THERE WILL BE NO 50 YEAR GROUNDSHINE DOSE AND NO INGESTION DOSE.

FOR SEVERITY CATEGORY 5 AREA 2 HAS BEEN INTERDICTED.
THERE WILL BE NO 50 YEAR GROUNDSHINE DOSE AND NO INGESTION DOSE.

FOR SEVERITY CATEGORY 5 AREA 3 HAS BEEN INTERDICTED.
THERE WILL BE NO 50 YEAR GROUNDSHINE DOSE AND NO INGESTION DOSE.

FOR SEVERITY CATEGORY 5 AREA 4 HAS BEEN INTERDICTED.
THERE WILL BE NO 50 YEAR GROUNDSHINE DOSE AND NO INGESTION DOSE.

FOR SEVERITY CATEGORY 5 AREA 5 HAS BEEN INTERDICTED.
THERE WILL BE NO 50 YEAR GROUNDSHINE DOSE AND NO INGESTION DOSE.

FOR SEVERITY CATEGORY 5 AREA 6 HAS BEEN INTERDICTED.
THERE WILL BE NO 50 YEAR GROUNDSHINE DOSE AND NO INGESTION DOSE.

_NO_SEPARATIONS_VITRIFIED_WITHOUT_CS_AND_SR

INCIDENT-FREE SUMMARY
******** **** *******

INCIDENT-FREE POPULATION EXPOSURE IN PERSON-REM

	PASSENGR	CREW	HANDLERS	OFF LINK	ON LINK	STOPS	STORAGE	TOTALS
LINK 1	0.00E+00	6.43E+04	3.15E+04	5.01E+02	6.55E+01	2.52E+03	8.87E+02	9.97E+04
TOTALS:	0.00E+00	6.43E+04	3.15E+04	5.01E+02	6.55E+01	2.52E+03	8.87E+02	9.97E+04

MAXIMUM INDIVIDUAL IN-TRANSIT DOSE

LINK 1 8.47E-02 REM

_NO_SEPARATIONS_VITRIFIED_WITHOUT_CS_AND_SR

EXPECTED VALUES OF POPULATION RISK IN PERSON REM

HLW	GROUND	INHALED	RESUSPD	CLOUDSH	*INGESTION	TOTAL
AM241	1.41E-05	4.00E-04	1.82E-03	1.24E-10	0.00E+00	2.24E-03
AM243	8.03E-09	1.28E-07	5.83E-07	1.06E-13	0.00E+00	7.19E-07
CM244	4.24E-10	2.39E-07	1.03E-06	6.21E-16	0.00E+00	1.27E-06
CS137	1.13E-01	2.85E-04	1.26E-03	0.00E+00	0.00E+00	1.14E-01
NI63	1.91E-05	5.26E-09	2.39E-08	0.00E+00	0.00E+00	1.91E-05
NP237	1.04E-08	2.55E-07	1.16E-06	1.00E-13	0.00E+00	1.43E-06
PU238	7.13E-09	3.73E-06	1.68E-05	5.97E-15	0.00E+00	2.06E-05
PU239	9.12E-08	9.83E-05	4.49E-04	1.36E-13	0.00E+00	5.47E-04
PU240	5.01E-08	2.49E-05	1.14E-04	3.63E-14	0.00E+00	1.39E-04
PU241	3.49E-10	4.84E-06	2.06E-05	0.00E+00	0.00E+00	2.54E-05
RU106	3.52E-12	7.74E-12	1.77E-11	0.00E+00	0.00E+00	2.89E-11
SM151	3.09E-08	1.36E-07	6.12E-07	3.61E-14	0.00E+00	7.78E-07
SN126	1.54E-07	3.52E-10	1.61E-09	1.91E-12	0.00E+00	1.56E-07
SR90	0.00E+00	6.83E-04	3.01E-03	0.00E+00	0.00E+00	3.69E-03
TC99	0.00E+00	2.94E-09	1.34E-08	1.07E-15	0.00E+00	1.63E-08
U233	6.87E-14	1.89E-11	8.65E-11	1.82E-19	0.00E+00	1.05E-10
U234	1.59E-12	1.79E-10	8.18E-10	2.03E-18	0.00E+00	9.99E-10
U235	1.37E-08	2.95E-08	1.35E-07	1.98E-13	0.00E+00	1.78E-07
U238	2.84E-09	6.91E-07	3.14E-06	3.14E-15	0.00E+00	3.84E-06
ZR93	3.34E-07	2.08E-09	9.49E-09	0.00E+00	0.00E+00	3.46E-07
TOTALS:	1.13E-01	1.50E-03	6.70E-03	1.26E-10	0.00E+00	1.21E-01

* NOTE THAT INGESTION RISK IS A SOCIETAL RISK;
THE USER MAY WISH TO TREAT THIS VALUE SEPARATELY.

_NO_SEPARATIONS_VITRIFIED_WITHOUT_CS_AND_SR

EXPECTED RISK VALUES - OTHER

LINK	ECON $$	EARLY FATALITY
1	0.00E+00	0.00E+00
TOTAL	0.00E+00	0.00E+00

TWRS EIS
CALCULATION COVER SHEET

DISCIPLINE & TITLE Alex Nazarali
Risk Assessment Lead

ORIGINATOR Loretta Crow LLC DATE March 7, 1996

REVISION NO. 0

OBJECTIVE To check the accuracy of the tables (in Appendix D of Rev. C) which had been wordprocessed from Excel tables (the original source documents).

METHODOLOGY For those tables with a "total" indicated, the components that comprise the total were added together. Any differences between the recalculated total and the total appearing in Rev. C were indicated and the total figure appearing in Rev. C was included in the line following the recalculated figure. Any differences that were significant enough to impact the analysis (i.e., orders of magnitude) were research by referring back to the original Excel tables, the figure(s) appearing in Rev. C were then reconciled to the Excel calculations, and this was noted on the recalculation sheet.

ASSUMPTIONS

1. Minor discrepancies may occur because of rounding numbers.
2. The more rounded numbers that are added together, the greater the potential that discrepancies will occur and that these discrepancies will be larger.
3. Discrepancies resulting from adding rounded numbers should not exceed a difference of a magnitude (exponent) of 1.
4. Discrepancies exceeding a difference of a magnitude of 1 indicate a potential error in data transcription.

Loretta Crow 3/8/96
SIGNATURE/DATE

A. H. Nazarali 3/11/96
CHECKED/DATE

CALCULATION & RESULTS
ATTACHED

TABLE D.4.1.6		
EMISSIONS	HAZARD/MEI WKR	RISK/MEI WKR
Carbon Monoxide		
Nitrogen Oxide		
1,3-Butadiene		5.70E-07
2-Hexanone		
2-Pentanone		
Acetone	4.72E-03	
Acetonitrile	1.62E-02	
Benzene	6.36E-03	1.34E-07
Heptane		
Methyl N-amyl Ketone	1.17E-03	
N-hexane	5.09E-04	
Nonane		
Octane		
Toluene	2.01E-05	
Ammonia	4.79E-02	
Phosphoric Acid Tributyl Ester		
Carbon Tetrachloride	3.94E-08	5.10E-13
Ethyl Butyl Ketone	3.27E-09	
Methyl Chloride		8.97E-15
Tetrahydrofuran		
TOTAL	7.69E-02	7.04E-07
TOTAL SHOWN IN REV C	*7.70E-02*	*7.05E-07*

TABLE D.4.1.7		
EMISSIONS	HAZARD/MEI WKR	RISK/MEI WKR
Carbon Monoxide		
Nitrogen Oxide		
1,3-Butadiene		2.46E-07
2-Hexanone		
2-Pentanone		
Acetone	2.04E-03	
Acetonitrile	7.03E-03	
Benzene	2.75E-03	
Heptane		5.81E-08
Methyl N-amyl Ketone	5.05E-04	
N-hexane	2.20E-04	
Nonane		
Octane		
Toluene	8.71E-06	
Ammonia	2.07E-02	
Phosphoric Acid Tributyl Ester		
Carbon Tetrachloride	1.71E-08	2.21E-13
Ethyl Butyl Ketone	1.42E-09	
Methyl Chloride		3.88E-15
Tetrahydrofuran		
TOTAL	3.33E-02	3.04E-07
TOTAL SHOWN IN REV C		*3.05E-07*

TABLE D.4.1.8		
EMISSIONS	HAZARD/MEI WKR	RISK/MEI WKR
Acetone	1.13E-06	
Ammonia	3.65E-06	
n-Butyl Alcohol	8.48E-06	
2-Hexanone		
Methyl Isobutyl Ketone	3.34E-07	
TOTAL	1.36E-05	

TABLE D.4.1.9		
EMISSIONS	HAZARD/MEI WKR	RISK/MEI WKR
Carbon Monoxide		
Nitrogen Oxide		
1,3-Butadiene		7.35E-11
2-Hexanone		
2-Pentanone		
Acetone	1.08E-06	
Acetonitrile	3.70E-06	
Benzene	1.45E-06	1.73E-11
Heptane		
Methyl N-amyl Ketone	2.65E-07	
N-hexane	1.16E-07	
Nonane		
Octane		
Toluene	4.58E-09	
Ammonia	1.09E-05	
Phosphoric Acid Tributyl Ester		
Carbon Tetrachloride	8.97E-12	6.57E-17
Ethyl Butyl Ketone	7.45E-13	
Methyl Chloride		1.16E-18
Tetrahydrofuran		
TOTAL	1.75E-05	9.08E-11
TABLE D.4.1.10		
EMISSIONS	HAZARD/MEI WKR	RISK/MEI WKR
Acetone	5.61E-08	
Ammonia	1.82E-07	
n-Butyl Alcohol	4.22E-07	
2-Hexanone		
Methyl Isobutyl Ketone	1.66E-08	
TOTAL	6.77E-07	
TOTAL SHOWN IN REV C	*6.76E-07*	
TABLE D.4.2.6		
EMISSIONS	HAZARD/MEI WKR	RISK/MEI WKR
Carbon Monoxide		
Nitrogen Oxide		
1,3-Butadiene		5.71E-07
2-Hexanone		
2-Pentanone		
Acetone	4.73E-03	
Acetonitrile	1.63E-02	
Benzene	6.37E-03	1.34E-07
Heptane		
Methyl N-amyl Ketone	1.17E-03	
N-hexane	5.10E-04	
Nonane		
Octane		
Toluene	2.02E-05	
Ammonia	4.80E-02	
Phosphoric Acid Tributyl Ester		
Carbon Tetrachloride	3.95E-08	5.11E-13
Ethyl Butyl Ketone	3.28E-09	
Methyl Chloride		8.97E-15
Tetrahydrofuran		
TOTAL	7.71E-02	7.05E-07

TABLE D.4.2.7				
EMISSIONS		HAZARD/MEI WKR		RISK/MEI WKR
Carbon Monoxide				
Nitrogen Oxide				
1,3-Butadiene				2.26E-07
2-Hexanone				
2-Pentanone				
Acetone		5.61E-03		
Acetonitrile		1.93E-02		
Benzene		7.55E-03		5.32E-08
Heptane				
Methyl N-amyl Ketone		1.38E-03		
N-hexane		6.02E-04		
Nonane				
Octane				
Toluene		2.38E-05		
Ammonia		5.73E-04		
Phosphoric Acid Tributyl Ester				
TOTAL		3.50E-02		2.79E-07
TABLE D.4.2.8				
EMISSIONS		HAZARD/MEI WKR		RISK/MEI WKR
Carbon Monoxide				
Nitrogen Oxide				
1,3-Butadiene				2.47E-07
2-Hexanone				
2-Pentanone				
Acetone		2.04E-03		
Acetonitrile		7.03E-03		
Benzene		2.75E-03		5.81E-08
Heptane				
Methyl N-amyl Ketone		5.05E-04		
N-hexane		2.20E-04		
Nonane				
Octane				
Toluene		8.71E-06		
Ammonia		2.07E-02		
Phosphoric Acid Tributyl Ester				
Carbon Tetrachloride		1.71E-08		2.21E-13
Ethyl Butyl Ketone		1.42E-09		
Methyl Chloride				3.88E-15
Tetrahydrofuran				
TOTAL		3.33E-02		3.05E-07

TABLE D.4.2.9		
EMISSIONS	HAZARD/MEI WKR	RISK/MEI WKR
Carbon Monoxide		
Nitrogen Oxide		
1,3-Butadiene		9.78E-08
2-Hexanone		
2-Pentanone		
Acetone	2.42E-03	
Acetonitrile	8.34E-03	
Benzene	3.26E-02	2.30E-08
Heptane		
Methyl N-amyl Ketone	5.98E-04	
N-hexane	2.60E-04	
Nonane		
Octane		
Toluene	1.03E-05	
Ammonia	2.48E-04	
Phosphoric Acid Tributyl Ester		
TOTAL	4.45E-02	1.21E-07
TOTAL IN REV. C	*1.51E-02*	
TABLE D.4.2.10		
EMISSIONS	HAZARD/MEI WKR	RISK/MEI WKR
Acetone	1.13E-06	
Ammonia	3.65E-06	
n-Butyl Alcohol	8.48E-06	
2-Hexanone		
Methyl Isobutyl Ketone	3.34E-07	
TOTAL	1.36E-05	
TABLE D.4.2.11		
EMISSIONS	HAZARD/MEI WKR	RISK/MEI WKR
Acetone	1.50E-05	
Ammonia	4.88E-05	
n-Butyl Alcohol	1.13E-04	
2-Hexanone		
Methyl Isobutyl Ketone	4.45E-06	
TOTAL	1.81E-04	

TABLE D.4.2.12		
EMISSIONS	HAZARD/MEI WKR	RISK/MEI WKR
Carbon Monoxide		
Nitrogen Oxide		
1,3-Butadiene		7.35E-11
2-Hexanone		
2-Pentanone		
Acetone	1.08E-06	
Acetonitrile	3.70E-06	
Benzene	1.45E-06	1.73E-11
Heptane		
Methyl N-amyl Ketone	2.65E-07	
N-hexane	1.16E-07	
Nonane		
Octane		
Toluene	4.58E-09	
Ammonia	1.09E-05	
Phosphoric Acid Tributyl Ester		
Carbon Tetrachloride	8.97E-12	6.57E-17
Ethyl Butyl Ketone	7.45E-13	
Methyl Chloride		1.16E-16
Tetrahydrofuran		
TOTAL	1.75E-05	9.08E-11

TABLE D.4.2.13		
EMISSIONS	HAZARD/MEI WKR	RISK/MEI WKR
Carbon Monoxide		
Nitrogen Oxide		
1,3-Butadiene		2.91E-11
2-Hexanone		
2-Pentanone		
Acetone	1.28E-06	
Acetonitrile	4.39E-06	
Benzene	1.72E-06	6.84E-12
Heptane		
Methyl N-amyl Ketone	3.15E-07	
N-hexane	1.37E-07	
Nonane		
Octane		
Toluene	5.40E-09	
Ammonia	1.30E-07	
Phosphoric Acid Tributyl Ester		
TOTAL	7.98E-06	3.59E-11
TOTAL IN REV. C	*7.96E-06*	*3.60E-11*

TABLE D.4.2.14		
EMISSIONS	HAZARD/MEI WKR	RISK/MEI WKR
Acetone	5.61E-08	
Ammonia	1.82E-07	
n-Butyl Alcohol	4.22E-07	
2-Hexanone		
Methyl Isobutyl Ketone	1.66E-08	
TOTAL	6.77E-07	
TOTAL IN REV. C	*6.76E-07*	

TABLE D.4.2.15				
EMISSIONS		HAZARD/MEI WKR		RISK/MEI WKR
Acetone		7.46E-07		
Ammonia		2.43E-06		
n-Butyl Alcohol		5.61E-06		
2-Hexanone				
Methyl Isobutyl Ketone		2.21E-07		
TOTAL		9.01E-06		
TOTAL IN REV. C		*9.00E-06*		
TABLE D.4.3.6				
EMISSIONS		HAZARD/MEI WKR		RISK/MEI WKR
Carbon Monoxide				
Nitrogen Oxide				
1,3-Butadiene				3.61E-07
2-Hexanone				
2-Pentanone				
Acetone		4.73E-03		
Acetonitrile		1.63E-03		
Benzene		6.37E-03		8.51E-08
Heptane				
Methyl N-amyl Ketone		1.17E-03		
N-hexane		5.10E-04		
Nonane				
Octane				
Toluene		2.02E-05		
Ammonia		4.80E-02		
Phosphoric Acid Tributyl Ester				
Carbon Tetrachloride		3.95E-08		3.23E-13
Ethyl Butyl Ketone		3.28E-09		
Methyl Chloride				5.68E-15
Tetrahydrofuran				
TOTAL		6.24E-02		4.46E-07
TOTAL IN REV. C		*7.71E-02*		

TABLE D.4.3.7		
EMISSIONS	HAZARD/MEI WKR	RISK/MEI WKR
Carbon Monoxide		
Nitrogen Oxide		
1,3-Butadiene		3.53E-09
2-Hexanone		
2-Pentanone		
Acetone	1.10E-04	
Acetonitrile	3.78E-04	
Benzene	1.48E-04	8.33E-10
Heptane		
Methyl N-amyl Ketone	2.71E-05	
N-hexane	1.18E-05	
Nonane		
Octane		
Toluene	4.68E-07	
Ammonia	1.11E-03	
Phosphoric Acid Tributyl Ester		
Carbon Tetrachloride	9.16E-10	3.16E-15
Ethyl Butyl Ketone	7.60E-11	
Methyl Chloride		5.56E-17
Tetrahydrofuran		
TOTAL	1.79E-03	4.36E-09
TOTAL IN REV. C		*4.37E-09*
TABLE D.4.3.8		
EMISSIONS	HAZARD/MEI WKR	RISK/MEI WKR
Carbon Monoxide		
Nitrogen Oxide		
1,3-Butadiene		1.56E-07
2-Hexanone		
2-Pentanone		
Acetone	2.04E-03	
Acetonitrile	7.03E-03	
Benzene	2.75E-03	3.68E-08
Heptane		
Methyl N-amyl Ketone	5.05E-04	
N-hexane	2.20E-04	
Nonane		
Octane		
Toluene	8.71E-06	
Ammonia	2.07E-02	
Phosphoric Acid Tributyl Ester		
Carbon Tetrachloride	1.71E-08	1.40E-13
Ethyl Butyl Ketone	1.42E-09	
Methyl Chloride		2.45E-15
Tetrahydrofuran		
TOTAL	3.33E-02	1.93E-07

TABLE D.4.3.9		
EMISSIONS	HAZARD/MEI WKR	RISK/MEI WKR
Carbon Monoxide		
Nitrogen Oxide		
1,3-Butadiene		1.53E-09
2-Hexanone		
2-Pentanone		
Acetone	4.74E-05	
Acetonitrile	1.63E-04	
Benzene	6.39E-05	3.60E-10
Heptane		
Methyl N-amyl Ketone	1.17E-05	
N-hexane	5.11E-06	
Nonane		
Octane		
Toluene	2.02E-07	
Ammonia	4.81E-04	
Phosphoric Acid Tributyl Ester		
Carbon Tetrachloride	3.96E-10	1.37E-15
Ethyl Butyl Ketone	3.29E-11	
Methyl Chloride		2.40E-17
Tetrahydrofuran		
TOTAL	7.72E-04	1.89E-09
TOTAL IN REV. C	*7.73E-02*	
(Document revised to correct total)		
TABLE D.4.3.10		
EMISSIONS	HAZARD/MEI WKR	RISK/MEI WKR
Acetone	1.13E-06	
Ammonia	3.65E-06	
n-Butyl Alcohol	8.48E-06	
2-Hexanone		
Methyl Isobutyl Ketone	3.34E-07	
TOTAL	1.36E-05	
TABLE D.4.3.11		
EMISSIONS	HAZARD/MEI WKR	RISK/MEI WKR
Acetone	1.50E-05	
Ammonia	4.88E-05	
n-Butyl Alcohol	1.13E-04	
2-Hexanone		
Methyl Isobutyl Ketone	4.45E-06	
TOTAL	1.81E-04	

TABLE D.4.3.12		
EMISSIONS	HAZARD/MEI WKR	RISK/MEI WKR
Carbon Monoxide		
Nitrogen Oxide		
1,3-Butadiene		4.65E-11
2-Hexanone		
2-Pentanone		
Acetone	1.08E-06	
Acetonitrile	3.70E-06	
Benzene	1.45E-06	1.10E-11
Heptane		
Methyl N-amyl Ketone	2.65E-07	
N-hexane	1.16E-07	
Nonane		
Octane		
Toluene	4.58E-09	
Ammonia	1.09E-05	
Phosphoric Acid Tributyl Ester		
Carbon Tetrachloride	8.97E-12	4.16E-17
Ethyl Butyl Ketone	7.45E-13	
Methyl Chloride		7.32E-19
Tetrahydrofuran		
TOTAL	1.75E-05	5.75E-11

TABLE D.4.3.13		
EMISSIONS	HAZARD/MEI WKR	RISK/MEI WKR
Carbon Monoxide		
Nitrogen Oxide		
1,3-Butadiene		4.13E-13
2-Hexanone		
2-Pentanone		
Acetone	2.27E-08	
Acetonitrile	7.80E-08	
Benzene	3.05E-08	9.74E-14
Heptane		
Methyl N-amyl Ketone	5.60E-09	
N-hexane	2.44E-09	
Nonane		
Octane		
Toluene	9.67E-11	
Ammonia	2.30E-07	
Phosphoric Acid Tributyl Ester		
Carbon Tetrachloride	1.89E-13	3.70E-19
Ethyl Butyl Ketone	1.57E-14	
Methyl Chloride		6.50E-21
Tetrahydrofuran		
TOTAL	3.69E-07	5.10E-13
TOTAL IN REV. C	*3.70E-07*	*5.11E-13*

TABLE D.4.3.14		
EMISSIONS	HAZARD/MEI WKR	RISK/MEI WKR
Acetone	5.61E-08	
Ammonia	1.82E-07	
n-Butyl Alcohol	4.22E-07	
2-Hexanone		
Methyl Isobutyl Ketone	1.66E-08	
TOTAL	6.77E-07	
TOTAL IN REV. C	*6.76E-07*	
TABLE D.4.3.15		
EMISSIONS	HAZARD/MEI WKR	RISK/MEI WKR
Acetone	7.46E-07	
Ammonia	2.43E-06	
n-Butyl Alcohol	5.61E-06	
2-Hexanone		
Methyl Isobutyl Ketone	2.21E-07	
TOTAL	9.01E-06	
TOTAL IN REV. C	*9.00E-06*	
TABLE D.4.4.6		
EMISSIONS	HAZARD/MEI WKR	RISK/MEI WKR
Carbon Monoxide		
Nitrogen Oxide		
1,3-Butadiene		3.61E-07
2-Hexanone		
2-Pentanone		
Acetone	4.73E-03	
Acetonitrile	1.63E-03	
Benzene	6.37E-03	8.51E-08
Heptane		
Methyl N-amyl Ketone	1.17E-03	
N-hexane	5.10E-04	
Nonane		
Octane		
Toluene	2.02E-05	
Ammonia	4.80E-02	
Phosphoric Acid Tributyl Ester		
Carbon Tetrachloride	3.95E-08	3.23E-13
Ethyl Butyl Ketone	3.28E-09	
Methyl Chloride		5.68E-15
Tetrahydrofuran		
TOTAL	6.24E-02	4.46E-07
TOTAL IN REV. C	*7.71E-02*	

TABLE D.4.4.7		
EMISSIONS	HAZARD/MEI WKR	RISK/MEI WKR
Carbon Monoxide		
Nitrogen Oxide		
1,3-Butadiene		3.98E-09
2-Hexanone		
2-Pentanone		
Acetone	1.10E-04	
Acetonitrile	3.78E-04	
Benzene	1.48E-04	9.37E-10
Heptane		
Methyl N-amyl Ketone	2.71E-05	
N-hexane	1.18E-05	
Nonane		
Octane		
Toluene	4.68E-07	
Ammonia	1.11E-03	
Phosphoric Acid Tributyl Ester		
Carbon Tetrachloride	9.16E-10	3.56E-15
Ethyl Butyl Ketone	7.60E-11	
Methyl Chloride		6.25E-17
Tetrahydrofuran		
TOTAL	1.79E-03	4.92E-09
TOTAL IN REV. C		*4.91E-09*

TABLE D.4.4.8		
EMISSIONS	HAZARD/MEI WKR	RISK/MEI WKR
Carbon Monoxide		
Nitrogen Oxide		
1,3-Butadiene		1.56E-07
2-Hexanone		
2-Pentanone		
Acetone	2.04E-03	
Acetonitrile	7.03E-03	
Benzene	2.75E-03	3.68E-08
Heptane		
Methyl N-amyl Ketone	5.05E-04	
N-hexane	2.20E-04	
Nonane		
Octane		
Toluene	8.71E-06	
Ammonia	2.07E-02	
Phosphoric Acid Tributyl Ester		
Carbon Tetrachloride	1.71E-08	1.40E-13
Ethyl Butyl Ketone	1.42E-09	
Methyl Chloride		2.45E-15
Tetrahydrofuran		
TOTAL	3.33E-02	1.93E-07

TABLE D.4.4.9		
EMISSIONS	HAZARD/MEI WKR	RISK/MEI WKR
Carbon Monoxide		
Nitrogen Oxide		
1,3-Butadiene		1.72E-09
2-Hexanone		
2-Pentanone		
Acetone	4.74E-05	
Acetonitrile	1.63E-04	
Benzene	6.39E-05	
Heptane		4.05E-10
Methyl N-amyl Ketone	1.17E-05	
N-hexane	5.11E-06	
Nonane		
Octane		
Toluene	2.02E-07	
Ammonia	4.81E-04	
Phosphoric Acid Tributyl Ester		
Carbon Tetrachloride	3.96E-10	1.54E-15
Ethyl Butyl Ketone	3.29E-11	
Methyl Chloride		2.70E-17
Tetrahydrofuran		
TOTAL	7.72E-04	2.13E-09
TOTAL IN REV. C	*7.73E-04*	*2.12E-09*
TABLE D.4.4.10		
EMISSIONS	HAZARD/MEI WKR	RISK/MEI WKR
Acetone	1.13E-06	
Ammonia	3.65E-06	
n-Butyl Alcohol	8.48E-06	
2-Hexanone		
Methyl Isobutyl Ketone	3.34E-07	
TOTAL	1.36E-05	
TABLE D.4.4.11		
EMISSIONS	HAZARD/MEI WKR	RISK/MEI WKR
Acetone	1.50E-05	
Ammonia	4.88E-05	
n-Butyl Alcohol	1.13E-04	
2-Hexanone		
Methyl Isobutyl Ketone	4.45E-06	
TOTAL	1.81E-04	

TABLE D.4.4.13		
EMISSIONS	HAZARD/MEI WKR	RISK/MEI WKR
Carbon Monoxide		
Nitrogen Oxide		
1,3-Butadiene		4.65E-11
2-Hexanone		
2-Pentanone		
Acetone	1.08E-06	
Acetonitrile	3.70E-06	
Benzene	1.45E-06	1.10E-11
Heptane		
Methyl N-amyl Ketone	2.65E-07	
N-hexane	1.16E-07	
Nonane		
Octane		
Toluene	4.58E-09	
Ammonia	1.09E-05	
Phosphoric Acid Tributyl Ester		
Carbon Tetrachloride	8.97E-12	4.16E-17
Ethyl Butyl Ketone	7.45E-13	
Methyl Chloride		7.32E-19
Tetrahydrofuran		
TOTAL	1.75E-05	5.75E-11

TABLE D.4.4.14		
EMISSIONS	HAZARD/MEI WKR	RISK/MEI WKR
Carbon Monoxide		
Nitrogen Oxide		
1,3-Butadiene		4.65E-13
2-Hexanone		
2-Pentanone		
Acetone	2.27E-08	
Acetonitrile	7.80E-08	
Benzene	3.05E-08	1.10E-13
Heptane		
Methyl N-amyl Ketone	5.60E-09	
N-hexane	2.44E-09	
Nonane		
Octane		
Toluene	9.67E-11	
Ammonia	2.30E-07	
Phosphoric Acid Tributyl Ester		
Carbon Tetrachloride	1.89E-13	4.16E-19
Ethyl Butyl Ketone	1.57E-14	
Methyl Chloride		7.31E-21
Tetrahydrofuran		
TOTAL	3.69E-07	5.75E-13
TOTAL IN REV. C	*3.70E-07*	*5.74E-13*

TABLE D.4.4.15		
EMISSIONS	HAZARD/MEI WKR	RISK/MEI WKR
Acetone	5.61E-08	
Ammonia	1.82E-07	
n-Butyl Alcohol	4.22E-07	
2-Hexanone		
Methyl Isobutyl Ketone	1.66E-08	
TOTAL	6.77E-07	
TOTAL IN REV. C	*6.76E-07*	

TABLE D.4.4.16		
EMISSIONS	HAZARD/MEI WKR	RISK/MEI WKR
Acetone	7.46E-07	
Ammonia	2.43E-06	
n-Butyl Alcohol	5.61E-06	
2-Hexanone		
Methyl Isobutyl Ketone	2.21E-07	
TOTAL	9.01E-06	
TOTAL IN REV. C	*9.00E-06*	

TABLE D.4.5.6		
EMISSIONS	HAZARD/MEI WKR	RISK/MEI WKR
Carbon Monoxide		
Nitrogen Oxide		
1,3-Butadiene		5.52E-07
2-Hexanone		
2-Pentanone		
Acetone	4.73E-03	
Acetonitrile	1.63E-03	
Benzene	6.37E-03	1.30E-07
Heptane		
Methyl N-amyl Ketone	1.17E-03	
N-hexane	5.10E-04	
Nonane		
Octane		
Toluene	2.20E-05	
Ammonia	4.80E-02	
Phosphoric Acid Tributyl Ester		
Carbon Tetrachloride	3.95E-08	4.93E-13
Ethyl Butyl Ketone	3.28E-09	
Methyl Chloride		8.67E-15
Tetrahydrofuran		
TOTAL	6.24E-02	6.82E-07
TOTAL IN REV. C	*7.71E-02*	

+ Due to Transportation Risk

TABLE D.4.5.7		
EMISSIONS	HAZARD/MEI WKR	RISK/MEI WKR
Carbon Monoxide		
Nitrogen Oxide		
1,3-Butadiene		1.48E-06
2-Hexanone		
2-Pentanone		
Acetone	1.42E-02	
Acetonitrile	4.88E-02	
Benzene	1.91E-02	3.50E-07
Heptane		
Methyl N-amyl Ketone	3.50E-03	
N-hexane	1.53E-03	
Nonane		
Octane		
Toluene	6.05E-05	
Ammonia	1.44E-01	
Phosphoric Acid Tributyl Ester		
Carbon Tetrachloride	1.18E-07	1.33E-12
Ethyl Butyl Ketone	9.83E-09	
Methyl Chloride		2.33E-14
Tetrahydrofuran		
TOTAL	2.31E-01	1.83E-06

TABLE D.4.5.8		
EMISSIONS	HAZARD/MEI WKR	RISK/MEI WKR
Carbon Monoxide		
Nitrogen Oxide		
1,3-Butadiene		2.38E-07
2-Hexanone		
2-Pentanone		
Acetone	2.04E-03	
Acetonitrile	7.03E-03	
Benzene	2.75E-03	5.62E-08
Heptane	2.75E-03	
Methyl N-amyl Ketone		
N-hexane	5.05E-04	
Nonane	2.20E-04	
Octane		
Toluene		
Ammonia	8.71E-06	
Phosphoric Acid Tributyl Ester	2.07E-02	
Carbon Tetrachloride		2.13E-13
Ethyl Butyl Ketone	1.71E-08	
Methyl Chloride	1.42E-09	3.75E-15
Tetrahydrofuran		
TOTAL	3.60E-02	2.94E-07
TOTAL IN REV. C	*3.33E-02*	
TABLE D.4.5.9		
EMISSIONS	HAZARD/MEI WKR	RISK/MEI WKR
Acetone	1.13E-06	
Ammonia	3.65E-06	
n-Butyl Alcohol	8.48E-06	
2-Hexanone		
Methyl Isobutyl Ketone	3.34E-07	
TOTAL	1.36E-05	
TABLE D.4.5.10		
EMISSIONS	HAZARD/MEI WKR	RISK/MEI WKR
Carbon Monoxide		
Nitrogen Oxide		
1,3-Butadiene		6.41E-07
2-Hexanone		
2-Pentanone		
Acetone	6.13E-03	
Acetonitrile	2.11E-02	
Benzene	8.26E-03	1.51E-07
Heptane		
Methyl N-amyl Ketone	1.51E-03	
N-hexane	6.61E-04	
Nonane		
Octane		
Toluene	2.61E-05	
Ammonia	6.22E-02	
Phosphoric Acid Tributyl Ester		
Carbon Tetrachloride	5.12E-08	5.73E-13
Ethyl Butyl Ketone	4.25E-09	
Methyl Chloride		1.01E-14
Tetrahydrofuran		
TOTAL	9.99E-02	7.92E-07

TABLE D.4.5.11		
EMISSIONS	HAZARD/MEI WKR	RISK/MEI WKR
Aluminum		
Arsenic		4.52E-10
Boron	6.34E-10	
Barium	1.88E-10	
Beryllium		7.74E-14
Bismuth		
Cadmium		3.73E-12
Cerium		
Chromium (+3)	2.47E-06	
Copper		
Manganese		
Molybdenum		
Nickel		
Lead		
Silver		
Uranium		
Vanadium		
Zinc		
TOTAL	2.47E-06	4.56E-10

TABLE D.4.5.12		
EMISSIONS	HAZARD/MEI WKR	RISK/MEI WKR
Carbon Monoxide		
Nitrogen Oxide		
1,3-Butadiene		7.10E-11
2-Hexanone		
2-Pentanone		
Acetone	1.08E-06	
Acetonitrile	3.70E-06	
Benzene	1.45E-06	1.67E-11
Heptane		
Methyl N-amyl Ketone	2.65E-07	
N-hexane	1.16E-07	
Nonane		
Octane		
Toluene	4.58E-09	
Ammonia	1.09E-05	
Phosphoric Acid Tributyl Ester		
Carbon Tetrachloride	8.97E-12	6.36E-17
Ethyl Butyl Ketone	7.45E-13	
Methyl Chloride		1.12E-18
Tetrahydrofuran		
TOTAL	1.75E-05	8.77E-11
TOTAL IN REV. C		*8.78E-11*

TABLE D.4.5.13		
EMISSIONS	HAZARD/MEI WKR	RISK/MEI WKR
Acetone	5.61E-08	
Ammonia	1.82E-07	
n-Butyl Alcohol	4.22E-07	
2-Hexanone		
Methyl Isobutyl Ketone	1.66E-08	
TOTAL	6.77E-07	
TOTAL IN REV. C	*6.76E-07*	

TABLE D.4.5.14		
EMISSIONS	HAZARD/MEI WKR	RISK/MEI WKR
Carbon Monoxide		
Nitrogen Oxide		
1,3-Butadiene		1.91E-10
2-Hexanone		
2-Pentanone		
Acetone	3.23E-06	
Acetonitrile	1.11E-05	
Benzene	4.35E-06	4.50E-11
Heptane		
Methyl N-amyl Ketone	7.96E-07	
N-hexane	3.48E-07	
Nonane		
Octane		
Toluene	1.38E-08	
Ammonia	3.27E-05	
Phosphoric Acid Tributyl Ester		
Carbon Tetrachloride	2.69E-11	1.71E-16
Ethyl Butyl Ketone	2.24E-12	
Methyl Chloride		3.00E-18
Tetrahydrofuran		
TOTAL	5.25E-05	2.36E-10
TOTAL IN REV. C	*5.26E-05*	
TABLE D.4.5.15		
EMISSIONS	HAZARD/MEI WKR	RISK/MEI WKR
Aluminum		
Arsenic		2.18E-10
Boron	5.36E-10	
Barium	1.59E-10	
Beryllium		3.72E-14
Bismuth		
Cadmium		1.80E-12
Cerium		
Chromium (+3)	2.09E-06	
Copper		
Manganese		
Molybdenum		
Nickel		
Lead		
Silver		
Uranium		
Vanadium		
Zinc		
TOTAL	2.09E-06	2.20E-10
TOTAL IN REV. C		*2.19E-10*

TABLE D.4.6.6		
EMISSIONS	HAZARD/MEI WKR	RISK/MEI WKR
Carbon Monoxide		
Nitrogen Oxide		
1,3-Butadiene		4.56E-07
2-Hexanone		
2-Pentanone		
Acetone	4.73E-03	
Acetonitrile	1.63E-03	
Benzene	6.37E-03	1.08E-07
Heptane		
Methyl N-amyl Ketone	1.17E-03	
N-hexane	5.10E-04	
Nonane		
Octane		
Toluene	2.02E-05	
Ammonia	4.80E-02	
Phosphoric Acid Tributyl Ester		
Carbon Tetrachloride	3.95E-08	4.08E-13
Ethyl Butyl Ketone	3.28E-09	
Methyl Chloride		7.17E-15
Tetrahydrofuran		
TOTAL	6.24E-02	5.64E-07
TOTAL IN REV. C	*7.71E-02*	

TABLE D.4.6.7		
EMISSIONS	HAZARD/MEI WKR	RISK/MEI WKR
Carbon Monoxide		
Nitrogen Oxide		
1,3-Butadiene		1.08E-06
2-Hexanone		
2-Pentanone		
Acetone	1.42E-02	
Acetonitrile	4.88E-02	
Benzene	1.91E-02	2.55E-07
Heptane		
Methyl N-amyl Ketone	3.50E-03	
N-hexane	1.53E-03	
Nonane		
Octane		
Toluene	6.05E-05	
Ammonia	1.44E-01	
Phosphoric Acid Tributyl Ester		
Carbon Tetrachloride	1.18E-07	9.69E-13
Ethyl Butyl Ketone	9.83E-09	
Methyl Chloride		1.70E-14
Tetrahydrofuran		
TOTAL	2.31E-01	1.34E-06

TABLE D.4.6.8		
EMISSIONS	HAZARD/MEI WKR	RISK/MEI WKR
Carbon Monoxide		
Nitrogen Oxide		
1,3-Butadiene		1.97E-07
2-Hexanone		
2-Pentanone		
Acetone	2.04E-03	
Acetonitrile	7.03E-03	
Benzene	2.75E-03	4.65E-08
Heptane		
Methyl N-amyl Ketone	5.05E-04	
N-hexane	2.02E-04	
Nonane		
Octane		
Toluene	8.71E-06	
Ammonia	2.07E-02	
Phosphoric Acid Tributyl Ester		
Carbon Tetrachloride	1.71E-08	1.76E-13
Ethyl Butyl Ketone	1.42E-09	
Methyl Chloride		3.10E-15
Tetrahydrofuran		
TOTAL	3.32E-02	2.44E-07
TOTAL IN REV. C	*3.33E-02*	
TABLE D.4.6.9		
EMISSIONS	HAZARD/MEI WKR	RISK/MEI WKR
Acetone	1.13E-06	
Ammonia	3.65E-06	
n-Butyl Alcohol	8.48E-06	
2-Hexanone		
Methyl Isobutyl Ketone	3.34E-07	
TOTAL	1.36E-05	
TABLE D.4.6.10		
EMISSIONS	HAZARD/MEI WKR	RISK/MEI WKR
Carbon Monoxide		
Nitrogen Oxide		
1,3-Butadiene		4.68E-07
2-Hexanone		
2-Pentanone		
Acetone	6.13E-03	
Acetonitrile	2.11E-02	
Benzene	8.26E-03	1.10E-07
Heptane		
Methyl N-amyl Ketone	1.51E-03	
N-hexane	6.61E-04	
Nonane		
Octane		
Toluene	2.61E-05	
Ammonia	6.22E-02	
Phosphoric Acid Tributyl Ester		
Carbon Tetrachloride	5.12E-08	4.19E-13
Ethyl Butyl Ketone	4.25E-09	
Methyl Chloride		7.36E-15
Tetrahydrofuran		
TOTAL	9.99E-02	5.78E-07

TABLE D.4.6.11		
EMISSIONS	HAZARD/MEI WKR	RISK/MEI WKR
Aluminum		
Antimony		
Arsenic		1.58E-10
Boron	2.32E-08	
Barium	1.79E-10	
Beryllium		2.22E-10
Bismuth		
Cadmium		1.36E-16
Cerium		
Chromium (+3)	3.13E-06	
Copper	3.04E-11	
Manganese		
Molybdenum		
Nickel		
Lead		
Silver		
Uranium		
Vanadium		
Zinc		
TOTAL	3.15E-06	3.80E-10
TOTAL IN REV. C	*3.16E-06*	
TABLE D.4.6.12.		
EMISSIONS	HAZARD/MEI WKR	RISK/MEI WKR
Carbon Monoxide		
Nitrogen Oxide		
1,3-Butadiene		5.88E-11
2-Hexanone		
2-Pentanone		
Acetone	1.08E-06	
Acetonitrile	3.70E-06	
Benzene	1.45E-06	1.39E-11
Heptane		
Methyl N-amyl Ketone	2.65E-07	
N-hexane	1.16E-07	
Nonane		
Octane		
Toluene	4.58E-09	
Ammonia	1.09E-05	
Phosphoric Acid Tributyl Ester		
Carbon Tetrachloride	8.97E-12	5.26E-17
Ethyl Butyl Ketone	7.45E-13	
Methyl Chloride		9.24E-19
Tetrahydrofuran		
TOTAL	1.75E-05	7.27E-11
TOTAL IN REV. C		*7.26E-11*
TABLE D.4.6.13		
EMISSIONS	HAZARD/MEI WKR	RISK/MEI WKR
Acetone	5.61E-08	
Ammonia	1.82E-07	
n-Butyl Alcohol	4.22E-07	
2-Hexanone		
Methyl Isobutyl Ketone	1.66E-08	
TOTAL	6.77E-07	
TOTAL IN REV. C	*6.76E-07*	

TABLE D.4.6.14				
EMISSIONS		HAZARD/MEI WKR		RISK/MEI WKR
Carbon Monoxide				
Nitrogen Oxide				
1,3-Butadiene				1.40E-10
2-Hexanone				
2-Pentanone				
Acetone		3.23E-06		
Acetonitrile		1.11E-05		
Benzene		4.35E-06		3.29E-11
Heptane				
Methyl N-amyl Ketone		7.96E-07		
N-hexane		3.48E-07		
Nonane				
Octane				
Toluene		1.38E-08		
Ammonia		3.27E-05		
Phosphoric Acid Tributyl Ester				
Carbon Tetrachloride		2.69E-11		1.25E-16
Ethyl Butyl Ketone		2.24E-12		
Methyl Chloride				2.20E-18
Tetrahydrofuran				
TOTAL		5.25E-05		1.73E-10
TOTAL IN REV. C		*5.26E-05*		
TABLE D.4.6.15				
EMISSIONS		HAZARD/MEI WKR		RISK/MEI WKR
Aluminum				
Antimony				
Arsenic				7.63E-11
Boron		1.96E-08		
Barium		1.52E-10		
Beryllium				1.07E-10
Bismuth				
Cadmium				6.57E-17
Cerium				
Chromium (+3)		2.65E-06		
Copper		2.57E-11		
Manganese				
Molybdenum				
Nickel				
Lead				
Silver				
Uranium				
Vanadium				
Zinc				
TOTAL		2.67E-06		1.83E-10

TABLE D.4.7.6		
EMISSIONS	HAZARD/MEI WKR	RISK/MEI WKR
Carbon Monoxide		
Nitrogen Oxide		
1,3-Butadiene		5.71E-07
2-Hexanone		
2-Pentanone		
Acetone	4.73E-03	
Acetonitrile	1.63E-03	
Benzene	6.37E-03	1.34E-07
Heptane		
Methyl N-amyl Ketone	1.17E-03	
N-hexane	5.10E-04	
Nonane		
Octane		
Toluene	2.02E-05	
Ammonia	4.80E-02	
Phosphoric Acid Tributyl Ester		
Carbon Tetrachloride	3.95E-08	5.11E-13
Ethyl Butyl Ketone	3.28E-09	
Methyl Chloride		8.97E-15
Tetrahydrofuran		
TOTAL	6.24E-02	7.05E-07
TOTAL SHOWN IN REV C	*7.71E-02*	

TABLE D.4.7.7		
EMISSIONS	HAZARD/MEI WKR	RISK/MEI WKR
Carbon Monoxide		
Nitrogen Oxide		
1,3-Butadiene		1.31E-06
2-Hexanone		
2-Pentanone		
Acetone	1.42E-02	
Acetonitrile	4.88E-02	
Benzene	1.91E-02	3.09E-07
Heptane		
Methyl N-amyl Ketone	3.50E-03	
N-hexane	1.53E-03	
Nonane		
Octane		
Toluene	6.05E-05	
Ammonia	1.44E-01	
Phosphoric Acid Tributyl Ester		
Carbon Tetrachloride	1.18E-07	1.17E-12
Ethyl Butyl Ketone	9.83E-09	
Methyl Chloride		2.06E-14
Tetrahydrofuran		
TOTAL	2.31E-01	1.62E-06
TOTAL SHOWN IN REV C		

TABLE D.4.7.8		
EMISSIONS	HAZARD/MEI WKR	RISK/MEI WKR
Carbon Monoxide		
Nitrogen Oxide		
1,3-Butadiene		2.46E-07
2-Hexanone		
2-Pentanone		
Acetone	2.04E-03	
Acetonitrile	7.03E-03	
Benzene	2.75E-03	5.81E-08
Heptane		
Methyl N-amyl Ketone	5.05E-04	
N-hexane	2.20E-04	
Nonane		
Octane		
Toluene	8.71E-06	
Ammonia	2.07E-02	
Phosphoric Acid Tributyl Ester		
Carbon Tetrachloride	1.71E-08	2.21E-13
Ethyl Butyl Ketone	1.42E-09	
Methyl Chloride		3.88E-15
Tetrahydrofuran		
TOTAL	3.33E-02	3.04E-07
TOTAL SHOWN IN REV C		*3.05E-07*
TABLE D.4.7.9		
EMISSIONS	HAZARD/MEI WKR	RISK/MEI WKR
Acetone	1.13E-06	
Ammonia	3.65E-06	
n-Butyl Alcohol	8.48E-06	
2-Hexanone		
Methyl Isobutyl Ketone	3.34E-07	
TOTAL	1.36E-05	
TABLE D.4.7.10		
EMISSIONS	HAZARD/MEI WKR	RISK/MEI WKR
Carbon Monoxide		
Nitrogen Oxide		
1,3-Butadiene		5.67E-07
2-Hexanone		
2-Pentanone		
Acetone	6.13E-03	
Acetonitrile	2.11E-02	
Benzene	8.26E-03	1.34E-07
Heptane		
Methyl N-amyl Ketone	1.51E-03	
N-hexane	6.61E-04	
Nonane		
Octane		
Toluene	2.61E-05	
Ammonia	6.22E-02	
Phosphoric Acid Tributyl Ester		
Carbon Tetrachloride	5.12E-08	5.07E-13
Ethyl Butyl Ketone	4.25E-09	
Methyl Chloride		8.91E-15
Tetrahydrofuran		
TOTAL	9.99E-02	7.01E-07
TOTAL SHOWN IN REV C		*7.00E-07*

TABLE D.4.7.11		
EMISSIONS	HAZARD/MEI WKR	RISK/MEI WKR
Aluminum		
Arsenic		3.96E-10
Boron	6.34E-10	
Barium	1.88E-10	
Beryllium		6.77E-14
Bismuth		
Cadmium		3.26E-12
Cerium		
Chromium	2.47E-06	
Copper		
Manganese		
Molybdenum		
Nickel		
Lead		
Silver		
Uranium		
Vanadium		
Zinc		
TOTAL	2.47E-06	3.99E-10

TABLE D.4.7.12		
EMISSIONS	HAZARD/MEI WKR	RISK/MEI WKR
Carbon Monoxide		
Nitrogen Oxide		
1,3-Butadiene		7.35E-11
2-Hexanone		
2-Pentanone		
Acetone	1.08E-06	
Acetonitrile	3.70E-06	
Benzene	1.45E-06	1.73E-11
Heptane		
Methyl N-amyl Ketone	2.65E-07	
N-hexane	1.16E-07	
Nonane		
Octane		
Toluene	4.58E-09	
Ammonia	1.09E-05	
Phosphoric Acid Tributyl Ester		
Carbon Tetrachloride	8.97E-12	6.57E-17
Ethyl Butyl Ketone	7.45E-13	
Methyl Chloride		1.16E-18
Tetrahydrofuran		
TOTAL	1.75E-05	9.08E-11

TABLE D.4.7.13		
EMISSIONS	HAZARD/MEI WKR	RISK/MEI WKR
Acetone	5.61E-08	
Ammonia	1.82E-07	
n-Butyl Alcohol	4.22E-07	
2-Hexanone		
Methyl Isobutyl Ketone	1.66E-08	
TOTAL	6.77E-07	
TOTAL SHOWN IN REV C	*6.76E-07*	

TABLE D.4.7.14		
EMISSIONS	HAZARD/MEI WKR	RISK/MEI WKR
Carbon Monoxide		
Nitrogen Oxide		
1,3-Butadiene		1.69E-10
2-Hexanone		
2-Pentanone		
Acetone	3.23E-06	
Acetonitrile	1.11E-05	
Benzene	4.35E-06	3.98E-11
Heptane		
Methyl N-amyl Ketone	7.96E-07	
N-hexane	3.48E-07	
Nonane		
Octane		
Toluene	1.38E-08	
Ammonia	3.27E-05	
Phosphoric Acid Tributyl Ester		
Carbon Tetrachloride	2.69E-11	1.51E-16
Ethyl Butyl Ketone	2.24E-12	
Methyl Chloride		3.66E-18
Tetrahydrofuran		
TOTAL	5.25E-05	2.09E-10
TOTAL SHOWN IN REV C	*5.26E-05*	
TABLE D.4.7.15		
EMISSIONS	HAZARD/MEI WKR	RISK/MEI WKR
Aluminum		
Arsenic		1.90E-10
Boron	5.36E-10	
Barium	1.59E-10	
Beryllium		3.26E-14
Bismuth		
Cadmium		1.57E-12
Cerium		
Chromium (+3)	2.09E-06	
Copper		
Manganese		
Molybdenum		
Nickel		
Lead		
Silver		
Uranium		
Vanadium		
Zinc		
TOTAL	2.09E-06	1.92E-10

TABLE D.4.8.6		
EMISSIONS	HAZARD/MEI WKR	RISK/MEI WKR
Carbon Monoxide		
Nitrogen Oxide		
1,3-Butadiene		5.52E-07
2-Hexanone		
2-Pentanone		
Acetone	4.73E-03	
Acetonitrile	1.63E-03	
Benzene	6.37E-03	1.30E-07
Heptane		
Methyl N-amyl Ketone	1.17E-03	
N-hexane	5.10E-04	
Nonane		
Octane		
Toluene	2.02E-05	
Ammonia	4.80E-02	
Phosphoric Acid Tributyl Ester		
Carbon Tetrachloride	3.95E-08	4.93E-13
Ethyl Butyl Ketone	3.28E-09	
Methyl Chloride		8.67E-15
Tetrahydrofuran		
TOTAL	6.24E-02	6.82E-07
TOTAL SHOWN IN REV C	*7.71E-02*	
TABLE D.4.8.7		
EMISSIONS	HAZARD/MEI WKR	RISK/MEI WKR
Carbon Monoxide		
Nitrogen Oxide		
1,3-Butadiene		1.48E-06
2-Hexanone		
2-Pentanone		
Acetone	1.42E-02	
Acetonitrile	4.88E-02	
Benzene	1.91E-02	3.50E-07
Heptane		
Methyl N-amyl Ketone	3.50E-03	
N-hexane	1.53E-03	
Nonane		
Octane		
Toluene	6.05E-05	
Ammonia	1.44E-01	
Phosphoric Acid Tributyl Ester		
Carbon Tetrachloride	1.18E-07	1.33E-12
Ethyl Butyl Ketone	9.83E-09	
Methyl Chloride		2.33E-14
Tetrahydrofuran		
TOTAL	2.31E-01	1.83E-06

TABLE D.4.8.8		
EMISSIONS	HAZARD/MEI WKR	RISK/MEI WKR
Carbon Monoxide		
Nitrogen Oxide		
1,3-Butadiene		3.53E-09
2-Hexanone		
2-Pentanone		
Acetone	1.10E-04	
Acetonitrile	3.78E-04	
Benzene	1.48E-04	8.33E-10
Heptane		
Methyl N-amyl Ketone	2.71E-05	
N-hexane	1.18E-05	
Nonane		
Octane		
Toluene	4.68E-07	
Ammonia	1.11E-03	
Phosphoric Acid Tributyl Ester		
Carbon Tetrachloride	9.16E-10	3.16E-15
Ethyl Butyl Ketone	7.60E-11	
Methyl Chloride		5.56E-17
Tetrahydrofuran		
TOTAL	1.79E-03	4.36E-09
TOTAL SHOWN IN REV C		*4.37E-09*
TABLE D.4.8.9		
EMISSIONS	HAZARD/MEI WKR	RISK/MEI WKR
Carbon Monoxide		
Nitrogen Oxide		
1,3-Butadiene		2.38E-07
2-Hexanone		
2-Pentanone		
Acetone	2.04E-03	
Acetonitrile	7.03E-03	
Benzene	2.75E-03	5.62E-08
Heptane		
Methyl N-amyl Ketone	5.05E-04	
N-hexane	2.20E-04	
Nonane		
Octane		
Toluene	8.71E-06	
Ammonia	2.07E-02	
Phosphoric Acid Tributyl Ester		
Carbon Tetrachloride	1.71E-08	2.13E-13
Ethyl Butyl Ketone	1.42E-09	
Methyl Chloride		3.75E-15
Tetrahydrofuran		
TOTAL	3.33E-02	2.94E-07
TABLE D.4.8.10		
EMISSIONS	HAZARD/MEI WKR	RISK/MEI WKR
Acetone	1.13E-06	
Ammonia	3.65E-06	
n-Butyl Alcohol	8.48E-06	
2-Hexanone		
Methyl Isobutyl Ketone	3.34E-07	
TOTAL	1.36E-05	

TABLE D.4.8.11		
EMISSIONS	HAZARD/MEI WKR	RISK/MEI WKR
Acetone	1.50E-05	
Ammonia	4.88E-05	
n-Butyl Alcohol	1.13E-04	
2-Hexanone		
Methyl Isobutyl Ketone	4.45E-06	
TOTAL	1.81E-04	

TABLE D.4.8.12		
EMISSIONS	HAZARD/MEI WKR	RISK/MEI WKR
Carbon Monoxide		
Nitrogen Oxide		
1,3-Butadiene		6.41E-07
2-Hexanone		
2-Pentanone		
Acetone	6.13E-03	
Acetonitrile	2.11E-02	
Benzene	8.26E-03	1.51E-07
Heptane		
Methyl N-amyl Ketone	1.51E-03	
N-hexane	6.61E-04	
Nonane		
Octane		
Toluene	2.61E-05	
Ammonia	6.22E-02	
Phosphoric Acid Tributyl Ester		
Carbon Tetrachloride	5.12E-08	5.73E-13
Ethyl Butyl Ketone	4.25E-09	
Methyl Chloride		1.01E-14
Tetrahydrofuran		
TOTAL	9.99E-02	7.92E-07

TABLE D.4.8.13		
EMISSIONS	HAZARD/MEI WKR	RISK/MEI WKR
Carbon Monoxide		
Nitrogen Oxide		
1,3-Butadiene		1.53E-09
2-Hexanone		
2-Pentanone		
Acetone	4.74E-05	
Acetonitrile	1.63E-04	
Benzene	6.39E-05	3.60E-10
Heptane		
Methyl N-amyl Ketone	1.17E-05	
N-hexane	5.11E-06	
Nonane		
Octane		
Toluene	2.02E-07	
Ammonia	4.81E-04	
Phosphoric Acid Tributyl Ester		
Carbon Tetrachloride	3.96E-10	1.37E-15
Ethyl Butyl Ketone	3.29E-11	
Methyl Chloride		2.40E-17
Tetrahydrofuran		
TOTAL	7.72E-04	1.89E-09
TOTAL SHOWN IN REV C	*7.73E-04*	

TABLE D.4.8.14		
EMISSIONS	HAZARD/MEI WKR	RISK/MEI WKR
Aluminum		
Arsenic		4.52E-10
Boron	6.34E-10	
Barium	1.88E-10	
Beryllium		7.74E-14
Bismuth		
Cadmium		3.73E-12
Cerium		
Chromium (+3)	2.47E-06	
Copper		
Manganese		
Molybdenum		
Nickel		
Lead		
Silver		
Uranium		
Vanadium		
Zinc		
TOTAL	2.47E-06	4.56E-10

TABLE D.4.8.15		
EMISSIONS	HAZARD/MEI WKR	RISK/MEI WKR
Carbon Monoxide		
Nitrogen Oxide		
1,3-Butadiene		7.10E-11
2-Hexanone		
2-Pentanone		
Acetone	1.08E-06	
Acetonitrile	3.70E-06	
Benzene	1.45E-06	1.67E-11
Heptane		
Methyl N-amyl Ketone	2.65E-07	
N-hexane	1.16E-07	
Nonane		
Octane		
Toluene	4.58E-09	
Ammonia	1.09E-05	
Phosphoric Acid Tributyl Ester		
Carbon Tetrachloride	8.97E-12	6.36E-17
Ethyl Butyl Ketone	7.45E-13	
Methyl Chloride		1.12E-18
Tetrahydrofuran		
TOTAL	1.75E-05	8.77E-11
TOTAL SHOWN IN REV C		*8.78E-11*

TABLE D.4.8.16		
EMISSIONS	HAZARD/MEI WKR	RISK/MEI WKR
Acetone	5.61E-08	
Ammonia	1.82E-07	
n-Butyl Alcohol	4.22E-07	
2-Hexanone		
Methyl Isobutyl Ketone	1.66E-08	
TOTAL	6.77E-07	
TOTAL SHOWN IN REV C	*6.76E-07*	

TABLE D.4.8.17		
EMISSIONS	HAZARD/MEI WKR	RISK/MEI WKR
Acetone	7.46E-07	
Ammonia	2.43E-06	
n-Butyl Alcohol	5.61E-06	
2-Hexanone		
Methyl Isobutyl Ketone	2.21E-07	
TOTAL	9.01E-06	
TOTAL SHOWN IN REV C	*9.00E-06*	
TABLE D.4.8.18		
EMISSIONS	HAZARD/MEI WKR	RISK/MEI WKR
Carbon Monoxide		
Nitrogen Oxide		
1,3-Butadiene		1.91E-10
2-Hexanone		
2-Pentanone		
Acetone	3.23E-06	
Acetonitrile	1.11E-05	
Benzene	4.35E-06	4.50E-11
Heptane		
Methyl N-amyl Ketone	7.96E-07	
N-hexane	3.48E-07	
Nonane		
Octane		
Toluene	1.38E-08	
Ammonia	3.27E-05	
Phosphoric Acid Tributyl Ester		
Carbon Tetrachloride	2.69E-11	1.71E-16
Ethyl Butyl Ketone	2.24E-12	
Methyl Chloride		3.00E-18
Tetrahydrofuran		
TOTAL	5.25E-05	2.36E-10
TOTAL SHOWN IN REV C	*5.26E-05*	

TABLE D.4.8.19		
EMISSIONS	HAZARD/MEI WKR	RISK/MEI WKR
Carbon Monoxide		
Nitrogen Oxide		
1,3-Butadiene		4.13E-13
2-Hexanone		
2-Pentanone		
Acetone	2.27E-08	
Acetonitrile	7.80E-08	
Benzene	3.05E-08	9.74E-14
Heptane		
Methyl N-amyl Ketone	5.60E-09	
N-hexane	2.44E-09	
Nonane		
Octane		
Toluene	9.67E-11	
Ammonia	2.30E-07	
Phosphoric Acid Tributyl Ester		
Carbon Tetrachloride	1.89E-13	3.70E-19
Ethyl Butyl Ketone	1.57E-14	
Methyl Chloride		6.50E-21
Tetrahydrofuran		
TOTAL	3.69E-07	5.10E-13
TOTAL SHOWN IN REV C	*3.70E-07*	*5.11E-13*
TABLE D.4.8.20		
EMISSIONS	HAZARD/MEI WKR	RISK/MEI WKR
Aluminum		
Arsenic		2.18E-10
Boron	5.36E-10	
Barium	1.59E-10	
Beryllium		3.72E-14
Bismuth		
Cadmium		1.80E-12
Cerium		
Chromium (+3)	2.09E-06	
Copper		
Manganese		
Molybdenum		
Nickel		
Lead		
Silver		
Uranium		
Vanadium		
Zinc		
TOTAL	2.09E-06	2.20E-10
TOTAL SHOWN IN REV C		*2.19E-10*

TABLE D.4.9.6		
EMISSIONS	HAZARD/MEI WKR	RISK/MEI WKR
Carbon Monoxide		
Nitrogen Oxide		
1,3-Butadiene		1.90E-07
2-Hexanone		
2-Pentanone		
Acetone	4.73E-03	
Acetonitrile	1.63E-03	
Benzene	6.37E-03	4.49E-08
Heptane		
Methyl N-amyl Ketone	1.17E-03	
N-hexane	5.10E-04	
Nonane		
Octane		
Toluene	2.02E-05	
Ammonia	4.80E-02	
Phosphoric Acid Tributyl Ester		
Carbon Tetrachloride	3.95E-08	1.70E-13
Ethyl Butyl Ketone	3.28E-09	
Methyl Chloride		2.99E-15
Tetrahydrofuran		
TOTAL	6.24E-02	2.35E-07
TOTAL SHOWN IN REV C	*7.71E-02*	

TABLE D.4.9.7		
EMISSIONS	HAZARD/MEI WKR	RISK/MEI WKR
Carbon Monoxide		
Nitrogen Oxide		
1,3-Butadiene		2.26E-07
2-Hexanone		
2-Pentanone		
Acetone	5.61E-03	
Acetonitrile	1.93E-02	
Benzene	7.55E-03	5.32E-08
Heptane		
Methyl N-amyl Ketone	1.38E-03	
N-hexane	6.02E-04	
Nonane		
Octane		
Toluene	2.38E-05	
Ammonia	5.73E-04	
Phosphoric Acid Tributyl Ester		
TOTAL	3.50E-02	2.79E-07

TABLE D.4.9.8		
EMISSIONS	HAZARD/MEI WKR	RISK/MEI WKR
Carbon Monoxide		
Nitrogen Oxide		
1,3-Butadiene		8.23E-08
2-Hexanone		
2-Pentanone		
Acetone	2.04E-03	
Acetonitrile	7.03E-03	
Benzene	2.75E-03	1.94E-08
Heptane		
Methyl N-amyl Ketone	5.05E-04	
N-hexane	2.20E-04	
Nonane		
Octane		
Toluene	8.71E-06	
Ammonia	2.07E-02	
Phosphoric Acid Tributyl Ester		
Carbon Tetrachloride	1.71E-08	7.36E-14
Ethyl Butyl Ketone	1.42E-09	
Methyl Chloride		1.29E-15
Tetrahydrofuran		
TOTAL	3.33E-02	1.02E-07

TABLE D.4.9.9		
EMISSIONS	HAZARD/MEI WKR	RISK/MEI WKR
Acetone	1.13E-06	
Ammonia	3.65E-06	
n-Butyl Alcohol	8.48E-06	
2-Hexanone		
Methyl Isobutyl Ketone	3.34E-07	
TOTAL	1.36E-05	

TABLE D.4.9.10		
EMISSIONS	HAZARD/MEI WKR	RISK/MEI WKR
Carbon Monoxide		
Nitrogen Oxide		
1,3-Butadiene		9.78E-08
2-Hexanone		
2-Pentanone		
Acetone	2.42E-03	
Acetonitrile	8.34E-03	
Benzene	3.26E-03	2.30E-08
Heptane		
Methyl N-amyl Ketone	5.98E-04	
N-hexane	2.60E-04	
Nonane		
Octane		
Toluene	1.03E-05	
Ammonia	2.48E-04	
Phosphoric Acid Tributyl Ester		
TOTAL	1.51E-02	1.21E-07

TABLE D.4.9.11		
EMISSIONS	HAZARD/MEI WKR	RISK/MEI WKR
Aluminum		
Arsenic		1.89E-10
Boron	6.34E-10	
Barium	1.88E-10	
Beryllium		3.23E-14
Bismuth		
Cadmium		1.56E-12
Cerium		
Chromium (+3)	2.47E-06	
Copper		
Manganese		
Molybdenum		
Nickel		
Lead		
Silver		
Uranium		
Vanadium		
Zinc		
TOTAL	2.47E-06	1.91E-10
TOTAL SHOWN IN REV C		*1.90E-10*
TABLE D.4.9.12		
EMISSIONS	HAZARD/MEI WKR	RISK/MEI WKR
Carbon Monoxide		
Nitrogen Oxide		
1,3-Butadiene		2.45E-11
2-Hexanone		
2-Pentanone		
Acetone	1.08E-06	
Acetonitrile	3.70E-06	
Benzene	1.45E-06	5.77E-12
Heptane		
Methyl N-amyl Ketone	2.65E-07	
N-hexane	1.16E-07	
Nonane		
Octane		
Toluene	4.58E-09	
Ammonia	1.09E-05	
Phosphoric Acid Tributyl Ester		
Carbon Tetrachloride	8.97E-12	2.19E-17
Ethyl Butyl Ketone	7.45E-13	
Methyl Chloride		3.85E-19
Tetrahydrofuran		
TOTAL	1.75E-05	3.03E-11
TABLE D.4.9.13		
EMISSIONS	HAZARD/MEI WKR	RISK/MEI WKR
Acetone	5.61E-08	
Ammonia	1.82E-07	
n-Butyl Alcohol	4.22E-07	
2-Hexanone		
Methyl Isobutyl Ketone	1.66E-08	
TOTAL	6.77E-07	
TOTAL SHOWN IN REV C	*6.76E-07*	

TABLE D.4.9.14		
EMISSIONS	HAZARD/MEI WKR	RISK/MEI WKR
Carbon Monoxide		
Nitrogen Oxide		
1,3-Butadiene		2.91E-11
2-Hexanone		
2-Pentanone		
Acetone	1.28E-06	
Acetonitrile	4.39E-06	
Benzene	1.72E-06	6.84E-12
Heptane		
Methyl N-amyl Ketone	3.15E-07	
N-hexane	1.37E-07	
Nonane		
Octane		
Toluene	5.40E-09	
Ammonia	1.30E-07	
Phosphoric Acid Tributyl Ester		
TOTAL	7.98E-06	3.59E-11
TOTAL SHOWN IN REV C	*7.96E-06*	*3.60E-11*

TABLE D.4.9.15		
EMISSIONS	HAZARD/MEI WKR	RISK/MEI WKR
Aluminum		
Arsenic		9.07E-11
Boron	5.36E-10	
Barium	1.59E-10	
Beryllium		1.55E-14
Bismuth		
Cadmium		7.48E-13
Cerium		
Chromium (+3)	2.09E-06	
Copper		
Manganese		
Molybdenum		
Nickel		
Lead		
Silver		
Uranium		
Vanadium		
Zinc		
TOTAL	2.09E-06	9.15E-11
TOTAL SHOWN IN REV C		*9.14E-11*

TABLE D.4.9.21		
EMISSIONS	HAZARD/MEI WKR	RISK/MEI WKR
Carbon Monoxide		
Nitrogen Oxide		
1,3-Butadiene		3.52E-07
2-Hexanone		
2-Pentanone		
Acetone	4.73E-03	
Acetonitrile	1.63E-03	
Benzene	6.37E-03	1.30E-07
Heptane		
Methyl N-amyl Ketone	1.17E-03	
N-hexane	5.10E-04	
Nonane		
Octane		
Toluene	2.02E-05	
Ammonia	4.80E-02	
Phosphoric Acid Tributyl Ester		
Carbon Tetrachloride	3.95E-08	4.93E-13
Ethyl Butyl Ketone	3.28E-09	
Methyl Chloride		8.67E-15
Tetrahydrofuran		
TOTAL	6.24E-02	4.82E-07
TOTAL SHOWN IN REV C	*7.71E-02*	*6.82E-07*
TABLE D.4.9.22		
EMISSIONS	HAZARD/MEI WKR	RISK/MEI WKR
Carbon Monoxide		
Nitrogen Oxide		
1,3-Butadiene		1.48E-06
2-Hexanone		
2-Pentanone		
Acetone	1.42E-02	
Acetonitrile	4.88E-02	
Benzene	1.91E-02	3.50E-07
Heptane		
Methyl N-amyl Ketone	3.50E-03	
N-hexane	1.53E-03	
Nonane		
Octane		
Toluene	6.05E-05	
Ammonia	1.44E-01	
Phosphoric Acid Tributyl Ester		
Carbon Tetrachloride	1.18E-07	1.33E-12
Ethyl Butyl Ketone	9.83E-09	
Methyl Chloride		2.33E-14
Tetrahydrofuran		
TOTAL	2.31E-01	1.83E-06

TABLE D.4.9.23		
EMISSIONS	HAZARD/MEI WKR	RISK/MEI WKR
Carbon Monoxide		
Nitrogen Oxide		
1,3-Butadiene		2.38E-07
2-Hexanone		
2-Pentanone		
Acetone	2.04E-03	
Acetonitrile	7.03E-03	
Benzene	2.75E-03	5.62E-08
Heptane		
Methyl N-amyl Ketone	5.05E-04	
N-hexane	2.20E-04	
Nonane		
Octane		
Toluene	8.71E-06	
Ammonia	2.07E-02	
Phosphoric Acid Tributyl Ester		
Carbon Tetrachloride	1.71E-08	2.13E-13
Ethyl Butyl Ketone	1.42E-09	
Methyl Chloride		3.75E-15
Tetrahydrofuran		
TOTAL	3.33E-02	2.94E-07

TABLE D.4.9.24		
EMISSIONS	HAZARD/MEI WKR	RISK/MEI WKR
Acetone	1.13E-06	
Ammonia	3.65E-06	
n-Butyl Alcohol	8.48E-06	
2-Hexanone		
Methyl Isobutyl Ketone	3.34E-07	
TOTAL	1.36E-05	

TABLE D.4.9.25		
EMISSIONS	HAZARD/MEI WKR	RISK/MEI WKR
Carbon Monoxide		
Nitrogen Oxide		
1,3-Butadiene		6.41E-07
2-Hexanone		
2-Pentanone		
Acetone	6.13E-03	
Acetonitrile	2.11E-02	
Benzene	8.26E-03	1.51E-07
Heptane		
Methyl N-amyl Ketone	1.51E-03	
N-hexane	6.61E-04	
Nonane		
Octane		
Toluene	2.61E-05	
Ammonia	6.22E-02	
Phosphoric Acid Tributyl Ester		
Carbon Tetrachloride	5.12E-08	5.73E-13
Ethyl Butyl Ketone	4.25E-09	
Methyl Chloride		1.01E-14
Tetrahydrofuran		
TOTAL	9.99E-02	7.92E-07

TABLE D.4.9.26		
EMISSIONS	HAZARD/MEI WKR	RISK/MEI WKR
Aluminum		
Arsenic		1.89E-10
Boron	6.34E-10	
Barium	1.88E-10	
Beryllium		3.23E-14
Bismuth		
Cadmium		1.56E-12
Cerium		
Chromium (+3)	2.47E-06	
Copper		
Manganese		
Molybdenum		
Nickel		
Lead		
Silver		
Uranium		
Vanadium		
Zinc		
TOTAL	2.47E-06	1.91E-10

TABLE D.4.9.27		
EMISSIONS	HAZARD/MEI WKR	RISK/MEI WKR
Aluminum		
Arsenic		4.52E-10
Boron	6.34E-10	
Barium	1.88E-10	
Beryllium		7.74E-14
Bismuth		
Cadmium		3.73E-12
Cerium		
Chromium (+3)	2.47E-06	
Copper		
Manganese		
Molybdenum		
Nickel		
Lead		
Silver		
Uranium		
Vanadium		
Zinc		
TOTAL	2.47E-06	4.56E-10

TABLE D.4.9.28		
EMISSIONS	HAZARD/MEI WKR	RISK/MEI WKR
Carbon Monoxide		
Nitrogen Oxide		
1,3-Butadiene		7.10E-11
2-Hexanone		
2-Pentanone		
Acetone	1.08E-06	
Acetonitrile	3.70E-06	
Benzene	1.45E-06	1.67E-11
Heptane		
Methyl N-amyl Ketone	2.65E-07	
N-hexane	1.16E-07	
Nonane		
Octane		
Toluene	4.58E-09	
Ammonia	1.09E-05	
Phosphoric Acid Tributyl Ester		
Carbon Tetrachloride	8.97E-12	6.36E-17
Ethyl Butyl Ketone	7.45E-13	
Methyl Chloride		1.12E-18
Tetrahydrofuran		
TOTAL	1.75E-05	8.77E-11
TOTAL SHOWN IN REV C		*8.78E-11*
TABLE D.4.9.29		
EMISSIONS	HAZARD/MEI WKR	RISK/MEI WKR
Acetone	5.61E-08	
Ammonia	1.82E-07	
n-Butyl Alcohol	4.22E-07	
2-Hexanone		
Methyl Isobutyl Ketone	1.66E-08	
TOTAL	6.77E-07	
TOTAL SHOWN IN REV C	*6.76E-07*	

TABLE D.4.9.30		
EMISSIONS	HAZARD/MEI WKR	RISK/MEI WKR
Carbon Monoxide		
Nitrogen Oxide		
1,3-Butadiene		1.91E-10
2-Hexanone		
2-Pentanone		
Acetone	3.23E-06	
Acetonitrile	1.11E-05	
Benzene	4.33E-06	4.50E-11
Heptane		
Methyl N-amyl Ketone	7.96E-07	
N-hexane	3.48E-07	
Nonane		
Octane		
Toluene	1.38E-08	
Ammonia	3.27E-05	
Phosphoric Acid Tributyl Ester		
Carbon Tetrachloride	2.69E-11	1.71E-16
Ethyl Butyl Ketone	2.24E-12	
Methyl Chloride		3.00E-18
Tetrahydrofuran		
TOTAL	5.25E-05	2.36E-10
TOTAL SHOWN IN REV C	*5.26E-05*	
TABLE D.4.9.31		
EMISSIONS	HAZARD/MEI WKR	RISK/MEI WKR
Aluminum		
Arsenic		2.18E-10
Boron	5.36E-10	
Barium	1.59E-10	
Beryllium		3.72E-14
Bismuth		
Cadmium		1.80E-12
Cerium		
Chromium (+3)	2.09E-06	
Copper		
Manganese		
Molybdenum		
Nickel		
Lead		
Silver		
Uranium		
Vanadium		
Zinc		
TOTAL	2.09E-06	2.20E-10
TOTAL SHOWN IN REV C		*2.19E-10*

CONFIRMATION OF TOTALS FOR TABLE D.6.4.2				
EVAPORATOR 1	**MOUSE**	**COYOTE**	**DEER**	**HAWK**	**SHRIKE**
Cs-137	5.93E-12	1.29E-12	2.20E-13	1.04E-12	4.33E-12
H-3	1.81E-10	3.10E-11	5.32E-12	2.69E-11	1.32E-10
I-129	1.22E-12	1.69E-13	2.89E-14	2.00E-13	8.91E-13
Sr-90	2.01E-11	2.00E-12	3.42E-13	2.98E-12	1.47E-11
TOTAL	2.08E-10	3.45E-11	5.91E-12	3.11E-11	1.52E-10
EVAPORATOR 2	**MOUSE**	**COYOTE**	**DEER**	**HAWK**	**SHRIKE**
Cs-137	1.84E-12	4.00E-13	6.84E-14	3.24E-13	1.35E-12
H-3	1.04E-11	1.78E-12	3.06E-13	1.54E-12	7.60E-12
I-129	1.22E-12	1.69E-13	2.89E-14	2.00E-13	8.91E-13
Sr-90	5.83E-12	5.80E-13	9.93E-14	8.66E-13	4.26E-12
TOTAL	1.93E-11	2.93E-12	5.03E-13	2.93E-12	1.41E-11
TOTAL IN REV C			*5.02E-13*		
OPERATIONS PHASE	**MOUSE**	**COYOTE**	**DEER**	**HAWK**	**SHRIKE**
Cs-137	3.10E-10	6.72E-11	1.15E-11	5.44E-11	2.26E-10
I-129	1.05E-11	1.45E-12	2.48E-13	1.72E-12	7.65E-12
Sr-90	8.22E-10	8.18E-11	1.40E-11	1.22E-10	6.01E-10
TOTAL	1.14E-09	1.50E-10	2.57E-11	1.78E-10	8.35E-10
TOTAL IN REV C			*2.58E-11*		
OPERATIONS PHASE	**MOUSE**	**COYOTE**	**DEER**	**HAWK**	**SHRIKE**
Cs-137	1.12E-13	2.43E-14	4.17E-15	1.97E-14	8.20E-14
I-129	3.80E-15	5.24E-16	8.98E-17	6.23E-16	2.77E-15
Sr-90	2.98E-13	2.96E-14	5.08E-15	4.42E-14	2.18E-13
TOTAL	4.14E-13	5.44E-14	9.34E-15	6.45E-14	3.03E-13
TOTAL IN REV C		*5.45E-14*		*6.46E-14*	

CONFIRMATION OF TOTALS TABLE D.6.4.6						
SOURCE	FISH	CRAWDAD	DUCK-p	DUCK-f	HERON	MUSKRAT
300 Year Maximum						
INTERNAL	3.10E-07	3.60E-07	2.90E-07	8.70E-07	5.60E-07	2.90E-07
IMMERSION OR SURFACE	3.60E-10	1.80E-10	2.00E-10	2.00E-10	5.40E-11	1.10E-10
SEDIMENT	9.50E-12	1.90E-11	3.80E-12	3.80E-12	5.70E-12	5.70E-12
TOTAL	3.10E-07	3.60E-07	2.90E-07	8.70E-07	5.60E-07	2.90E-07
SOURCE	FISH	CRAWDAD	DUCK-p	DUCK-f	HERON	MUSKRAT
500 Year Maximum						
INTERNAL	4.20E-07	4.30E-07	4.80E-07	1.20E-06	7.70E-07	4.80E-07
IMMERSION OR SURFACE	2.60E-13	1.30E-13	1.40E-13	1.40E-13	3.90E-14	7.90E-14
SEDIMENT	7.50E-12	1.50E-11	3.00E-12	3.00E-12	4.50E-12	4.50E-12
TOTAL	4.20E-07	4.30E-07	4.80E-07	1.20E-06	7.70E-07	4.80E-07

CONFIRMATION OF TOTALS - TABLE D.6.4.7					
MINIMUM DOSE					
RADIONUCLIDE	MOUSE	COYOTE	DEER	HAWK	SHRIKE
Am-241	4.35E-09	4.24E-10	7.26E-11	6.47E-10	3.18E-09
C-14	1.13E-04	1.12E-05	1.92E-06	1.67E-05	8.24E-05
Cs-137	4.12E-05	8.93E-06	1.53E-06	7.24E-06	3.01E-05
I-129	1.25E-05	1.73E-06	2.97E-07	2.06E-06	9.17E-06
Pu-239	4.46E-10	4.43E-11	7.59E-12	6.62E-11	3.26E-10
Pu-240	4.46E-10	4.44E-11	7.61E-12	6.63E-11	3.26E-10
Ru-106	2.54E-13	2.74E-14	4.70E-15	3.83E-14	1.86E-13
Sm-151					
Sr-90	1.25E-04	1.24E-05	2.12E-06	1.85E-05	9.10E-05
Tc-99	5.81E-11	5.78E-12	9.89E-13	8.62E-12	4.24E-11
Zr-93					
TOTAL	2.92E-04	3.43E-05	5.87E-06	4.45E-05	2.13E-04
TOTAL IN REV C	*2.91E-04*				
MAXIMUM DOSE					
RADIONUCLIDE	MOUSE	COYOTE	DEER	HAWK	SHRIKE
Am-241	7.12E-04	6.95E-05	1.19E-05	1.06E-04	5.21E-04
C-14	1.85E+01	1.84E+00	3.15E-01	2.74E+00	1.35E+01
Cs-137	6.75E+00	1.46E+00	2.51E-01	1.19E+00	4.93E+00
I-129	2.06E+00	2.84E-01	4.86E-02	3.37E-01	1.50E+00
Pu-239	7.30E-05	7.26E-06	1.24E-06	1.08E-05	5.34E-05
Pu-240	7.32E-05	7.28E-06	1.25E-06	1.09E-05	5.35E-05
Ru-106	4.17E-08	4.49E-09	7.70E-10	6.28E-09	3.05E-08
Sm-151					
Sr-90	2.04E+01	2.03E+00	3.48E-01	3.03E+00	1.49E+01
Tc-99	9.51E-06	9.47E-07	1.62E-07	1.41E-06	6.95E-06
Zr-93					
TOTAL	4.77E+01	5.61E+00	9.63E-01	7.30E+00	3.48E+01
TOTAL IN REV C		*5.62E+00*	*9.62E-01*		

CONFIRMATION OF TOTALS - TABLE D.6.4.8					
IN SITU CHEM - 6 YRS					
MINIMUM DOSE					
RADIONUCLIDE	MOUSE	COYOTE	DEER	HAWK	SHRIKE
Am-241	1.46E-12	1.42E-13	2.44E-14	2.17E-13	1.07E-12
C-14	2.72E-14	2.71E-15	4.64E-16	4.04E-15	1.99E-14
Cs-137	9.69E-09	2.10E-09	3.60E-10	1.70E-09	7.08E-09
I-129	9.45E-16	1.31E-16	2.24E-17	1.55E-16	6.90E-16
Pu-239	2.21E-13	2.20E-14	3.77E-15	3.29E-14	1.62E-13
Pu-240	2.22E-13	2.21E-14	3.78E-15	3.29E-14	1.62E-13
Ru-106	2.02E-19	2.18E-20	3.73E-21	3.04E-20	1.47E-19
Sm-151					
Sr-90	4.51E-08	4.49E-09	7.69E-10	6.70E-09	3.30E-08
Tc-99	2.17E-14	2.16E-15	3.70E-16	3.23E-15	1.59E-14
Zr-93					
TOTAL	5.48E-08	6.59E-09	1.13E-09	8.40E-09	4.01E-08
TOTAL IN REV C				*8.41E-09*	
MAXIMUM DOSE					
RADIONUCLIDE	MOUSE	COYOTE	DEER	HAWK	SHRIKE
Am-241	2.39E-07	2.33E-08	4.00E-09	3.56E-08	1.75E-07
C-14	4.46E-09	4.44E-10	7.61E-11	6.63E-10	3.26E-09
Cs-137	1.59E-03	3.44E-04	5.90E-05	2.79E-04	1.16E-03
I-129	1.55E-10	2.14E-11	3.66E-12	2.54E-11	1.13E-10
Pu-239	3.63E-08	3.61E-09	6.18E-10	5.39E-09	2.65E-08
Pu-240	3.63E-08	3.62E-09	6.19E-10	5.40E-09	2.66E-08
Ru-106	3.31E-14	3.56E-15	6.10E-16	4.98E-15	2.42E-14
Sm-151					
Sr-90	7.40E-03	7.36E-04	1.26E-04	1.10E-03	5.41E-03
Tc-99	3.56E-09	3.54E-10	6.07E-11	5.29E-10	2.60E-09
Zr-93					
TOTAL	8.99E-03	1.08E-03	1.85E-04	1.38E-03	6.57E-03

CONFIRMATION OF TOTALS - TABLE D.6.4.8 (cont)					
IN SITU FILL AND CAP- 14 YRS					
MINIMUM DOSE					
RADIONUCLIDE	MOUSE	COYOTE	DEER	HAWK	SHRIKE
Am-241	1.52E-12	1.48E-13	2.53E-14	2.25E-13	1.11E-12
C-14	2.74E-14	2.72E-15	4.66E-16	4.06E-15	2.00E-14
Cs-137	9.69E-09	2.10E-09	3.60E-10	1.70E-09	7.08E-09
I-129	9.28E-16	1.28E-16	2.20E-17	1.52E-16	6.78E-16
Pu-239	2.18E-13	2.17E-14	3.72E-15	3.24E-14	1.59E-13
Pu-240	2.19E-13	2.18E-14	3.73E-15	3.25E-14	1.60E-13
Ru-106	1.99E-19	2.15E-20	3.68E-21	3.00E-20	1.46E-19
Sm-151					
Sr-90	4.60E-08	4.57E-09	7.83E-10	6.82E-09	3.36E-08
Tc-99	2.21E-14	2.20E-15	3.76E-16	3.28E-15	1.61E-14
Zr-93					
TOTAL	5.57E-08	6.67E-09	1.14E-09	8.52E-09	4.07E-08
TOTAL IN REV C	*5.56E-08*			*8.53E-09*	
MAXIMUM DOSE					
RADIONUCLIDE	MOUSE	COYOTE	DEER	HAWK	SHRIKE
Am-241	2.48E-07	2.42E-08	4.15E-09	3.69E-08	1.81E-07
C-14	4.48E-09	4.46E-10	7.64E-11	6.66E-10	3.28E-09
Cs-137	1.59E-03	3.44E-04	5.90E-05	2.79E-04	1.16E-03
I-129	1.52E-10	2.10E-11	3.60E-12	2.49E-11	1.11E-10
Pu-239	3.58E-08	3.56E-09	6.09E-10	5.31E-09	2.61E-08
Pu-240	3.58E-08	3.56E-09	6.10E-10	5.32E-09	2.62E-08
Ru-106	3.27E-14	3.52E-15	6.03E-16	4.92E-15	2.39E-14
Sm-151					
Sr-90	7.53E-03	7.49E-04	1.28E-04	1.12E-03	5.50E-03
Tc-99	3.62E-09	3.60E-10	6.16E-11	5.37E-10	2.64E-09
Zr-93					
TOTAL	9.12E-03	1.09E-03	1.87E-04	1.40E-03	6.66E-03

CONFIRMATION OF TOTALS - TABLE D.6.4.8 (cont)					
IN SITU VIT - 9 YRS					
MINIMUM DOSE					
RADIONUCLIDE	MOUSE	COYOTE	DEER	HAWK	SHRIKE
Am-241	1.48E-12	1.44E-13	2.47E-14	2.20E-13	1.08E-12
C-14	2.72E-14	2.71E-15	4.64E-16	4.04E-15	1.99E-14
Cs-137	9.53E-09	2.07E-09	3.54E-10	1.68E-09	6.97E-09
I-129	9.18E-16	1.27E-16	2.17E-17	1.51E-16	6.71E-16
Pu-239	2.21E-13	2.20E-14	3.77E-15	3.29E-14	1.62E-13
Pu-240	2.22E-13	2.21E-14	3.78E-15	3.29E-14	1.62E-13
Ru-106	1.99E-19	2.14E-20	3.67E-21	2.99E-20	1.45E-19
Sm-151					
Sr-90	4.51E-08	4.49E-09	7.69E-10	6.70E-09	3.30E-08
Tc-99	2.21E-14	2.20E-15	3.77E-16	3.28E-15	1.62E-14
Zr-93					
TOTAL	5.46E-08	6.56E-09	1.12E-09	8.38E-09	4.00E-08
TOTAL IN REV C	*5.47E-08*				
MAXIMUM DOSE					
RADIONUCLIDE	MOUSE	COYOTE	DEER	HAWK	SHRIKE
Am-241	2.42E-07	2.36E-08	4.04E-09	3.60E-08	1.77E-07
C-14	4.46E-09	4.44E-10	7.61E-11	6.63E-10	3.26E-09
Cs-137	1.56E-03	3.39E-04	5.80E-05	2.75E-04	1.14E-03
I-129	1.50E-10	2.08E-11	3.56E-12	2.47E-11	1.10E-10
Pu-239	3.63E-08	3.61E-09	6.18E-10	5.39E-09	2.65E-08
Pu-240	3.63E-08	3.62E-09	6.19E-10	5.40E-09	2.66E-08
Ru-106	3.26E-14	3.51E-15	6.02E-16	4.91E-15	2.38E-14
Sm-151					
Sr-90	7.40E-03	7.36E-04	1.26E-04	1.10E-03	5.41E-03
Tc-99	3.62E-09	3.61E-10	6.18E-11	5.38E-10	2.65E-09
Zr-93					
TOTAL	8.96E-03	1.08E-03	1.84E-04	1.38E-03	6.55E-03
TOTAL IN REV C		*1.07E-03*		*1.37E-03*	

CONFIRMATION OF TOTALS - TABLE D.6.4.9					
MINIMUM DOSE					
RADIONUCLIDE	MOUSE	COYOTE	DEER	HAWK	SHRIKE
Am-241	7.44E-09	7.26E-10	1.24E-10	1.11E-09	5.44E-09
C-14	1.93E-04	1.92E-05	3.29E-06	2.87E-05	1.41E-04
Cs-137	5.06E-05	1.10E-05	1.88E-06	8.90E-06	3.70E-05
I-129	2.15E-05	2.97E-06	5.09E-07	3.53E-06	1.57E-05
Pu-239	7.69E-10	7.65E-11	1.31E-11	1.14E-10	5.62E-10
Pu-240	7.70E-10	7.66E-11	1.31E-11	1.14E-10	5.63E-10
Ru-106	4.36E-13	4.70E-14	8.05E-15	6.57E-14	3.19E-13
Sm-151					
Sr-90	2.13E-04	2.12E-05	3.63E-06	3.16E-05	1.56E-04
Tc-99	1.00E-10	9.95E-12	1.70E-12	1.49E-11	7.31E-11
Zr-93					
TOTAL	4.78E-04	5.44E-05	9.31E-06	7.27E-05	3.50E-04
MAXIMUM DOSE					
RADIONUCLIDE	MOUSE	COYOTE	DEER	HAWK	SHRIKE
Am-241	1.22E-03	1.19E-04	2.04E-05	1.81E-04	8.91E-04
C-14	3.17E+01	3.15E+00	5.40E-01	4.70E+00	2.32E+01
Cs-137	8.29E+00	1.80E+00	3.08E-01	1.46E+00	6.06E+00
I-129	3.52E+00	4.87E-01	8.34E-02	5.78E-01	2.58E+00
Pu-239	1.26E-04	1.25E-05	2.15E-06	1.87E-05	9.20E-05
Pu-240	1.26E-04	1.26E-05	2.15E-06	1.87E-05	9.22E-05
Ru-106	7.15E-08	7.70E-09	1.32E-09	1.08E-08	5.22E-08
Sm-151					
Sr-90	3.49E+01	3.47E+00	5.94E-01	5.18E+00	2.55E+01
Tc-99	1.64E-05	1.63E-06	2.79E-07	2.43E-06	1.20E-05
Zr-93					
TOTAL	7.84E+01	8.91E+00	1.53E+00	1.19E+01	5.73E+01

CONFIRMATION OF TOTALS - TABLE D.7.1.1								
RADIONUCLIDE	1WSS	2WSS	1ESS	2ESS	4ESS	3WDS	3EDS	5EDS
Ac-225	7.43E-12	1.15E-11	2.60E-11	2.42E-11	4.89E-11			
Ac-227	2.23E-08	1.71E-08	3.81E-08	1.67E-08	4.77E-09			
Am-241	7.32E-03	3.80E-02	3.22E-02	1.05E-01	7.96E-02	6.83E-01	9.19E-01	6.13E-03
Am-242	1.15E-05	7.75E-05	8.10E-05	2.15E-04	1.49E-04			
Am-242m	1.16E-05	7.79E-05	8.14E-05	2.16E-04	1.50E-04			
Am-243	4.37E-06	3.13E-05	4.12E-05	1.25E-04	5.38E-05			
At-217	7.43E-12	1.15E-11	2.60E-11	2.42E-11	4.89E-11			
Ba-137m	3.64E+00	1.51E+01	1.52E+01	1.36E+00	2.35E+00	2.10E+02	3.42E+02	4.79E+01
Bi-210	6.46E-14	4.65E-14	5.77E-14	7.56E-14	4.85E-14			
Bi-211	2.23E-08	1.71E-08	3.81E-08	1.67E-08	4.77E-09			
Bi-212								
Bi-213	7.43E-12	1.15E-11	2.60E-11	2.42E-11	4.89E-11			
Bi-214	2.62E-13	2.01E-13	2.24E-13	3.21E-13	2.72E-13			
C-14	1.22E-03	1.96E-03	7.88E-03	2.31E-03	3.13E-03	4.63E-05	3.64E-02	6.44E-05
Cm-242	9.56E-06	6.43E-05	6.72E-05	1.78E-04	1.24E-04			
Cm-244	1.39E-05	9.57E-05	2.16E-04	5.75E-04	1.24E-04			
Cm-245	8.95E-10	6.98E-09	1.65E-08	4.41E-08	9.50E-09			
Cs-135	8.90E-05	2.72E-04	2.27E-04	1.73E-05	3.67E-05			
Cs-137	3.84E+00	1.60E+01	1.61E+01	1.44E+00	2.49E+00	2.10E+02	3.42E+02	4.79E+01
Eu-154						2.51E-02	1.15E+00	6.55E-03
Fr-221	7.43E-12	1.15E-11	2.60E-11	2.42E-11	4.89E-11			
Fr-223	3.08E-10	2.35E-10	5.25E-10	2.31E-10	6.58E-11			
I-129	7.32E-06	1.76E-05	3.94E-05	6.43E-06	2.95E-06			
Nb-93m	3.68E-04	2.71E-03	1.60E-03	4.36E-03	2.59E-02			
Ni-59		6.84E-03	1.43E-02					
Ni-63	2.94E-02	1.95E-01	2.28E-01	6.32E-01	1.88E+00			
Np-237	3.56E-05	4.41E-05	2.13E-04	3.63E-06	7.72E-06	2.18E-05	7.05E-04	1.75E-06
Np-238	5.51E-08	3.71E-07	3.88E-07	1.03E-06	7.14E-07			
Np-239	4.37E-06	3.13E-05	4.12E-05	1.25E-04	5.38E-05			
Pa-231	4.14E-08	2.93E-08	6.57E-08	3.64E-08	1.10E-08			
Pa-233	3.56E-05	4.41E-05	2.13E-04	3.63E-06	7.72E-06			
Pa-234	1.18E-06	4.15E-07	1.12E-06	1.11E-06	4.55E-07			
Pa-234m	7.40E-04	2.59E-04	7.02E-04	6.95E-04	2.84E-04			
Pb-209	7.43E-12	1.15E-11	2.60E-11	2.42E-11	4.89E-11			
Pb-210	6.46E-14	4.65E-14	5.77E-14	7.56E-14	4.85E-14			
Pb-211	2.23E-08	1.71E-08	3.81E-08	1.67E-08	4.77E-09			
Pb-214	2.62E-13	2.01E-13	2.24E-13	3.21E-13	2.72E-13			
Pd-107	3.89E-05	9.32E-05	2.13E-04	3.94E-05	1.68E-05			
Po-210	6.46E-14	4.65E-14	5.77E-14	7.56E-14	4.85E-14			
Po-211	6.09E-11	4.66E-11	1.04E-10	4.56E-11	1.30E-11			
Po-213	7.27E-12	1.13E-11	2.54E-11	2.36E-11	4.78E-11			
Po-214	2.62E-13	2.01E-13	2.24E-13	3.21E-13	2.72E-13			
Po-215	2.23E-08	1.71E-08	3.81E-08	1.67E-08	4.77E-09			
Po-218	2.62E-13	2.01E-13	2.24E-13	3.21E-13	2.72E-13			
Pu-238	9.03E-04	1.19E-03	7.96E-04	2.14E-03	3.85E-03	6.04E-02	2.67E-03	2.40E-03
Pu-239	8.96E-03	1.44E-02	1.25E-02	5.21E-02	7.91E-02	1.23E-01	7.74E-02	1.57E-02
Pu-240	1.76E-03	3.17E-03	2.99E-03	1.33E-02	2.02E-02	4.38E-02	1.99E-02	4.42E-03
Pu-241	1.69E-02	2.55E-02	3.64E-02	1.42E-01	1.91E-01	1.06E+00	1.69E-01	1.27E-01
Pu-242	5.71E-11	3.84E-10	4.01E-10	1.06E-09	7.39E-10			
Ra-223	2.23E-08	1.71E-08	3.81E-08	1.67E-08	4.77E-09			
Ra-225	7.43E-12	1.15E-11	2.60E-11	2.42E-11	4.89E-11			

Ra-226	2.62E-13	2.01E-13	2.24E-13	3.21E-13	2.72E-13			
Rh-106	2.63E-10	6.79E-08	3.55E-07	1.05E-06	6.83E-06			
Rn-219	2.23E-08	1.71E-08	3.81E-08	1.67E-08	4.77E-09			
Rn-222	2.62E-13	2.01E-13	2.24E-13	3.21E-13	2.72E-13			
Ru-106	2.63E-10	6.79E-08	3.55E-07	1.05E-06	6.83E-06			
Sb-126	3.42E-05	9.33E-05	2.89E-05	1.50E-04	6.19E-04			
Sb-126m	2.44E-04	6.66E-04	2.06E-04	1.07E-03	4.42E-03			
Se-79	4.18E-04	1.01E-03	2.24E-03	3.48E-04	1.64E-04			
Sm-151	2.69E-01	7.37E-01	2.36E-01	1.09E+00	4.27E+00			
Sn-126	2.44E-04	6.66E-04	2.06E-04	1.07E-03	4.42E-03			
Sr-90	6.46E+00	5.73E+01	3.58E+01	5.27E+01	3.27E+02			
Tc-99	5.04E-03	1.21E-02	2.71E-02	4.23E-03	1.98E-03			
Th-227	2.20E-08	1.68E-08	3.76E-08	1.65E-08	4.70E-09			
Th-229	7.43E-12	1.15E-11	2.60E-11	2.42E-11	4.89E-11			
Th-230	3.87E-11	3.15E-11	3.23E-11	4.86E-11	5.36E-11			
Th-231	3.11E-05	1.17E-05	2.98E-05	3.02E-05	1.20E-05			
Th-232	7.95E-20	1.43E-19	1.35E-19	6.02E-19	9.08E-19			
Th-234	7.40E-04	2.59E-04	7.02E-04	6.95E-04	2.84E-04			
Tl-207	2.22E-08	1.70E-08	3.80E-08	1.67E-08	4.76E-09			
Tl-209	1.60E-13	2.49E-13	5.61E-13	5.22E-13	1.06E-12			
U-233	5.16E-09	7.02E-09	2.54E-08	8.69E-09	2.03E-08			
U-234	2.11E-07	1.84E-07	1.86E-07	3.27E-07	4.34E-07			
U-235	3.11E-05	1.17E-05	2.98E-05	3.02E-05	1.20E-05			
U-236	9.31E-10	1.67E-09	1.58E-09	7.04E-09	1.06E-08			
U-237	4.13E-07	6.24E-07	8.92E-07	3.48E-06	4.68E-06			
U-238	7.40E-04	2.59E-04	7.02E-04	6.95E-04	2.84E-04			
Y-90	6.52E+00	5.80E+01	3.62E+01	5.33E+01	3.30E+02	3.50E+00	1.72E+02	8.56E-01
Zr-93	1.95E-04	3.20E-03	1.04E-03	6.06E-03	3.94E-02			
Total Ci	2.08E+01	1.47E+02	1.04E+02	1.11E+02	6.68E+02	4.25E+02	8.58E+02	9.68E+01
TOTAL IN REV C					*6.69E+02*	*4.30E+02*	*1.03E+03*	*9.77E+01*

CONFIRMATION OF TOTALS - TABLE D.7.1.2					
RADIONUCLIDE	INVENTOR	RADIONU	INVENTOR	RADIONU	INVENTORY
Ac-225	6.63E-12	Pa-234	2.57E-07	Rn-220	1.25E-20
Ac-227	7.42E-09	Pa-234m	1.60E-04	Rn-222	9.03E-14
Am-241	3.07E-01	Pb-209	6.63E-12	Ru-106	1.27E-08
Am-242	2.29E-05	Pb-210	2.40E-14	Sb-126	2.94E-05
Am-242m	2.29E-05	Pb-211	7.49E-09	Sb-126m	2.10E-04
Am-243	1.11E-05	Pb-212	1.25E-20	Se-79	3.05E-04
At-217	6.63E-12	Pb-214	9.03E-14	Sm-151	2.11E-01
Ba-137m	1.11E+01	Pd-107	2.90E-05	Sn-126	2.10E-04
Bi-210	2.40E-14	Po-210	2.40E-14	Sr-90	1.79E+01
Bi-211	7.42E-09	Po-211	2.02E-11	Tc-99	1.08E-02
Bi-212	1.25E-20	Po-212	7.98E-21	Th-227	7.32E-09
Bi-213	6.63E-12	Po-213	6.49E-12	Th-228	1.25E-20
Bi-214	9.03E-14	Po-214	9.03E-14	Th-229	6.63E-12
Cm-242	1.90E-05	Po-215	7.42E-09	Th-230	1.31E-11
Cm-244	3.96E-05	Po-216	1.25E-20	Th-231	6.90E-06
Cm-245	3.49E-09	Po-218	9.03E-14	Th-232	2.15E-19
Cs-135	4.86E-05	Pu-238	3.61E-04	Th-234	1.60E-04
Cs-137	1.17E+01	Pu-239	8.83E-03	Tl-207	7.39E-09
Fr-221	6.63E-12	Pu-240	2.24E-03	Tl-208	4.48E-21
Fr-223	1.02E-10	Pu-241	2.51E-02	Tl-209	1.44E-13
Nb-93m	1.07E-03	Pu-242	1.45E-10	U-233	4.03E-09
Ni-59	1.68E-03	Ra-223	7.42E-09	U-234	7.09E-08
Ni-63	9.00E-02	Ra-224	1.25E-20	U-235	6.90E-06
Np-237	2.33E-05	Ra-225	6.63E-12	U-236	9.64E-10
Np-238	1.09E-07	Ra-226	9.03E-14	U-237	2.91E-07
Np-239	1.11E-05	Ra-228	2.48E-20	U-238	1.60E-03
Pa-231	1.27E-08	Rh-106	1.27E-08	Y-90	1.79E+01
Pa-233	2.33E-05	Rn-219	7.42E-09	Zr-93	1.32E-03
SUBTOTAL	2.32E+01		3.67E-02		3.60E+01
				TOTAL	5.93E+01
TOTAL IN REV C					*3.62E+04*
TOTAL IN REV C SIGNIFICANTLY DIFFERENT -					
ORIGINAL INPUT RESEARCHED - TOTAL CORRECTED					
TO REFLECT ORIGINAL EXCEL TABLE					

CONFIRMATION OF TOTALS - TABLE D.7.1.3								
RADIONUCLIDE	1WSS	2WSS	1ESS	2ESS	4ESS	3WDS	3EDS	5EDS
Ac-225	7.43E-14	1.15E-13	2.60E-13	2.42E-13	4.89E-13			
Ac-227	2.23E-10	1.71E-10	3.81E-10	1.67E-10	4.77E-11			
Am-241	7.32E-05	3.80E-04	3.22E-04	1.05E-03	7.96E-04	6.83E-03	9.19E-03	6.13E-05
Am-242	1.15E-07	7.75E-07	8.10E-07	2.15E-06	1.49E-06			
Am-242m	1.16E-07	7.79E-07	8.14E-07	2.16E-06	1.50E-06			
Am-243	4.37E-08	3.13E-07	4.12E-07	1.25E-06	5.38E-07			
At-217	7.43E-14	1.15E-13	2.60E-13	2.42E-13	4.89E-13			
Ba-137m	3.64E-02	1.51E-01	1.52E-01	1.36E-02	2.35E-02	2.10E+00	3.42E+00	4.79E-01
Bi-210	6.46E-16	4.65E-16	5.77E-16	7.56E-16	4.85E-16			
Bi-211	2.23E-10	1.71E-10	3.81E-10	1.67E-10	4.77E-11			
Bi-213	7.43E-14	1.15E-13	2.60E-13	2.42E-13	4.89E-13			
Bi-214	2.62E-15	2.01E-15	2.24E-15	3.21E-15	2.72E-15			
C-14	1.22E-05	1.96E-05	7.88E-05	2.31E-05	3.13E-05	4.63E-07	3.64E-04	6.44E-07
Cm-242	9.56E-08	6.43E-07	6.72E-07	1.78E-06	1.24E-06			
Cm-244	1.39E-07	9.57E-07	2.16E-06	5.75E-06	1.24E-06			
Cm-245	8.95E-12	6.98E-11	1.65E-10	4.41E-10	9.50E-11			
Cs-135	8.90E-07	2.72E-06	2.27E-06	1.73E-07	3.67E-07			
Cs-137	3.84E-02	1.60E-01	1.61E-01	1.44E-02	2.49E-02	2.10E+00	3.42E+00	4.79E-01
Eu-154						2.51E-04	1.15E-02	6.55E-05
Fr-221	7.43E-14	1.15E-13	2.60E-13	2.42E-13	4.89E-13			
Fr-223	3.08E-12	2.35E-12	5.25E-12	2.31E-12	6.58E-13			
I-129	7.32E-08	1.76E-07	3.94E-07	6.43E-08	2.95E-08			
Nb-93m	3.68E-06	2.71E-05	1.60E-05	4.36E-05	2.59E-04			
Ni-59		6.84E-05	1.43E-04					
Ni-63	2.94E-04	1.95E-03	2.28E-03	6.32E-03	1.88E-02			
Np-237	3.56E-07	4.41E-07	2.13E-06	3.63E-08	7.72E-08	2.18E-07	7.05E-06	1.75E-08
Np-238	5.51E-10	3.71E-09	3.88E-09	1.03E-08	7.14E-09			
Np-239	4.37E-08	3.13E-07	4.12E-07	1.25E-06	5.38E-07			
Pa-231	4.14E-10	2.93E-10	6.57E-10	3.64E-10	1.10E-10			
Pa-233	3.56E-07	4.41E-07	2.13E-06	3.63E-08	7.72E-08			
Pa-234	1.18E-08	4.15E-09	1.12E-08	1.11E-08	4.55E-09			
Pa-234m	7.40E-06	2.59E-06	7.02E-06	6.95E-06	2.84E-06			
Pb-209	7.43E-14	1.15E-13	2.60E-13	2.42E-13	4.89E-13			
Pb-210	6.46E-16	4.65E-16	5.77E-16	7.56E-16	4.85E-16			
Pb-211	2.23E-10	1.71E-10	3.81E-10	1.67E-10	4.77E-11			
Pb-214	2.62E-15	2.01E-15	2.24E-15	3.21E-15	2.72E-15			
Pd-107	3.89E-07	9.32E-07	2.13E-06	3.94E-07	1.68E-07			
Po-210	6.46E-16	4.65E-16	5.77E-16	7.56E-16	4.85E-16			
Po-211	6.09E-13	4.66E-13	1.04E-12	4.56E-13	1.30E-13			
Po-213	7.27E-14	1.13E-13	2.54E-13	2.36E-13	4.78E-13			
Po-214	2.62E-15	2.01E-15	2.24E-15	3.21E-15	2.72E-15			
Po-215	2.23E-10	1.71E-10	3.81E-10	1.67E-10	4.77E-11			
Po-218	2.62E-15	2.01E-15	2.24E-15	3.21E-15	2.72E-15			
Pu-238	9.03E-06	1.19E-05	7.96E-06	2.14E-05	3.85E-05	6.04E-04	2.67E-05	2.40E-05
Pu-239	8.96E-05	1.44E-04	1.25E-04	5.21E-04	7.91E-04	1.23E-03	7.74E-04	1.57E-04
Pu-240	1.76E-05	3.17E-05	2.99E-05	1.33E-04	2.02E-04	4.38E-04	1.99E-04	4.42E-05
Pu-241	1.69E-04	2.55E-04	3.64E-04	1.42E-03	1.91E-03	1.06E-02	1.69E-03	1.27E-03
Pu-242	5.71E-13	3.84E-12	4.01E-12	1.06E-11	7.39E-12			
Ra-223	2.23E-10	1.71E-10	3.81E-10	1.67E-10	4.77E-11			
Ra-225	7.43E-14	1.15E-13	2.60E-13	2.42E-13	4.89E-13			
Ra-226	2.62E-15	2.01E-15	2.24E-15	3.21E-15	2.72E-15			
Rh-106	2.63E-12	6.79E-10	3.55E-09	1.05E-08	6.83E-08			
Rn-219	2.23E-10	1.71E-10	3.81E-10	1.67E-10	4.77E-11			
Rn-222	2.62E-15	2.01E-15	2.24E-15	3.21E-15	2.72E-15			
Ru-106	2.63E-12	6.79E-10	3.55E-09	1.05E-08	6.83E-08			
Sb-126	3.42E-07	9.33E-07	2.89E-07	1.50E-06	6.19E-06			

Sb-126m	2.44E-06	6.66E-06	2.06E-06	1.07E-05	4.42E-05			
Se-79	4.18E-06	1.01E-05	2.24E-05	3.48E-06	1.64E-06			
Sm-151	2.69E-03	7.37E-03	2.36E-03	1.09E-02	4.27E-02			
Sn-126	2.44E-06	6.66E-06	2.06E-06	1.07E-05	4.42E-05			
Sr-90	6.46E-02	5.73E-01	3.58E-01	5.27E-01	3.27E+00	3.50E-02	1.72E+00	8.56E-03
Tc-99	5.04E-05	1.21E-04	2.71E-04	4.23E-05	1.98E-05	2.10E-03	2.48E-03	1.97E-04
Th-227	2.20E-10	1.68E-10	3.76E-10	1.65E-10	4.70E-11			
Th-229	7.43E-14	1.15E-13	2.60E-13	2.42E-13	4.89E-13			
Th-230	3.87E-13	3.15E-13	3.23E-13	4.86E-13	5.36E-13			
Th-231	3.11E-07	1.17E-07	2.98E-07	3.02E-07	1.20E-07			
Th-232	7.95E-22	1.43E-21	1.35E-21	6.02E-21	9.08E-21			
Th-234	7.40E-06	2.59E-06	7.02E-06	6.95E-06	2.84E-06			
Tl-207	2.22E-10	1.70E-10	3.80E-10	1.67E-10	4.76E-11			
Tl-209	1.60E-15	2.49E-15	5.61E-15	5.22E-15	1.06E-14			
U-233	5.16E-11	7.02E-11	2.54E-10	8.69E-11	2.03E-10			
U-234	2.11E-09	1.84E-09	1.86E-09	3.27E-09	4.34E-09			
U-235	3.11E-07	1.17E-07	2.98E-07	3.02E-07	1.20E-07			
U-236	9.31E-12	1.67E-11	1.58E-11	7.04E-11	1.06E-10			
U-237	4.13E-09	6.24E-09	8.92E-09	3.48E-08	4.68E-08			
U-238	7.40E-06	2.59E-06	7.02E-06	6.95E-06	2.84E-06			
Y-90	6.52E-02	5.80E-01	3.62E-01	5.33E-01	3.30E+00	3.50E-02	1.72E+00	8.56E-03
Zr-93	1.95E-06	3.20E-05	1.04E-05	6.06E-05	3.94E-04			
Total Ci	2.08E-01	1.47E+00	1.04E+00	1.11E+00	6.68E+00	4.29E+00	1.03E+01	9.77E-01
TOTAL IN REV C					*6.69E+00*	*4.30E+00*		
CONFIRMATION OF TOTALS - TABLE D.7.1.4								
RADIONUCLIDE		INTERMEDIATE		EXTENSIVE		EX SITU/IN SITU		
Am-241		4.13E-02		7.78E-04		4.13E-02		
Am-243		1.38E-05		2.49E-07		1.38E-05		
Cm-244		4.98E-06		4.83E-06		4.98E-06		
Cs-135		5.09E-06		9.71E-07		5.09E-06		
Cs-137		1.27E+00		2.34E-01		1.27E+00		
Ni-63		2.76E-02		1.94E+00		2.76E-02		
Np-237		3.39E-05		1.98E-05		3.39E-05		
Pu-238		3.29E-04		8.27E-05		3.29E-04		
Pu-239		8.06E-03		2.01E-03		8.06E-03		
Pu-240		2.01E-03		5.13E-04		2.01E-03		
Pu-241		7.10E-03		5.73E-03		7.10E-03		
Ra-226				7.63E-16				
Rh-106		9.01E-09		1.07E-10		9.01E-09		
Sm-151		3.29E-02		1.78E-03		3.29E-02		
Sn-126		7.63E-04		1.77E-06		7.63E-04		
Sr-90		4.56E+00		3.94E-02		4.56E+00		
Tc-99		1.27E-01		1.12E-03		1.27E-01		
Th-230		2.44E-12		1.10E-13		2.44E-12		
U-233		2.97E-09		5.50E-11		2.97E-09		
U-234		5.19E-08		9.65E-10		5.19E-08		
U-235		5.09E-06		9.37E-08		5.09E-06		
U-238		1.17E-04		2.18E-06		1.17E-04		
Zr-93		1.70E-05		2.84E-02		1.70E-05		
Total Ci		6.08E+00		2.25E+00		6.08E+00		

CONFIRMATION OF TOTALS - TABLE D.7.1.5								
RADIONUCLIDE	1WSS	2WSS	1ESS	2ESS	4ESS	3WDS	3EDS	5EDS
Ac-225	2.59E-12	6.35E-12	3.70E-12	6.60E-12	2.31E-12			
Ac-227	2.99E-09	1.84E-09	4.01E-09	1.55E-09	1.57E-09			
Am-241	8.37E-04	9.90E-03	1.51E-03	3.26E-03	1.02E-02	6.56E-01	1.49E-01	4.49E-03
Am-242	1.09E-06	1.74E-05	3.32E-06	5.22E-06	1.99E-05			
Am-242m	1.10E-06	1.75E-05	3.34E-06	5.24E-06	2.00E-05			
Am-243	5.57E-07	5.44E-06	1.85E-06	2.79E-06	1.12E-05			
At-217	2.60E-12	6.35E-12	3.71E-12	6.60E-12	2.31E-12			
Ba-137m	6.02E-01	1.83E+00	1.51E+00	5.66E-01	9.38E-01	3.63E+01	6.52E+01	3.05E+01
Bi-210	7.79E-15	1.66E-14	5.19E-15	1.34E-14	1.96E-14			
Bi-211	2.99E-09	1.84E-09	4.01E-09	1.55E-09	1.57E-09			
Bi-213	2.59E-12	6.36E-12	3.71E-12	6.60E-12	2.31E-12			
Bi-214	3.30E-14	7.26E-14	2.02E-14	4.00E-14	4.49E-14			
C-14	1.68E-04	1.84E-04	4.89E-04	1.06E-04	3.72E-04	4.63E-05	3.64E-04	4.61E-05
Cm-242	9.05E-07	1.44E-05	2.75E-06	4.33E-06	1.65E-05			
Cm-244	2.85E-06	5.42E-06	1.42E-05	1.16E-05	5.68E-05			
Cm-245	1.95E-10	3.93E-10	1.09E-09	8.86E-10	4.36E-09			
Cs-135	1.98E-05	4.47E-05	2.60E-05	7.85E-06	1.16E-05			
Cs-137	6.37E-01	1.93E+00	1.60E+00	5.98E-01	9.91E-01	2.61E+01	4.89E+01	2.93E+01
Eu-154						3.48E-02	4.22E-01	9.05E-03
Fr-221	2.59E-12	6.35E-12	3.71E-12	6.59E-12	2.31E-12			
Fr-223	4.12E-11	2.53E-11	5.54E-11	2.14E-11	2.16E-11			
I-129	1.33E-06	1.61E-06	2.74E-06	3.93E-07	1.06E-06			
Nb-93m	5.04E-05	1.11E-03	9.76E-05	3.15E-04	7.04E-03			
Ni-63	9.00E-03	1.07E-01	2.35E-02	4.88E-02	3.32E-01			
Np-237	6.06E-06	7.61E-06	1.71E-05	2.85E-06	1.82E-06	2.18E-05	7.24E-06	1.74E-06
Np-238	7.03E-09	6.45E-08	1.74E-08	2.29E-08	1.49E-07			
Np-239	5.58E-07	5.45E-06	1.85E-06	2.79E-06	1.13E-05			
Pa-231	4.68E-09	3.24E-09	6.16E-09	2.98E-09	3.32E-09			
Pa-233	6.05E-06	7.61E-06	1.71E-05	2.86E-06	1.82E-06			
Pa-234	5.73E-08	9.11E-08	8.15E-08	1.46E-07	7.99E-08			
Pa-234m	3.58E-05	5.69E-05	5.09E-05	9.13E-05	4.99E-05			
Pb-209	2.60E-12	6.35E-12	3.71E-12	6.60E-12	2.31E-12			
Pb-210	7.80E-15	1.66E-14	5.18E-15	1.34E-14	1.96E-14			
Pb-211	2.99E-09	1.84E-09	4.01E-09	1.55E-09	1.57E-09			
Pb-214	3.29E-14	7.27E-14	2.02E-14	4.00E-14	4.48E-14			
Pd-107	6.98E-06	8.18E-06	1.42E-05	2.19E-06	6.20E-06			
Po-210	7.77E-15	1.66E-14	5.18E-15	1.39E-14	2.04E-14			
Po-211	7.31E-12	1.66E-11	9.34E-12	8.38E-12	5.49E-12			
Po-213	2.54E-12	6.21E-12	3.62E-12	6.46E-12	2.27E-12			
Po-214	3.29E-14	7.27E-14	2.02E-14	4.00E-14	4.48E-14			
Po-215	2.99E-09	1.83E-09	4.01E-09	1.55E-09	1.57E-09			
Po-218	3.29E-14	7.27E-14	2.02E-14	4.00E-14	4.49E-14			
Pu-238	1.81E-04	5.06E-04	1.06E-04	2.56E-04	1.30E-03	6.22E-02	1.05E-04	2.47E-03
Pu-239	2.63E-03	5.77E-03	1.98E-03	5.23E-03	1.64E-02	1.20E-01	4.21E-02	1.51E-02
Pu-240	4.44E-04	1.27E-03	3.91E-04	1.27E-03	4.50E-03	4.31E-02	1.05E-02	4.26E-03
Pu-241	2.19E-03	9.68E-03	3.80E-03	1.03E-02	5.88E-02	1.29E+00	2.56E-02	1.54E-01
Pu-242	1.67E-11	1.54E-10	6.35E-11	1.07E-10	1.53E-10			
Ra-223	2.99E-09	1.84E-09	4.01E-09	1.55E-09	1.57E-09			
Ra-225	2.60E-12	6.35E-12	3.70E-12	6.61E-12	2.32E-12			
Ra-226	3.29E-14	7.26E-14	2.02E-14	4.00E-14	4.48E-14			
Rh-106	3.31E-11	2.45E-08	3.20E-08	1.31E-07	1.13E-06			
Rn-219	2.80E-09	6.15E-09	3.43E-09	2.08E-09	7.86E-10			
Rn-222	3.29E-14	7.26E-14	2.02E-14	4.00E-14	4.48E-14			
Ru-106	1.40E-11	3.70E-08	1.71E-08	2.15E-08	6.25E-06			
Sb-126	1.69E-06	4.54E-05	2.30E-06	8.29E-06	2.01E-04			
Sb-126m	1.21E-05	3.24E-04	1.64E-05	5.92E-05	1.44E-03			

Se-79	7.61E-05	9.12E-05	1.56E-04	2.20E-05	5.89E-05			
Sm-151	1.81E-02	3.62E-01	2.19E-02	7.97E-02	1.36E+00			
Sn-126	1.21E-05	3.25E-04	1.64E-05	5.92E-05	1.44E-03			
Sr-90	9.44E-01	3.02E+01	3.57E+00	3.24E+00	1.36E+02	1.84E+00	3.78E+01	8.96E-01
Tc-99	9.18E-04	1.11E-03	1.89E-03	2.67E-04	7.14E-04	2.11E-03	1.15E-02	1.22E-02
Th-227	2.94E-09	1.81E-09	3.96E-09	1.53E-09	1.55E-09			
Th-229	2.59E-12	6.35E-12	3.69E-12	6.60E-12	2.33E-12			
Th-230	5.11E-12	1.22E-11	3.15E-12	7.49E-12	7.03E-12			
Th-231	1.53E-06	2.70E-06	2.18E-06	3.87E-06	2.26E-06			
Th-232	3.90E-21	3.29E-20	9.88E-21	7.69E-20	1.71E-19			
Th-234	3.58E-05	5.69E-05	5.09E-05	9.12E-05	4.99E-05			
Tl-207	2.98E-09	1.83E-09	4.00E-09	1.55E-09	1.57E-09			
Tl-209	2.15E-14	2.68E-14	5.91E-14	4.85E-14	3.48E-13			
U-233	1.69E-09	3.49E-09	2.88E-09	2.59E-09	1.90E-09			
U-234	2.91E-08	7.21E-08	1.93E-08	3.67E-08	1.10E-07			
U-235	1.53E-06	2.70E-06	2.19E-06	3.87E-06	2.26E-06			
U-236	4.57E-11	3.85E-10	1.16E-10	9.01E-10	2.00E-09			
U-237	2.03E-08	1.43E-07	6.54E-08	4.45E-07	8.81E-07			
U-238	3.58E-05	5.69E-05	5.09E-05	9.13E-05	4.99E-05			
Y-90	9.52E-01	3.05E+01	3.61E+00	3.28E+00	1.37E+02	1.84E+00	3.78E+01	8.96E-01
Zr-93	4.99E-05	1.71E-03	9.02E-05	3.53E-04	1.45E-02			
Total Ci	3.17E+00	6.50E+01	1.03E+01	7.83E+00	2.77E+02	6.83E+01	1.90E+02	6.18E+01
TOTAL IN REV C			***1.04E+01***					

TWRS EIS
CALCULATION COVER SHEET

DISCIPLINE & TITLE ENGR / COST - CAPSULE ALTERNATIVE

ORIGINATOR D. Stein DATE ~~2/6/96~~ 3/18/96

REVISION NO. ~~A~~ B

OBJECTIVE IDENTIFY THE COST FOR THE CAPSULE ALTERNATIVES DISCUSSED IN THE TWRS EIS - MODIFY PER PROPOSED DRAFT EIS (SMALL CANISTER)

METHODOLOGY SAME AS REV. 0 BUT ALSO USE NEW REPOSITORY COST ESTIMATES PER PROPOSED DRAFT EIS CONDITIONS

ASSUMPTIONS

Rev B - Revised repository fee per latest direction — $360,000 per canister (1995 $)

(Continue on another sheet if necessary)

D. Stein
SIGNATURE

CHK: C. Henderson 3/25/96

CALCULATION & RESULTS ATTACHED

JACOBS\FORMS\CALCVR.SET

JACOBS ENGINEERING GROUP INC.

DATE ~~2/5/96~~ 3/18/96 SUBJECT Rev B ~~Rev A~~ SHEET NO. 1-2

BY D Stein CHKD. JOB NO.

CAPSULE OVERPACK + SHIP ALTERNATIVE

Cost Estimate

Modification per proposed Draft EIS use of 61 x 305 cm canister as a standard

previously 68 x 457 cm canister was estimated for this alternative

Since max loading of 5 capsules per canister, the 61 x 305 cm canister will still be able to easily hold the 5 capsules. Therefore the same # of HMPCs (100) and # of canisters (400) as before.

~~The new costs will however have to be estimated based on new repository fees estimated per DEIS~~

~~new inter. sep. for DEIS has 33,386 canisters and costs $6,500 million in repository fees.~~

~~Variation from this inter. sep. case has 44,500 canisters and costs $7,800 million~~

~~Therefore Δ 11,114 canisters cost Δ $1,300 million or $0.117 million each~~

~~repository fee = $0.117 million/canister × 400 canisters~~

~~repository fee = $46.8 million~~

3/18/96 revision per #360,000 per canister repository fee (1995 $) repository fee = $0.36 million/canister × 400 canisters = $144 million

FORM 91-005-1 (4/81)

JACOBS ENGINEERING GROUP INC.

DATE 2/6/96 SUBJECT Rev 15 ~~Rev A~~ SHEET NO. 2-2

BY DStern CHKD. JOB NO.

operating cost, which includes cost of canisters, HMPCs and casks will be same as previous because same numbers are used and costs should be similar.

VITRIFY WITH TANK WASTE ALTERNATIVE

Cost Estimate

250 canisters @ 1.6 m^3/canister for a total Δ volume of 400 m^3 was previously estimated for Cs/Sr Capsules from Ext Sep table 9-14

We now have 0.62 m^3/canister or

$$\frac{1.6\ m^3}{0.62\ m^3} \times 250 = 645 \text{ canisters}$$

~~repository fee = \$0.117 million/canister × 645 canisters~~

~~repository fee = \$75.4 million~~

3/18/96 revision
\$360,000 per canister
repository fee (1995 \$)
repository fee = \$0.36 million/can × 645 can
= \$232 million

		Δ #	Δ cost
Δ op. cost	\$10,000/canister	(645 − 250)	3.9 million
	\$25,000/HMPC	(161 − 63)	2.5 million
	\$60,000/cask	(161 − 63)	5.8 million
			\$12.2 million

base cost = \$34 million

Δ cost = \$12 million

new op. cost = \$46 million

FORM 91-005-1 (4/81)

TWRS ALTERNATIVE COST SUMMARY

Cost Component		Capsules No Action	Capsules Onsite Disposal	Capsules Overpack and Ship	Vitrify with Tank Waste
Current Operations		$112	$377	$377	$315
Transfer System Upgrades(in current ops)					
Research and Development					
	Wast Retrieval and Transfer				
	Treatment			$14	$5
	Total R&D	$0	$0	$14	$5
Capital					
	Waste Retrieval and Transfer				
	Treatment		$83	$32	$36
	Closure		$5		
	Total Capital Costs	$0	$88	$32	$36
Operating					
	Waste Retrieval and Transfer				
	Treatment		$226	$34	$46 ~~$34~~
	Total Operating Costs	$0	$226	$34	$46 ~~$34~~
Monitoring and Maintenance					$1
D&D			$6	$6	$6
Repository Fee			$0	144 ~~$47~~ ~~$15~~	232 ~~$75~~ ~~$9~~
Total Cost (1995)		$112	$697	607 ~~$510~~ ~~$120~~	641 ~~$489~~ ~~$106~~
Total Cost summary in billions of dollars		$0.11	$0.70	~~$0.51~~ ~~$0.48~~	~~$0.48~~ ~~$0.41~~

The Overpack and Ship disposal fee is based on sending other wastes to the repository under the Intermediate Separations alternative. If no wastes other than capsules are sent to the repository the disposal fee would be approx. $3,385 million 1995 dollars.

~~Rev A~~

Rev B

3/18/96

Stein, David

From: Stein, David
To: Henderson, Colin
Subject: Capsule Alternatives Cost Revision(Repository Fee Change)
Date: Monday, March 18, 1996 1:54PM

Incorporating the revised Repository Fee method ($360,000 per canister) results in the following for the Capsule Alternatives:

	CAPSULE ALTERNATIVES	
	OVERPACK AND SHIP (millions)	VITRIFY WITH TANK WASTE (millions)
Current Operations	$377	$315
R&D	$14	$5
Capital	$32	$36
Operating	$34	$46
M&M	----	$1
D&D	$6	$6
Repository Fee	$144	$232
Total	$607	$641

RECEIVED
MAR 19 1996

TWRS EIS
CALCULATION COVER SHEET

DISCIPLINE & TITLE Risk Assessment, Senior Eng/Sci.

ORIGINATOR Phil Bramson. DATE 3/5/96

REVISION NO. _____

OBJECTIVE Calculation of risk from ground-water concentration from other sources than TWRS.

METHODOLOGY Hand Calculation using the Unit Risk Factor for Residential Farmer.

ASSUMPTIONS Use of Table D.2.1.14 of Appendix D, URF for converting the Groundwater Concentration to Risk + Dose. Use 6.0×10^{-4} Risk/rem Conversion Factor (Risk is Cancer incidence not Fatalities).

(Continue on another sheet if necessary)

A. H. [signature] 3/6/96
SIGNATURE/DATE

P. Bramson 3/15/96
CHECKED/DATE

CALCULATION & RESULTS
ATTACHED

JACOBS\FORMS\CALCVR.SHT

JACOBS ENGINEERING GROUP INC.

DATE 3/6/96 SUBJECT SHEET NO. 1

BY AN CHKD. JOB NO. Phil Bronson

Conversion of Groundwater Concentration to Risk + Dose.

The unit Risk Factors (URF) for Tc-99, I-129, C-14, and U-238 for Residential Farmer Scenario are tabulated in table D.2.1.14 of Appendix D and they are 2.61E+08, 1.29E+10, 6.06E+08, and 1.28E+09 respectively. The unit of URF in the above table is in Ci/mL.

The calculation is as the following.

	Risk/Ci/mL	Conversion	Risk/pCi/L	Risk/Rem	Rem/pCi/L
Tc-99 →	2.61×10^{8}	$\times 10^{-15}$ =	2.61×10^{-7}	$\div 6.0\times10^{-4}$ =	4.35×10^{-4}
I-129 →	1.29×10^{10}	$\times 10^{-15}$ =	1.29×10^{-5}	$\div 6.0\times10^{-4}$ =	2.15×10^{-2}
C-14 →	6.06×10^{8}	$\times 10^{-15}$ =	6.06×10^{-7}	$\div 6.0\times10^{-4}$ =	1.01×10^{-3}
U-238 →	1.28×10^{9}	$\times 10^{-15}$ =	1.28×10^{-6}	$\div 6.0\times10^{-4}$ =	2.13×10^{-3}

The above Unit Dose Factors are calculated for the given Groundwater Concentration which has unit of pCi/L.

The Result of Doses (mRem) from the Given Concentration are shown the table below. The above Dose factor are converted from Rem/pCi/L to mRem/pCi/L then multiplied by the Concentration.

FORM 91-005-1 (4/81)

JACOBS ENGINEERING GROUP INC.

DATE 3/6/96

BY AMN CHKD. %

SUBJECT

SHEET NO. 2

JOB NO.

FORM 91-005-1 (4/81)

DOSE in mrem for other Sources than TWRS

SITE	Tc-99		I-129		C-14		U-238		%
	Concent (1)	Dose (2)	Conc. (1)	Dose (2)	Conc. (1)	Dose (2)	Conc (1)	Dose (2)	
U.S. Ecology	3.301	1.436	0.00674	0.145	5.41	5.464	0.34	0.724	0.17
ERDF	7.376185	3.209	0.000978	0.021	223.092	225.30	0.171233	0.365	7.77
200W Buried Cat. 1	2.6	1.131	0.068	1.462	0.085	0.086	0.0021	0.0045	4.91
Cat. 2	1685.985	733.40	0.831703	17.88	3392.042	3426.0	114.1553	243.20	0.06
						3.426 Rem?			94.85

228.8

2.68

4420

4659.85

Say 4.7 rc

1) Concentrations are in Pci/L

2) Dose are in mrem

Enclosed:

The Predicted Maximum Groundwater Concentration

Environmental Science & Engineering, Inc.

Alex – Source terms for GW

FACSIMILE

DATE: 3/5/96 TIME:

TO: Phil Brauzin FROM: Phil Rogers

FAX#: JOB#: 8946001-6-0200

SUBJECT:

Number of Pages
(Including this Cover Sheet)
2

ADDITIONAL MESSAGE:

Cummulative Impact Predicted Concentrations

If you have any questions, please call us immediately at (303) 790-0770.

7 Inverness Drive East, Suite 201 Englewood, CO 80112 Phone (303) 790-0770 Fax (303) 790-4411

	Tc-99 pCi/L (years)	I-129 pCi/L (years)	C-14 pCi/L (years)	U-238 pCi/L (years)	Nitrate Metric Tonnes (years)
Predicted Maximum Groundwater Concentration U.S. Ecolocgy Site And Time of Peak	3.301	6.74E-03	5.41	3.4E-01	pCi/L
Predicted Maximum Groundwater Concentrations for the ERDF	7.376185	0.000078	223.092	0.171233	pCi/L
Peak Arrival Time	(1445 yrs))	(1445 yrs)	(1445 yrs)	(1445 yrs)	
Dose Conv. Factor (mrem/pCi)	1.3E-06	2.8E-04	2.1E-06	2.4E-04	
Max GW Dose (mrem/yr)	0.007	0.0002	0.342	0.03	
Predicted Maximum Groundwater Concentrations for the LLW Burial in 200W Peak Arrival Time					
Category 1 (no cap)					
Max GW Dose (mrem/yr)	2.5E-03	1.4E-02	1.3E-04	3.6E-04	
Max GW concentration (pCi/L)	2.6E+00	6.8E-02	8.5E-02	2.1E-03	pCi/L
	(123yrs)	(123yrs)	(123yrs)	(123yrs)	
Category 3 (cap)					
Max GW Dose (mrem/yr)	1.6	1.7E-01	5.2	20	
Max GW concentration (pCi/L)	1685.985	0.831703	3392.042	114.1553	pCi/L
Time to Peak (years)	(1000)	(1000)	(1000)	(1000)	
MCL	900	1	2000		

TWRS EIS
CALCULATION COVER SHEET

DISCIPLINE & TITLE Engineering - Group One Radioisotope Concentrations in Columbia River

ORIGINATOR D. Murray DATE 3/24/96

REVISION NO. _____

OBJECTIVE Determine concentrations of C-14, I-129, Tc-99 & U-238 in Columbia River for Long Term Management alternative

METHODOLOGY Ratio concentrations in river to be proportional to inventories in tanks

ASSUMPTIONS 1. Dissolution follows congruent dissolution model. 2. Nitrate conc = 0.08 g/L 3. All group one (K_d=0) contaminants will reach the river when nitrate reaches the river 4. Background concentrations aren't considered

(Continue on another sheet if necessary)

David J. Murray 3/24/
SIGNATURE/DATE

3/28/96
CHECKED/DATE

CALCULATION & RESULTS
ATTACHED

JACOBS\FORMS\CALCVR.SHT

JACOBS ENGINEERING GROUP INC.

DATE 3/24/96 SUBJECT Group One Radioisotope Concentrations in Columbia River SHEET NO. 1/1

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

Concentrations of Group One Radioisotopes in the Columbia River at Median River Flow.

① Amounts in mt:

$NO_3^- = 1.07E+05$ mt - Appendix A

C-14 = 0.004
I-129 = 0.24
Tc-99 = 1.64
U-238 = 1423

} See calculations for selective retrieval

② So for NO_3^- $1.07 \times 10^5 \cdot f = 0.08$ g/L *
where f is a conversion factor from mt to g/L.

$$f = \frac{8 \times 10^{-2}}{1.07 \times 10^5} = 7.5 \times 10^{-7}$$

③ Corresponding concentrations of radioisotopes

C-14 = 3×10^{-9} g/L

I-129 = 2×10^{-7} g/L

Tc-99 = 1×10^{-6} g/L

U-238 = 1×10^{-3} g/L

* 0.08 g/L is the ultimate nitrate concentration in the river at median flow rate

FORM 91-005-1 (4/81)

TWRS EIS
CALCULATION COVER SHEET

DISCIPLINE & TITLE Engineering \ Revised Schedules. in Support of Modifications made to DEIS Rev C.

ORIGINATOR Colin Henderson DATE 1/21/96

REVISION NO. 0

OBJECTIVE Calculate Revised Schedules based on basis changes made for DEIS Rev C.

METHODOLOGY 1) Calculate Revised Op Duration Required to produce the required Volume of HLW or LAW.
2) Adjust schedule for other functions to support 1.

ASSUMPTIONS Waste Volumes & Operating Durations taken from Waste Loading and blending modifications Calc. Operating Efficiency taken at 60% (up to 70% for Phase 2 of Phased Imp).

(Continue on another sheet if necessary)

J.C. Henderson 2/21/96
SIGNATURE/DATE

David J. Murray 3/15/96
CHECKED/DATE

CALCULATION & RESULTS
ATTACHED

JACOBS\FORMS\CALCVR.SHT

NO ACTION SCHEDULE				
	REV O DATA PACKAGE SCHEDULE			DEIS CHAPTER 3 SCHEDULE
Continued Operations				
Construction	N/A			
Operations	N/A			
D&D	N/A			
Monitoring & Maintenance	1995-2095		(100 years)	1997-2097
LONG-TERM MANAGEMENT SCHEDULE				
	REV O DATA PACKAGE SCHEDULE			DEIS CHAPTER 3 SCHEDULE
Continued Operations				
Construction				
Waste Retrieval	2032-2039	2082-2089	(7 years each)	2033-2037 2083-2087
New Tanks	2033-2037	2083-2087	(4 years each)	2033-2037 2083-2087
Operations	2037-2042	2087-2092	(5 years each)	2037-2042 2087-2092
D&D	2042-2047	2092-2097	(5 years each)	2042-2047 2092-2097 42-49,92-99 for WR&T
Monitoring & Maintenance	1995-2095		(100 years)	1997-2097
IN SITU FILL AND CAP SCHEDULE				
	REV O DATA PACKAGE SCHEDULE			PDEIS CHAPTER 3 SCHEDULE
Continued Operations	1995-2009	(14 years)		
Research and Development	N/A			N/A
Construction	2003-2005	(2 years)		2003-2005
Operation	2000-2009	(9 years)		2000-2009
D&D	2009-2012	(3 years)		2009-2012
Monitoring and Maintenance	2009-2029	(20 years)		2009-2029
Closure	2012-2029	(17 years)		2012-2029
Post Closure Monitoring	2029-2129	(100 years)		2029-2129
IN SITU VITRIFICATION SCHEDULE				
	REV O DATA PACKAGE SCHEDULE			DEIS CHAPTER 3 SCHEDULE
Continued Operations	1995-2013	(18 years)		
Research and Development	1995-2002	(7 years)		1997-2002
Construction	1998-2016	(18 years)		1998-2016
Operation	2000-2013	(13 years)		2005-2016
DST evaporation	2000-2005	(5 years)		2000-2005
ISV strart up	2005-2008	(3 years)		2005-2008
ISV operation	2008-2013	(5 years)		2008-2013
D&D	2013-2016	(3 years)		2013-2016
Monitoring and Maintenance	2013-2033	(20 years)		2016-2033

Closure	2016-2033	(17 years)	2016-2033
Post Closure Monitoring	2033-2133	(100 years)	2033-2133
EX SITU INTERMEDIATE SEPARATIONS SCHEDULE			
	REV O DATA PACKAGE SCHEDULE		DEIS CHAPTER 3 SCHEDULE
Continued Operations			1997
Research and Development	1995-2018	(23 years)	~~1995~~-2018
Construction			
Waste Retrieval and Transfer	1998-2017	(19 years)	1998-2017
Waste Treatment	1997-2007	(10 years)	1997-2007
Operation			
Waste Retrieval	2001-2023	(22 years)	2001-2024
Treatment	2004-2023	(19 years)	2004-2024
Pretreatment	2004-2019	(15 years)	
LLW Vitrification	2005-2019	(14 years)	2004-2024
HLW Vitrification	2009-2023	(14 years)	2011-2024
LLW Disposal	2005-2019	(14 years)	
HLW Transportation and Disposal	2019-2029	(10 years)	2019-2029
D&D			
Waste Retrieval facilities	2012-2025	(13 years)	2013-2026
Treatment Facilities	2019-2028	(9 years)	2024-2033
Monitoring and Maintenance			
HLW	2023-2029	(6 years)	2024-2029
LLW Disposal	2023-2034	(11 years)	
Closure	2010-2034	(24 years)	2010-2034
Post Closure Monitoring	2034-2134	(100 years)	2034-2134
EX SITU NO SEPARATIONS (VITRIFICATION AND CALCINATION)			
	REV O DATA PACKAGE SCHEDULE		PDEIS CHAPTER 3 SCHEDULE
Continued Operations	1995-2018	(23 years)	1997
Research and Development	1995-2005	(10 years)	~~1995~~-2005
Construction			
Waste Retrieval and Transfer	1998-2017	(19 years)	1998-2017
Waste Treatment	1997-2002	(5 years)	1997-2002
Operation			
Waste Retrieval	2001-2018	(17 years)	2001-2019
HLW Vitrification	2004-2018	(14 years)	2004-2019
HLW Transportation and Disposal	2017-2027	(10 years)	2017-2037
D&D			
Waste Retrieval facilities	2012-2020	(8 years)	2013-2021
Treatment Facilities	2018-2023	(5 years)	2019-2024

Monitoring and Maintenance			
HLW	2004-2027	(23 years)	2019-2037
Closure	2010-2024	(14 years)	2010-2024
Post Closure Monitoring	2024-2124	(100 years)	2024-2124
EX SITU EXTENSIVE SEPARATIONS SCHEDULE			
	REV O DATA PACKAGE SCHEDULE		DEIS CHAPTER 3 SCHEDULE
Continued Operations	1995-2024	(29 years)	1997
Research and Development	1995-2018	(23 years)	~~1995~~-2018
Construction			
Waste Retrieval and Transfer	1998-2017	(19 years)	1998-2017
Waste Treatment	1997-2006	(9 years)	1997-2006
Operation			
Waste Retrieval	2001-2024	(23 years)	2001-2024
Treatment	2003-2024	(21 years)	2004-2024
Pretreatment	2003-2018	(15 years)	
LLW Vitrification	2005-2024	(19 years)	
HLW Vitrification	2005-2019	(14 years)	
LLW Disposal	2005-2024	(19 years)	
HLW Transportation and Disposal	2020-2029	(9 years)	2020-2029
D&D			
Waste Retrieval facilities	2012-2025	(13 years)	2012-2025
Treatment Facilities	2019-2024	(5 years)	2024-2029
Monitoring and Maintenance			
HLW	2019-2029	(10 years)	2024-2029
LLW Disposal	2023-2030	(7 years)	
Closure	2010-2030	(20 years)	2010-2030
Post Closure Monitoring	2030-2130	(100 years)	2030-2130
IN SITU/EX SITU COMBINATION SCHEDULE			
	REV O DATA PACKAGE SCHEDULE		DEIS CHAPTER 3 SCHEDULE
Continued Operations	1995-2023	(28 years)	1997
Research and Development	1995-2018	(23 years)	~~1995~~-2018
Construction			
Waste Retrieval and Transfer	1998-2017	(19 years)	1998-2017
Waste Treatment	1997-2007	(10 years)	1997-2007
Fill & Cap	2003-2005	(2 years)	2003-2005
Operation			
Waste Retrieval	2001-2023	(22 years)	2001-2024
Treatment	2004-2023	(19 years)	2004-2024
Pretreatment	2004-2019	(15 years)	
LLW Vitrification	2005-2019	(14 years)	
HLW Vitrification	2009-2023	(14 years)	

LLW Disposal	2005-2019	(14 years)	
HLW Transportation and Disposal	2019-2029	(10 years)	2019-2029
Fill and Cap Operations	2000-2009	(9 years)	2005-2018
D&D			2019-2028
Waste Retrieval facilities	2012-2025	(13 years)	2012-2026
Treatment Facilities	2019-2028	(9 years)	2024-2033
Fill and Cap Equipment	2009-2012	(3 years)	2018-2021
Monitoring and Maintenance			
HLW	2023-2029	(6 years)	2024-2029
LLW Disposal	2023-2034	(11 years)	
In Situ Tanks	2009-2029	(20 years)	2018-2034
Closure	2010-2034	(24 years)	2010-2034
Post Closure Monitoring	2034-2134	(100 years)	2034-2134
			Phase 1 / Phase 2
PHASED IMPLEMENTATION SCHEDULE			
	REV O DATA PACKAGE SCHEDULE		DEIS CHAPTER 3 SCHEDULE
Continued Operations			
Research and Development	1995-1998	(3 years)	
Construction	1997-2002	(5 years)	
Phase 1			1997-2002
Retrieval			2004-2020
Phase 2			2005-2012
Operation	2002-2012	(10 years)	
Phase 1			2002-2012
LAW Treatment Plants	2002-2012	(10 years)	
HLW Treatment Plant	2002-2008	(6 years)	
Phase 2			
Waste Retrieval			2007-2028
Treatment			2011-2028
D&D	2012-1014	(2 years)	2015-2031
Monitoring and Maintenance			
Closure	2012-2014	(2 years)	2016-2040
Post Closure M&M			2040-2140
CAPSULES NO ACTION	REV O DATA PACKAGE SCHEDULE		DEIS CHAPTER 3 SCHEDULE
Continued Operation			1997-2007
Research and Development			
Construction			
Operation			
D&D			
Monitoring and Maintenance			
CAPSULES ONSITE DISPOSAL			

	REV O DATA PACKAGE SCHEDULE		DEIS CHAPTER 3 SCHEDULE
Continued Operation	1995-2028		1997-2028
Research and Development			
Construction	2002-2009	(7 years)	2002-2009
Operation	2010-2029	(19 years)	2010-2029
D&D			
Monitoring and Maintenance			2029-2129

CAPSULES OVERPACK AND SHIP

	REV O DATA PACKAGE SCHEDULE	DEIS CHAPTER 3 SCHEDULE
Continued Operation	1995-2028	1997-2028
Research and Development		
Construction	2002-2009	2002-2009
Operation	2010-2028	2010-2028
HLW Transportation and Disposal	2035-2040	2028-2029
D&D		
Monitoring and Maintenance		2010-2029

CAPSULES VITRIFY WITH TANK WASTES

	REV O DATA PACKAGE SCHEDULE	DEIS CHAPTER 3 SCHEDULE
Continued Operation		1997-2023
Research and Development		
Construction		2002-2007
Operation		2005-2023
D&D		2024-2029
Monitoring and Maintenance		2023-2029

TWRS EIS
CALCULATION COVER SHEET

DISCIPLINE & TITLE Engineering / Revised Land Use Numbers To Support DEIS Rev C

ORIGINATOR Colin Henderson DATE 2/21/96

REVISION NO. 0

OBJECTIVE Calculate Land Use Numbers for all alternatives using Assumptions for Waste loading & blending defined for DEIS Rev C.

METHODOLOGY Use spreadsheet to organize data & summarize into Data specific to Section 5 tables.

ASSUMPTIONS Numbers reported to 2 significant figures. Assumptions for shrub steppe area and facility specific Land Use Requirements are shown on the attached backup data. This calc is supported by other CALCS for resizing of the LAW Vaults and HLW interim Storage.

(Continue on another sheet if necessary)

J.C. Henderson 2/21/96
SIGNATURE/DATE

David J. Murray 3/15/96
CHECKED/DATE

CALCULATION & RESULTS
ATTACHED

JACOBS\FORMS\CALCVR.SHT

	Table 5.7.1				Table 5.7.1			
	Temporary Land Commitments				Permanent Land Commitments			
	Remediation		Total		Remediation		Total	
	ha	(ac)	ha	(ac)	ha	(ac)	ha	(ac)
No Action	0	0	0	0	0	0	17	(42)
Long Term Management	50	(120)	50	(120)	8	(20)	25	(62)
In Situ Fill and Cap	26	(64)	97	(240)	17	(42)	25	(62)
In Situ Vitrification	110	(270)	180	(440)	17	(42)	25	(62)
Ex Situ Intermediate Separations	120	(300)	250	(620)	37	(91)	49	(120)
Ex Situ No Separations	150	(370)	250	(620)	19	(47)	27	(67)
Ex Situ Extensive Separations	110	(270)	240	(590)	34	(84)	46	(110)
Ex Situ/In Situ Combination	110	(270)	200	(490)	31	(77)	41	(100)
Phased Implementation (Phase1)	33	(82)	33	(82)	0	0	0	0
Phased Imp. Total Alternative	**150**	**(370)**	**280**	**(690)**	**40**	**(99)**	**52**	**(130)**
Capsules No Action	0	0	0	0	0.6	(1.5)	0.6	(1.5)
Capsules On-Site Disposal	4	(10)	4	(10)	1.8	(4.4)	1.8	(4.4)
Capsules Overpack and Ship	2	(5)	2	(5)	0	0	0	0
Capsules Vitrify with Tank Waste	1	(2)	1	(2)	0	0	0	0
All Capsule Alternatives								

	Table 5.14.1				Table 5.14.1				Table 5.14.1		Table 5.14.1	
	200 Area Temp		200 Area Perm.		Borrow Sites		200 Area		Borrow Site		LAW Vault Area	
	Remediation		Total		temporary		Shrub-Steppe		Shrub-Steppe			
	ha	(ac)	ha	(ac)	ha	(ac)	ha	(ac)	ha	(ac)	ha	(ac)
No Action	0	0	17	(42)	0	0	0	0	0	0	N/A	
Long Term Management	50	(120)	25	(62)	0	0	10	(25)	0	0	N/A	
In Situ Fill and Cap	21	(52)	25	(62)	76	(190)	0	0	65	(160)	N/A	
In Situ Vitrification	110	(270)	25	(62)	71	(180)	23	(57)	60	(150)	N/A	
Ex Situ Intermediate Separations	120	(300)	49	(120)	130	(320)	59	(150)	110	(270)	17	(42)
Ex Situ No Separations	170	(420)	27	(67)	84	(210)	96	(240)	71	(180)	N/A	
Ex Situ Extensive Separations	110	(270)	46	(110)	120	(300)	57	(140)	110	(270)	14	(35)
Ex Situ/In Situ Combination	110	(270)	41	(100)	95	(230)	57	(140)	80	(200)	9	(22)
Phased Implementation (Phase1)	32	(79)	0	0	1	(2)	20	(49)	1	(2)	N/A	
Phased Imp. Total Alternative	150	(370)	52	(130)	130	(320)	79	(200)	110	(270)	17	(42)
Capsules No Action	0.6	(1.5)	0.6	(1.5)			0	0	0	0		
Capsules On-Site Disposal	1.8	(4.4)	1.8	(4.4)			1.5	(3.7)	0	0		
Capsules Overpack and Ship	0	0	0	0			0	0	0	0		
Capsules Vitrify with Tank Waste	0	0	0	0			0	0	0	0		
All Capsule Alternatives												

	Table 5.19.2			
	Continued Access Restrictions			
	Remediation		Total	
	ha	(ac)	ha	(ac)
No Action	0	0	17	(42)
Long Term Management	8	(20)	25	(62)
In Situ Fill and Cap	17	(42)	25	(62)
In Situ Vitrification	17	(42)	25	(62)
Ex Situ Intermediate Separations	37	(91)	49	(120)
Ex Situ No Separations	19	(47)	27	(67)
Ex Situ Extensive Separations	34	(84)	46	(110)
Ex Situ/In Situ Combination	31	(77)	41	(101)
Phased Implementation (Phase1)	0	0	0	0
Phased Imp. Total Alternative	40	(99)	52	(130)
Capsules No Action			0.6	[1.5]
Capsules On-Site Disposal			1.8	[4.4]
Capsules Overpack and Ship			none	
Capsules Vitrify with Tank Waste			none	
All Capsule Alternatives				

	Table 5.4.1 Shrub-Steppe Habitat				Table 5.4.1 Shrub-Steppe Habitat				Table 5.4.1 Shrub-Steppe Habitat			
	200 Areas Remediation				Borrow Sites				Total			
	Temporary		Total		Remediation		Total		Remediation		Total	
	ha	(ac)	ha	(ac)	ha	(ac)	ha	(ac)	ha	(ac)	ha	(ac)
No Action	0	0	0	0	0	0	0	0	0	0	0	0
Long Term Management	10	(25)	10	(25)	0	0	0	0	10	(25)	10	(25)
In Situ Fill and Cap	0	0	0	0	23	(57)	65	(160)	23	(57)	65	(160)
In Situ Vitrification	23	(57)	23	(57)	18	(44)	60	(150)	41	(100)	83	(210)
Ex Situ Intermediate Separations	59	(150)	59	(150)	24	(59)	110	(270)	83	(210)	170	(420)
Ex Situ No Separations	96	(240)	96	(240)	7	(17)	71	(180)	100	(250)	170	(420)
Ex Situ Extensive Separations	57	(140)	57	(140)	15	(37)	110	(270)	72	(180)	170	(420)
Ex Situ/In Situ Combination	57	(140)	57	(140)	17	(42)	80	(200)	74	(180)	140	(350)
Phased Implementation (Phase1)	20	(49)	20	(49)	1	(2)	1	(2)	21	(52)	21	(52)
Phased Imp. Total Alternative	79	(200)	79	(200)	21	(52)	110	(270)	**100**	**(250)**	**190**	**(470)**
Capsules No Action												
Capsules On-Site Disposal												
Capsules Overpack and Ship												
Capsules Vitrify with Tank Waste												
All Capsule Alternatives	<2	<5	0	0	0	0	0	0	<2	<5	<2	<5

	Table 5.1.1				Table 5.1.1				
	Soil Disturbance Remediation				Soil Distsurbance Total Proj.				
	Temporary		Permanent		Temporary		Permanent		
	ha	(ac)	ha	(ac)	ha	(ac)	ha	(ac)	
No Action	0	0	0	0	0	0	17	(42)	
Long Term Management	50	(120)	8	(20)	50	(120)	25	(62)	
In Situ Fill and Cap	26	(64)	17	(42)	97	(240)	25	(62)	
In Situ Vitrification	110	(270)	17	(42)	180	(440)	25	(62)	
Ex Situ Intermediate Separations	120	(300)	37	(91)	250	(620)	49	(120)	
Ex Situ No Separations	150	(370)	19	(47)	250	(620)	27	(67)	
Ex Situ Extensive Separations	110	(270)	34	(84)	240	(590)	46	(110)	
Ex Situ/In Situ Combination	110	(270)	31	(77)	200	(490)	41	(100)	
Phased Implementation (Phase1)	33	(82)	0	0	33	(82)	0	0	
Phased Imp. Total Alternative	150	(370)	40	(99)	280	(690)	52	(130)	
Capsules No Action	0	0	0.6	(1.5)	0	0	0.6	(1.5)	
Capsules On-Site Disposal	4	(10)	1.8	(4.4)	4	(10)	1.8	(4.4)	
Capsules Overpack and Ship	2	(5)	0	0	2	(5)	0	0	
Capsules Vitrify with Tank Waste	1	(3)	0	0	1	(2)	0	0	
All Capsule Alternatives									

Land Use/Habitat Numbers

Alternative	Location	Remediation Temporary Disturbance hectares	Remediation Temporary Disturbance % Shrub-Steppe	Remediation Shrub-Steppe Impacts hectares	Remediation Permanent Disturbance hectares	Remediation Permenant Dist. % Shrub-Steppe	Remediation Shrub-Steppe Permanent Impact hectares
No Action							
	Tank Farms	0					
Long Term Management							
	Tank Farms						
	New Tank Farms	50	20%	10	8	0.2	0
	Total	50		0	8		0
In Situ Fill and Cap							
	Tank Farms(operations)	1	0%	0	17	0	
	Pit 30 (operations)	25	90%	23			
	Tank Farms (barrier const.)						
	Pit 30 (barrier)						
	McGee						
	Vernita						
	Total	26		23	17		
In Situ Vitrification							
	Tank Farms (operations)	21	0%	0	17	0	
	Power Lines	70	33%	23			
	Pit 30 (operations)	20	90%	18			
	Tank Farms (barrier const.)						
	Pit 30 (barrier)						
	McGee (barrier)						
	Vernita (barrier)						
	Total	111		41	17		
Ex Situ Intermediate Separations							
	Retrieval Annexes	3	0%	0	0.4	0	
	Pit 30 (retrieval annexes)	1	90%	1			
	Vit Plant	88	67%	59	7	0	
	LAW Vaults				13	0	
	Pit 30 (treatment facilities)	25	90%	23			

Land Use/Habitat Numbers

Alternative	Location	Remediation Temporary Disturbance hectares	Remediation Temporary Disturbance % Shrub-Steppe	Remediation Shrub-Steppe Impacts hectares	Remediation Permanent Disturbance hectares	Remediation Permenant Dist. % Shrub-Steppe	Remediation Shrub-Steppe Permanent Impact hectares
	Tank Farms				17		
	Pit 30 (post rem)						
	McGee	0					
	Vernita	0					
	Total	117		83	37		
Ex Situ No Separations							
	Retrieval Annexes	3	0%	0	0.4	0	
	Pit30 (ret annexes)	1	90%	1		0	
	Vit Plant	143	67%	96	2		
	LAW Vaults	0					
	Pit 30 (treatment facilities)	7	90%	6			
	Tank Farms				17	0	
	Pit 30 (post rem)						
	McGee						
	Vernita						
	Total	154		103	19		
Ex Situ Extensive Separations							

Alternative	Location	Remediation Temporary Disturbance hectares	Remediation Temporary Disturbance % Shrub-Steppe	Remediation Shrub-Steppe Impacts hectares	Remediation Permanent Disturbance hectares	Remediation Permenant Dist. % Shrub-Steppe	Remediation Shrub-Steppe Permanent Impact hectares
	Retrieval Annexes	3	0%	0	0.4		
	Pit30 (ret annexes)	1	90%	1			
	Vit Plant	85	67%	57	7		
	LAW Vaults				10		
	Pit 30 (treatment facilities)	16	90%	14			
	Tank Farms	0			17		
	Pit 30 (post rem)	0					
	McGee						
	Vernita						
	Total	105		72	34		
Ex Situ/In Situ Combination							
	Retrieval Annexes	2	0%	0	0.2		
	Pit30 (ret annexes)	1	90%	1			
	Vit Plant	85	67%	57	7		
	LAW Vaults				7		
	Pit 30 (treatment facilities)	18	90%	16			
	Tank Farms	0			17		
	Pit 30 (post rem)	0					
	McGee						
	Vernita						
	Total	106		74	31		
Phased Implementation (Phase1)							
	Retrieval Annexes	0					
	Vit Plant	32		20			
	Pit 30	1		1			
	Tank Farms	0					
	Total	33		21	0		
Phased Imp. Total Alternative							
	Retrieval Annexes	3			0.4		

Land Use/Habitat Numbers

Alternative	Location	Remediation Temporary Disturbance hectares	Remediation Temporary Disturbance % Shrub-Steppe	Remediation Shrub-Steppe Impacts hectares	Remediation Permanent Disturbance hectares	Remediation Permenant Dist. % Shrub-Steppe	Remediation Shrub-Steppe Permanent Impact hectares
	Pit30 (ret annexes)	1	90%	0.9			
	Vit Plant	88	67%	58.96	7		
	LAW Vaults				13		
	Pit 30 (treatment facilities)	22	90%	19.8			
	Tank Farms				17		
	Pit 30 (post rem)						
	McGee						
	Vernita						
	Phase 1 Vit Plant				3		
	Total	147		79.66	40		
Capsules No Action							

Land Use/Habitat Numbers

Alternative	Location	Remediation Temporary Disturbance hectares	Remediation Temporary Disturbance % Shrub-Steppe	Remediation Shrub-Steppe Impacts hectares	Remediation Permanent Disturbance hectares	Remediation Permenant Dist. % Shrub-Steppe	Remediation Shrub-Steppe Permanent Impact hectares
	WESF	0			0.6	0	
Capsules On-Site Disposal							
	Dry-Well Facility	4		1.5	1.8		1
Capsules Overpack and Ship							
	Vit Site	2	0%				
Capsules Vitrify with Tank Waste							
	Vit Site	1	0%				
All Capsule Alternatives							

Post Remediation (Closure)					
Temporary	Temporary	Temporary	Permanent	Permanent	Permanent
Disturbance	Dist. %	Shrub-Steppe	Disturbance	Dist %	SS Dist.
hectares	Shrub-Steppe	hectares	hectares	shrub-steppe	hectares
			17		
			17		
			17		0
				0	
20	0	0	8		
14	0.9	13		0.9	
16	0.75	12			
21	0.8	17			
71		42	8		0
				0	
20	0	0	8	0	0
14	0.9	13		0.9	
16	0.75	12		0.75	
21	0.8	17		0.8	
71		42	8		0
			4	0	

Post Remediation (Closure)					
Temporary	Temporary	Temporary	Permanent	Permanent	Permanent
Disturbance	Dist. %	Shrub-Steppe	Disturbance	Dist %	SS Dist.
hectares	Shrub-Steppe	hectares	hectares	shrub-steppe	hectares
24	0	0	8	0	
50	0.9	45			
25	0.75	19			
31	0.8	25			
130		89	12		0
20	0	0	8	0	
39	0.9	35			
16	0.75	12			
21	0.8	17			
96		64	8		0

Post Remediation (Closure)					
Temporary	Temporary	Temporary	Permanent	Permanent	Permanent
Disturbance	Dist. %	Shrub-Steppe	Disturbance	Dist %	SS Dist.
hectares	Shrub-Steppe	hectares	hectares	shrub-steppe	hectares
			4	0	
24	0	0	8	0	
51	0.9	46			
25	0.75	19			
31	0.8	25			
131		90	12		0
			2	0	
22	0	0	8	0	
29	0.9	26			
21	0.75	16			
26	0.8	21			
98		63	10		0

Post Remediation (Closure)					
Temporary	Temporary	Temporary	Permanent	Permanent	Permanent
Disturbance	Dist. %	Shrub-Steppe	Disturbance	Dist %	SS Dist.
hectares	Shrub-Steppe	hectares	hectares	shrub-steppe	hectares
			4		
24	0	0	8		
50	0.9	45			
25	0.75	19			
31	0.8	25			
130		89	12		0

Post Remediation (Closure)					
Temporary	Temporary	Temporary	Permanent	Permanent	Permanent
Disturbance	Dist. %	Shrub-Steppe	Disturbance	Dist %	SS Dist.
hectares	Shrub-Steppe	hectares	hectares	shrub-steppe	hectares

TWRS EIS
CALCULATION COVER SHEET

DISCIPLINE & TITLE ENGR/COST Proposed Draft EIS Alternatives

ORIGINATOR D. Stein DATE 2/20/96

REVISION NO. Ø 1* C.H. 3/2

OBJECTIVE Re-estimate Alternative Costs based on Proposed Draft EIS basis changes (DEIS Rev C)

METHODOLOGY factor from previous cost estimates

ASSUMPTIONS Op. cost & repository fees only will be affected by changes proposed, other changes are minor & are neglected herein due to time constraints.

(Continue on another sheet if necessary)

* see ATTACHED Revision description

D. L. Stein
SIGNATURE

CHECKED: C. Henderson 3/25/96.

CALCULATION & RESULTS ATTACHED

93 ~~99~~ pages total excluding cover sheet.

1.72

JACOBS\FORMS\CALCVR.SET

JACOBS ENGINEERING GROUP INC.

DATE _____ SUBJECT _____ SHEET NO. _____

BY _____ CHKD. _____ JOB NO. _____

CALCULATION: Engr/Cost - Proposed Draft EIS Alternatives.

3/25/96 Revision:

1) Removed Phased Implementation alternative estimate with attached Calc. dated 2/27/96 for Phased Implementation.

2) Removed Cost Estimate for Modified Combo. Alternative.

FORM 91-005-1 (4/81)

RECEIVED
MAR 21 1996

Stein, David

From: Stein, David
To: Henderson, Colin
Subject: Hanford TWEIS Alternatives Cost Update
Date: Wednesday, March 20, 1996 1:35PM

Following are Hanford TWEIS Alternatives cost updates with corrections for Treatment Operating Costs. These corrections were noted in the engineering calculations dated 2/20/96, but were never transferred to the final cost tables until now. The operating costs corrections are also presented here for your comparison.

TABLE 1

	PREVIOUS OPERATING COSTS (MILLIONS)	CORRECTED OPERATING COSTS(MILLIONS)
Intermediate Separations	$5,577	$5,509
No Separations(Vitrification)	$23,273	$22,742
No Separations(Calcination)	$8,182	$7,548
ExSitu/InSitu Combination	$2,672	$2,638

TABLE 2

ALTERNATIVE	TOTAL COST(WITH REPOSITORY FEE@$360,000 PER CANISTER) TARGET VALUE (MILLIONS)	95% CONFIDENCE RANGE (MILLIONS)
Intermediate Separations	$37,818	$30,399 ----- $40,552
No Separations(Vitrification)	$252,669	$69,475 ----- $252,669
No Separations(Calcination)	$85,815	$38,789 ----- $86,141
ExSitu/InSitu Combination	$25,526	$22,990 ----- $27,913

TABLE 3

ALTERNATIVE	COST EXCLUDING REPOSITORY FEE TARGET VALUE (MILLIONS)	95% CONFIDENCE RANGE (MILLIONS)
Intermediate Separations	$25,798	$23,775 ----- $29,741
No Separations(Vitrification)	$41,209	$25,560 ----- $43,559
No Separations(Calcination)	$26,015	$22,157 ----- $28,708
ExSitu/InSitu Combination	$19,516	$17,956 ----- $22,407

These changes should bring the alternatives up to date. Let me know if I can do anything else.

Stein, David

From: Stein, David
To: Henderson, Colin
Subject: TWEIS Cost Uncertainty Update
Date: Monday, March 18, 1996 10:04AM

Following are Hanford TWEIS Alternatives Cost Uncertainty updates which include an increase for tank characterization costs ($903 million for InSitu Fill & Cap and InSitu Vitrification and 60% of $903 or $542 million for InSitu/ExSitu Combo):

ALTERNATIVE	TARGET VALUE (millions)	95% CONFIDENCE RANGE (millions)
InSitu Fill & Cap	$7,884	$6,972 — $8,815
InSitu Vitrification	$16,578	$16,185 — $23,840
InSitu/ExSitu Combo with Repository Fee @ $360,000 per canister($6,010 million)	$25,560	$22,996 — $27,947
InSitu/ExSitu Combo without Repository Fee	$19,550	$17,968 — $22,441
InSitu/ExSitu Combo with Repository Fee @ $5,000 million(Feb 96)	$24,550	$22,466 — $27,151

After reviewing the cost components of the Repository Fee in the TRW Report, I can confirm that there was no double counting when compared to the Westinghouse Data Packages. The Repository Fee included a cost for an outer barrier for the HLW package in which it is placed before insertion into the vault. This outer barrier is either in addition to the MPC or replaces the MPC, I cannot determine which.

RECEIVED
MAR 19 1996

RECEIVED
MAR 14 1996

Stein, David

From: Stein, David
To: Henderson, Colin
Subject: Hanford TWEIS Alternatives Cost Uncertainty
Date: Wednesday, March 13, 1996 12:51PM

Following are Hanford TWEIS Alternatives Cost Uncertainty Tables with and without Repository Fee (fee has been calculated using $360,000 per canister per latest directive):

TABLE 1

ALTERNATIVE	TOTAL ALTERNATIVE COST(WITH REPOSITORY FEE) TARGET VALUE (millions)	95% CONFIDENCE RANGE (millions)
Intermediate Separations	$37,886	$30,465 — $40,598
No Separations (Vitrification)	$253,200	$69,971 — $253,200
No Separations (Calcination)	$86,449	$39,406 — $86,548
Extensive Separations	$28,544	$27,477 — $36,471
ExSitu/InSitu Combination	$25,018	$22,691 — $27,197
Phased Implementation	$38,728	$31,843 — $41,756
Junior Combo	$19,461	$18,512 — $22,053

Note: For most alternatives, repository fee is so high that it dominates the cost uncertainty. I would recommend that the repository fee be considered as a separate item with no range included and just a note as to how it was calculated; e.g. $360,000 charge per canister.

TABLE 2

ALTERNATIVE	ALTERNATIVE REMEDIATION COST(EXCLUDES REP FEE) TARGET VALUE (millions)	95% CONFIDENCE RANGE (million)
Intermediate Separations	$25,866	$23,818 — $29,808
No Separations (Vitrification)	$41,740	$25,628 — $44,074
No Separations (Calcination)	$26,649	$22,276 — $29,269
Extensive Separations	$27,979	$26,580 — $35,476
ExSitu/InSitu Combination	$19,008	$17,742 — $21,774
Phased Implementation	$26,708	$25,000 — $31,109
Junior Combo	$16,331	$15,089 — $18,633

I will send copies of the model output by Fed Ex this afternoon. Give me a call if you have any questions.

Henderson, Colin

From: Stein, David
To: Henderson, Colin
Subject: Hanford TWEIS Alternatives Cost Update
Date: Wednesday, March 20, 1996 1:35PM

Following are Hanford TWEIS Alternatives cost updates with corrections for Treatment Operating Costs. These corrections were noted in the engineering calculations dated 2/20/96, but were never transferred to the final cost tables until now. The operating costs corrections are also presented here for your comparison.

TABLE 1

	PREVIOUS OPERATING COSTS (MILLIONS)	CORRECTED OPERATING COSTS(MILLIONS)
Intermediate Separations	$5,577	$5,509
No Separations(Vitrification)	$23,273	$22,742
No Separations(Calcination)	$8,182	$7,548
ExSitu/InSitu Combination	$2,672	$2,638

TABLE 2

ALTERNATIVE	TOTAL COST(WITH REPOSITORY FEE@$360,000 PER CANISTER) TARGET VALUE (MILLIONS)	95% CONFIDENCE RANGE (MILLIONS)
Intermediate Separations	$37,818	$30,399 ----- $40,552
No Separations(Vitrification)	$252,669	$69,475 ----- $252,669
No Separations(Calcination)	$85,815	$38,789 ----- $86,141
ExSitu/InSitu Combination	$25,526	$22,990 ----- $27,913

TABLE 3

ALTERNATIVE	COST EXCLUDING REPOSITORY FEE TARGET VALUE (MILLIONS)	95% CONFIDENCE RANGE (MILLIONS)
Intermediate Separations	$25,798	$23,775 ----- $29,741
No Separations(Vitrification)	$41,209	$25,560 ----- $43,559
No Separations(Calcination)	$26,015	$22,157 ----- $28,708
ExSitu/InSitu Combination	$19,516	$17,956 ----- $22,407

These changes should bring the alternatives up to date. Let me know if I can do anything else.

Henderson, Colin

From: Stein, David
To: Henderson, Colin
Subject: TWEIS Cost Uncertainty Update
Date: Monday, March 18, 1996 10:04AM

Following are Hanford TWEIS Alternatives Cost Uncertainty updates which include an increase for tank characterization costs ($903 million for InSitu Fill & Cap and InSitu Vitrification and 60% of $903 or $542 million for InSitu/ExSitu Combo):

ALTERNATIVE	TARGET VALUE (millions)	95% CONFIDENCE RANGE (millions)
InSitu Fill & Cap	$7,884	$6,972 --- $8,815
InSitu Vitrification	$16,578	$16,185 --- $23,840
InSitu/ExSitu Combo with Repository Fee @ $360,000 per canister($6,010 million)	$25,560	$22,996 --- $27,947
InSitu/ExSitu Combo without Repository Fee	$19,550	$17,968 --- $22,441
InSitu/ExSitu Combo with Repository Fee @ $5,000 million(Feb 96)	$24,550	$22,466 --- $27,151

After reviewing the cost components of the Repository Fee in the TRW Report, I can confirm that there was no double counting when compared to the Westinghouse Data Packages. The Repository Fee included a cost for an outer barrier for the HLW package in which it is placed before insertion into the vault. This outer barrier is either in addition to the MPC or replaces the MPC, I cannot determine which.

Henderson, Colin

From: Stein, David
To: Henderson, Colin
Subject: Capsule Alternatives Cost Revision(Repository Fee Change)
Date: Monday, March 18, 1996 1:54PM

Incorporating the revised Repository Fee method ($360,000 per canister) results in the following for the Capsule Alternatives:

	CAPSULE ALTERNATIVES	
	OVERPACK AND SHIP (millions)	VITRIFY WITH TANK WASTE (millions)
Current Operations	$377	$315
R&D	$14	$5
Capital	$32	$36
Operating	$34	$46
M&M	-----	$1
D&D	$6	$6
Repository Fee	$144	$232
Total	$607	$641

JACOBS ENGINEERING GROUP INC.

DATE 2/13/96 SUBJECT SHEET NO. 1-10

BY DLS CHKD. JOB NO.

Intermediate Separations Proposed DEIS

previous HLW glass — 45% waste oxide loading, 1.0 blend factor

from mass balance info

1.36E+04 MT glass formers
2.51E+04 MT glass product

proposed HLW glass — 20% waste oxide loading, 1.5 blend factor

from mass balance info

4.29E+04 MT glass formers
5.44E+04 MT glass product

ratio glass formers | ratio glass product

$\frac{4.29E+04}{1.36E+04} = 3.15$ | $\frac{5.44E+04}{2.51E+04} = 2.17$

previous LAW glass — 25% sodium oxide loading, 1.0 blend factor

from mass balance info

2.81E+05 MT glass formers
3.87E+05 MT glass product

proposed LAW glass — 15% sodium oxide loading, 1.25 blend factor

from mass balance info

7.01E+05 MT glass formers
8.07E+05 MT glass product

ratio glass formers | ratio glass product

$\frac{7.01E+05}{2.81E+05} = 2.49$ | $\frac{8.07E+05}{3.87E+05} = 2.09$

FORM 91-005-1 (4/81)

JACOBS ENGINEERING GROUP INC.

DATE 2/13/96 SUBJECT SHEET NO. 2 - 10

BY DZJ CHKD. JOB NO.

Δ cost for glass formers

HLW (see attached TPA Tables)

Category	# previous	ratio used	$ Δ
SiO_2	452,000	3.15	972,000
B_2O_3	1,750,000	3.15	3,762,000
Li_2O	2,500,000	3.15	5,375,000
electricity	110,700,000	2.17	129,519,000

12 yrs operation @ 60% overall rate — total HLW Δ $139,628,000

LAW

SiO_2	9,160,000	2.49	13,648,000
Al_2O_3	6,600,000	2.49	9,834,000
CaO	2,322,000	2.49	3,460,000
other electricity	59,300,000 × ½ (estimated)	2.09	86,820,000
Kerosene	8,670,000	2.09	9,450,000
Sulfur	46,990,000	2.09	51,219,000
DCPD	504,000	2.09	549,000
CPD	504,000	2.09	549,000

19 yrs operation @ 60% overall rate — total LAW Δ $175,529,000

Δ Other Op. Costs

	#	$ previous	HLW ratio	LAW ratio	$ Δ
vaults	(45)	225,000,000	—	$\frac{83}{40} = 2.08$	243,000,000
canisters	(6820)	68,200,000	$\frac{33,566}{6800} = 4.91$	—	266,662,000*
containers	(1705)	42,625,000	4.91	—	166,663,000
casks	(1705)	102,300,000	4.91	—	399,993,000
pads	(1)	26,000,000	4.91	—	101,660,000

total Δ other op. costs $1,177,978,000

*previously calculated in error @ $334,793,000

FORM 97-005-1 (4/87)

JACOBS ENGINEERING GROUP INC.

DATE 2/13/96 SUBJECT SHEET NO. 3-10

BY DLS CHKD. JOB NO.

Δ labor costs

total labor per TPA → $1,700,000,000

save 2yrs on HLW operations 12 vs 14

spend 5yrs on LAW operations 19 vs 14

per table 9-2 in TPA report

HLW vit. requires 1.1E+07 staff-hrs

LAW vit. requires 1.1E+07 staff-hrs

total staff hrs (everything) → 3.1E+07

$1,700,000,000 / 3.1E+07 hrs ⟹ $55/hr

2.2E+07 total

new HLW hrs = (1.1E+07) × 12/14 = 0.94E+07

new LAW hrs = (1.1E+07) × 19/14 = 1.49E+07

2.43E+07 new

vs 2.2E+07 previous

Δ labor costs = (2.43E+07) − (2.2E+07) × $55/hr

Δ labor costs = $115,500,000

other Δ op. costs for water, steam other chemicals, etc have been ignored in calculations due to their negligible effect on Δ.

Δ summary on op. costs

Δ HLW	$139,628,000
Δ LAW	175,529,000
Δ other	1,177,978,000
Δ labor	115,500,000
Δ total	$1,608,635,000
previous op. cost	$3,900,000,000
new op. cost	$5,508,635,000

FORM 91-005-1 (4/87)

JACOBS ENGINEERING GROUP INC.

DATE 2/13/96 SUBJECT SHEET NO. 4-10

BY DLS CHKD. JOB NO.

Intermediate Separations
Low Bounding Case

HLW @ 15%, 1.5 blend factor
LAW @ 10%, 1.25 blend factor

Low Bounding Case HLW glass — 15% waste oxide, 1.5 blend

mass of glass product — 7.26 E+04 mT
volume product — 2.76 E+04 m^3
Canisters — 44,500
above/below from mass balance info

Low Bounding Case HLW glass

6.11E+04 mT glass formers (7.26 − 2.51 + 1.36 = 6.11)
7.26E+04 mT glass product

(total now, total prev., formers prev.)

ratio glass formers: $\frac{6.11\text{ E+04}}{1.36\text{ E+04}} = 4.49$

ratio glass product: $\frac{7.26\text{ E+04}}{2.51\text{ E+04}} = 2.89$

Low Bounding Case LAW glass — 10% sodium oxide loading, 1.25 blend

mass of glass product — 1.21 E+06 mT
volume product — 6.57 E+05 m^3
vaults — 124
above/below from mass balance info

low bounding case LAW glass

1.10E+06 mT glass formers (12.1 − 3.87 + 2.81 = 11.04)
1.21E+06 mT glass product

(total now, total prev, formers prev)

ratio glass formers: $\frac{1.10}{2.81} = 3.91$

ratio glass product: $\frac{1.21}{3.87} = 3.13$

FORM 91-0051 (4/81)

JACOBS ENGINEERING GROUP INC.

DATE 2/13/91 SUBJECT SHEET NO. 5-10

BY DLS CHKD. JOB NO.

Δ cost for glass formers

HLW

category	$ (thousands) previous	ratio used	$ (thousands) Δ
SiO_2	452	4.49	1,577
B_2O_3	1,750	4.49	6,107
Li_2O	2,500	4.49	8,725
electricity	110,700	2.89	209,223

17 yrs operation total HLW Δ $225,632

LAW

SiO_2	9,160	3.91	26,655
Al_2O_3	6,600	3.91	19,206
CaO	2,322	3.91	6,757
other electricity	59,300 × ½	3.13	169,655 *
Kerosene	8,670	3.13	18,467
sulfur	46,990	3.13	100,089
DCPD	504	3.13	1,074
CPD	504	3.13	1,074

total LAW Δ $342,977

26 yrs operation

* previously calculated in error @ $90,005

Δ Other Op. Cost

	$ (thousands) previous	HLW ratio	LAW ratio	$ (thousands) Δ
vaults	225,000	—	$\frac{124}{40} = 3.10$	472,500
canisters	68,200	$\frac{4450}{680} = 6.54$	—	377,830
containers	42,625	6.54	—	236,140
casks	102,300	6.54	—	566,740
pads	26,000	6.54	—	144,040

total Δ other op cost $1,797,250

FORM 91-005-1 (4/81)

JACOBS ENGINEERING GROUP INC.

DATE 2/13/96 SUBJECT SHEET NO. 6-70

BY DLS CHKD. JOB NO.

Δ labor costs

new HLW hrs = (1.1E+07) × 17/14 = 1.34E+07

new LAW hrs = (1.1E+07) × 26/14 = 2.04E+07

3.38E+07 vs 2.2E+7 before

Δ labor costs = (3.38E+07) − (2.2E+07) × $55/hr

Δ labor costs = $649,000,000

Δ summary on op. costs

Δ HLW	$225,632,000
Δ LAW	342,977,000
Δ other	1,797,250,000
Δ labor	649,000,000
Δ total	$3,014,859,000
previous op. cost	3,900,000,000
new op. cost	$6,914,859,000

repository fee for 44,500 canisters = $9.1 billion

$16.02 billion

FORM 91-005-1 (4/87)

JACOBS ENGINEERING GROUP INC.

DATE 2/13/96 SUBJECT SHEET NO. 7-10

BY DLS CHKD. JOB NO.

Intermediate Separations
High Bounding Case

HLW @ 40%, 1.5 blend
LAW @ 25%, 1.25 blend

High Bounding Case HLW glass – 40%, 1.5 blend

- mass of glass product – 2.72E+04 MT
  volume product – 1.03E+04 m^3
  # canisters – 16,700

High Bounding Case HLW glass
1.57E+04 MT glass formers (2.72 – 2.51 + 1.36 = 1.57)
2.72E+04 MT glass product

(total prod, total pre, formers pre)

ratio glass formers: $\frac{1.57}{1.36} = 1.15$

ratio glass product: $\frac{2.72}{2.51} = 1.08$

High Bounding Case LAW glass – 25%, 1.25 blend

mass of glass product – 4.84E+05 MT
volume product – 2.63E+05 m^3
vaults – 50

High Bounding Case LAW glass
3.78E+05 MT glass formers (4.84 – 3.87 + 2.81 = 3.78)
4.84E+05 MT glass product

ratio glass formers: $\frac{3.78}{2.81} = 1.35$

ratio glass product: $\frac{4.84}{3.87} = 1.25$

FORM 91-005-1 (4/81)

JACOBS ENGINEERING GROUP INC.

DATE 2/13/96 SUBJECT SHEET NO. 8-10

BY DCS CHKD. JOB NO.

Δ cost for glass formers

HLW category	$ (Thousand) previous	ratio used	$ (Thousands) Δ
SiO_2	452	1.15	68
B_2O_3	1,750	1.15	262
Li_2O	2,500	1.15	375
electricity	110,700	1.08	8856
7 yrs operation		total HLW Δ	$9,561

LAW

SiO_2	9,160	1.35	3206
Al_2O_3	6,600	1.35	2310
CaO	2,322	1.35	813
other electricity	159,300 x 1/2	1.25	19913
Kerosene	8,670	1.25	2168
Sulfur	46,990	1.25	11748
DCPD	504	1.25	126
CPD	504	1.25	126
11 yrs operation		total LAW Δ	$40,410

Δ other Op. Costs	$ previous (thou)	HLW ratio	LAW ratio	$ (Thousands) Δ
Vaults	225,000	—	$\frac{50}{40}=1.25$	56,250
Canisters	68,200	$\frac{15700}{6800}=2.46$	—	99,512
Containers	42,625	2.46	—	62,232
Casks	102,300	2.46	—	149,358
pots	26,000	2.46	—	37,960
		total Δ other		$405,372

FORM 91-005-1 (4/81)

JACOBS ENGINEERING GROUP INC.

DATE 2/13/96 SUBJECT SHEET NO. 9-10

BY DLC CHKD. JOB NO.

Δ labor cost

new HLW hrs = (1.1E+07) × 7/14 = 0.55E+7

new LAW hrs = (1.1E+07) × 11/14 = 0.86E+7

1.41E+7 vs 2.2E+7

Δ labor cost = (1.41E+7) − (2.2E+7) × $55/hr

Δ labor costs = − $434,500,000

• Δ Summary on op. costs

Δ HLW	$ 9,561,000
Δ LAW	40,410,000
Δ other	405,372,000
Δ labor	−434,500,000
Δ total	$ 20,843,000
previous op. cost	$ 3,900,000,000
new op. cost	$ 3,920,843,000

repository fee for 16,700 canisters = ~~$6~~ billi

16,700 X 360,000 CAN = 6.012 billion

FORM 97-005-1 (4/81)

JACOBS ENGINEERING GROUP INC

DATE 2/13/96 SUBJECT

BY DLS CHKD.

JOB NO. 10-10 SHEET NO.

Intermediate Sep. Sensitivity Summary

	Low Bound (15% HLW, 1.5 blend; 10% LAW, 1.25 blend)	Proposed Draft ETS (20% HLW, 15% LAW)	High Bound (40% HLW, 25% LAW)
# canisters	44,500	33,386	14,700
# vaults	24	83	50
Δ HLW op cost	225.6	139.6	9.6
Δ LAW op. cost	343.0	175.5	40.4
Δ labor op. cost	649.0	115.5	-434.5
Δ other op. cost (vaults, cans, etc)	1,797.3	1,178.0	405.4
total Δ	3,014.9	1,608.6	20.9
Op. cost base	3,900	3,900	3,900
total treatment op. costs	$6,915	$5,509	$3,921
repository fees	16,020 ~~7,800~~	12,020 ~~6,500~~	$6,012 ~~5,000~~
Op. yrs. HLW	17	12	7
LAW	26	19	11

JACOBS ENGINEERING GROUP INC.

DATE 2/6/96 SUBJECT SHEET NO. 1-1

BY D Stein CHKD. JOB NO. 01K47101

Ex Situ Inter Sep Sensitivity Summary

		Proposed DEIS	
HLW glass loading	15%	20%	40%
LAW glass loading	10%	15%	25%
# canisters	44,500	33,386	16,700
# vaults	124	83	50
HLW op. yrs	17	12	7
LAW op. yrs	26	19	11
Cost Comparison			
Current Op.	$8,600	$8,600	$8,600
R+D	$820	$820	$820
Capital	$6,049	$6,049	$6,049
Operating	$~~11,655~~ 11,735	$~~10,397~~ 10329	$8,741
M+M	$1	$1	$1
Repository Fee	$~~16,020~~ ~~7,800~~	$~~12,020~~ ~~6,500~~	$~~6012~~ ~~3,000~~
	43,225	37,815	$36,223
Total Cost (1995)	$~~34,925~~	$~~32,367~~	$~~29,211~~
% variation from DEIS case	+7.9%	0%	−9.8%

WR+T Trent 4820 6835 *

WR+T Trent 4820 5577 **

WR+T Trent 4820 39,21

2/13/96 check (see calc)

2/13/96 check (see calc)

* should be corrected to 6915 per

** should be corrected to 5509 per

FORM 91-005-1 (4/81)

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			LAW		HLW		HLW fraction
	STREAM 1			407	437	314	344	
	solids	liquids		FRIT	GLASS	FRIT	GLASS	
Volume kilo-liters								
Specific Gravity								
Cs and Ba, (MCi)	5.28E+00	6.28E+01			4.93E-01		6.74E+01	0.990011751
Sr and Y, (MCi)	1.05E+02	2.10E+00			1.90E+00		1.05E+02	0.980392157
Tc, (MCi)	5.89E-03	2.61E-02			2.59E-02		5.91E-03	0.184745253
Am, (MCi)	9.51E-02	8.61E-03			8.60E-03		9.52E-02	0.917944268
Np, (MCi)	9.29E-05	1.03E-05			1.03E-05		9.29E-05	0.900193798
Pu-239, (MCi)	2.47E-02	1.67E-03			1.67E-03		2.47E-02	0.936670459
Pu-240, (MCi)	6.28E-03	4.14E-04			4.14E-04		6.28E-03	0.93815357
Pu-241,(MCi)	7.34E-02	1.49E-03			1.48E-03		7.34E-02	0.980104153
Total TRU, (MCi)	2.00E-01	1.22E-02			1.22E-02		2.00E-01	0.942507069
Total MCi	1.11E+02	6.49E+01			2.43E+00		1.73E+02	0.98351336
Total Mass Flow (MT)	1.94E+04	7.10E+05		2.81E+05	3.87E+05	1.36E+04	2.51E+04	
Total Cr, (MT)	1.32E+02	5.15E+01			1.44E+02		3.96E+01	
Total Na, (MT)	1.24E+03	6.51E+04			7.18E+04		2.33E+03	
Total Si, (MT)	5.24E+02	5.65E+00		1.07E+05	1.07E+05	5.29E+03	5.83E+03	
Total P, (MT)	7.80E+02	8.42E+02			1.35E+03		2.72E+02	
Total NO2-, (MT)	7.38E+01	9.54E+03						
Total NO3-, (MT)	1.03E+03	1.06E+05						
AG+	1.38E+00	3.28E-01						
AG2O					3.52E-01		1.48E+00	
AL+3	2.37E+03							
AL2O3				1.32E+04	1.94E+04		1.73E+03	
AL(OH)4-		4.83E+03						
AM+3	2.77E-02	2.51E-03						
AM2O3					3.76E-03		3.05E-02	
AS+5	4.98E-01	7.70E-01						
AS2O5					1.18E+00		7.66E-01	
B+3	9.94E-01	5.19E-01						
B2O3					1.67E+00	1.75E+03	1.76E+03	
BA+2	3.09E+00	7.91E-01						
BAO					8.81E-01		3.45E+00	
BE+2	7.61E-03	8.19E-02						
BEO					2.27E-01		2.16E-02	
BI+3	1.96E+02	6.76E+01						
BI2O3					7.52E+01		2.19E+02	
C14	4.53E-04	7.45E-04						
CA+2	1.35E+02	1.67E+01						
CANCRINITE	2.70E+03							
CAO				3.87E+04	3.87E+04		1.89E+02	
CD+2	7.93E+00	2.09E+00						
CDO					2.38E+00		9.06E+00	
CE+3	2.35E+02	2.37E+00						
CE2O3					2.79E+00		2.76E+02	
CL-	3.49E+00	3.11E+02						
CL2								
CO								
CO2								
CO3-2	2.25E+02	3.37E+03						
CR+3	1.32E+02							
CR2O3					2.11E+02		5.79E+01	
CR(OH)4-		1.19E+02						
CS+	9.25E-02	8.19E-01						
CS2O					6.83E-03		9.58E-01	
CU+2	7.46E-01	1.77E-01						
CUO					2.21E-01		9.34E-01	

CUSO4								
F-	5.97E+01	1.12E+03						
F2								
FE+3	7.63E+02	1.44E+01						
FE2O3					2.06E+01		1.21E+03	
H2								
H2O		5.07E+05						
H2S								
HG								
HG+2	9.00E-03	9.49E-01						
I-	2.02E+01	5.46E+02						
I2								
K+	2.10E+01	2.19E-01						
K2O					2.65E-01		2.53E+01	
KEROSENE								
LA+3	2.10E+01	2.19E-01						
LA2O3					2.58E-01		2.46E+01	
LI+	2.46E-02	5.77E-03						
LI2O					1.24E-02	5.00E+02	5.03E+02	
MG+2	1.10E+01	9.65E-01						
MGO					1.60E+00		1.88E+01	
MNO2	2.09E+02	2.17E+01			2.16E+01		2.09E+02	
MO+6	8.01E-01	4.87E+00						
MOO3					7.29E+00		1.22E+00	
N2								
NA+	7.77E+02	6.51E+04						
NA2O					9.68E+04		3.14E+03	
NH3								
NI+3	6.57E+00	4.07E+00						
NI2FECN6	5.00E+02							
NI2O3					5.72E+00		9.27E+00	
NIO					1.50E-02		2.27E+02	
NO								
NO2								
NO2-	7.38E+01	9.54E+03						
NO3-	1.03E+03	1.06E+05						
NP+4	1.32E-01	1.46E-02						
NPO2					1.66E-02		1.50E-01	
O2								
OH-	5.00E+03	6.44E+03						
PB+4	3.28E+00	1.96E+00						
PBO2					2.26E+00		3.79E+00	
PO4-3	2.39E+03	2.58E+03						
P2O5					3.09E+03		6.22E+02	
P2O5:24W	5.21E-01							
PU+4	4.27E-01	2.88E-02						
PUO2					3.26E-02		4.84E-01	
S								
SI+4	7.90E+01	5.65E+00						
SIO2				2.29E+05	2.29E+05	1.13E+04	1.25E+04	
SO2								
SO4-2	3.97E+01	2.01E+03						
SR+2	3.64E+01	3.75E-01						
SRO					4.00E-01		4.29E+01	
TCO2								
TCO4-	5.68E-01	2.52E+00						
TC2O7					2.39E+00		5.45E-01	
TOC	1.16E+02	1.42E+03						
UO2+2	1.58E+03	8.52E+01						
UO3					9.02E+01		1.67E+03	
V+5	1.88E-01	6.20E-02						
V2O5					1.11E-01		3.35E-01	
W+6		7.47E-01						
WO2					2.91E-05		4.41E-01	
WO3					9.40E-01		2.06E-03	
ZN+2	9.45E-01	3.59E+00						
ZNO					4.46E+00		1.19E+00	

ZR+4	2.77E+02	4.48E-01							
ZRO2					6.49E-01			5.90E+02	
ZRO2:2H2	4.09E+02	2.15E+01							
WHC Data Package Basis:									
Mass LAW waste oxides					106544.7302				
LAW waste loading (waste oxide)					28%				
LAW waste loading (sodium oxide)					25%				
Mass HLW waste oxides								7.26E+03	
HLW waste loading (waste oxides)								29%	
HLW									
20 wt. % waste oxide loading									
Blending factor				1	1.25	1.5	2	3.5	
Mass of glass required to achieve 25% wo loading, MT				36293.1358	45366.41975	54439.7037	72586.2716	127025.9753	
additional frit required (equals increased glass) MT				1.12E+04	2.03E+04	2.93E+04	4.75E+04	1.02E+05	
total frit required, MT				2.48E+04	3.39E+04	4.29E+04	6.11E+04	1.16E+05	
glass density (MT/m^3)	2.63								
cullet packing fraction	0.7	(LAW only)							
Waste volume (m^3)				1.38E+04	1.72E+04	2.07E+04	2.76E+04	4.83E+04	
Canister Volume (m^3)	0.62								
Number of Canisters (1x)				2.23E+04	2.78E+04	3.34E+04	4.45E+04	7.79E+04	
No. of Canisters /HMPC	4								
Number of HMPCs				5.56E+03	6.96E+03	8.35E+03	1.11E+04	1.95E+04	
Number of trips @ 10 HMPCs /trip				556	696	835	1113	1948	
Glass formulation:									
(ref Ext. Sep Data Pkg.)	acceptable range			1	1.25	1.5	2	3.5	
SiO2	42 to 57 wt %			60.07%	64.68%	67.75%	71.59%	76.52%	
B2O3	5 to 20 wt %			8.82%	9.63%	10.17%	10.84%	11.71%	
Na2O	5 to 20 wt %			8.65%	6.92%	5.77%	4.33%	2.47%	
Li2O	1 to 7 wt %			2.52%	2.75%	2.91%	3.10%	3.35%	
Fe2O3	2 to 15 wt %			3.33%	0.00%	0.00%	0.00%	0.00%	
CaO	< or= 10 wt %			0.52%	0.42%	0.35%	0.26%	0.15%	
MgO	< or = 8 wt %			0.05%	0.04%	0.03%	0.03%	0.01%	
Al2O3	< or = 15 wt %			4.77%	3.81%	3.18%	2.38%	1.36%	
ZrO2	< or = 13 wt %			1.90%	1.52%	1.27%	0.95%	0.54%	
Cr2O3	< or = 0.5 wt %			0.16%	0.13%	0.11%	0.08%	0.05%	
P2O5	< or = 3 wt %			1.71%	1.37%	1.14%	0.86%	0.49%	
SO3	< or = 0.5 wt %								
HLW Facility Sizing									
Schedule	14 yrs								
Capacity MT/day	20								
Overall efficiency, %				36%	44%	53%	71%	124%	
Required capacity MT/day (assuming 14 yrs ops, 60% OE)				11.84	14.80	17.76	23.67	41.43	
Required operating duration yrs (assuming 20 MT/day, 60% OE)					10.36	12.43	16.57	29.00	
~~15 wt. % waste oxide loading~~									
Mass of glass required to achieve 15% wo loading MT				4.84E+04	6.05E+04	7.26E+04	9.68E+04	1.69E+05	
Volume (m^3)				1.84E+04	2.30E+04	2.76E+04	3.68E+04	6.44E+04	
Number of Canisters (1x)				2.97E+04	3.71E+04	4.45E+04	5.94E+04	1.04E+05	
40 wt. % waste oxide loading									
Mass of glass required to achieve 40% wo loading MT				1.81E+04	2.27E+04	2.72E+04	3.63E+04	6.35E+04	
Volume (m^3)				6.90E+03	8.62E+03	1.03E+04	1.38E+04	2.41E+04	
Number of Canisters (1x)				1.11E+04	1.39E+04	1.67E+04	2.23E+04	3.90E+04	
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		6.45E+05	8.07E+05	9.68E+05	1.29E+06	2.26E+06	
additional frit required (equals increased glass) MT		3.64E+05	5.26E+05	6.87E+05	1.01E+06	1.98E+06	
total frit required, MT		6.45E+05	8.07E+05	9.68E+05	1.29E+06	2.26E+06	
glass density (MT/m^3)	2.63						
cullet packing fraction	0.7						
Waste volume (m^3)		3.51E+05	4.38E+05	5.26E+05	7.01E+05	1.23E+06	
Number of 5300 m^3 vaults		66	83	99	132	231	
LAW facility sizing							
Schedule, years	14						
Capacity MT/day.	200						
Overall efficiency, %		63%	79%	95%	126%	221%	
Required capacity MT/day (assuming 14 yrs ops, 60% OE)		210.48	263.10	315.72	420.96	736.68	
Required operating duration yrs (assuming 200 MT/day, 60% OE)		14.73	18.42	22.10	29.47	51.57	
10 wt. % sodium oxide loading							
Blending factor		1	[illegible]		2	3.5	
Mass of glass required to achieve 10 wt % Na2O		968000	1210000		1936000	3388000	
Waste volume, m^3		525801.195	657251.49		1051602.39	1840304.183	
Number of 5,300 m^3 vaults		99	124		198	347	
25 wt. % sodium oxide loading							
Blending factor		1	[illegible]		2	3.5	
Mass of glass required to achive 25 wt % Na2O		387200	484000		774400	1355200	
Waste Volume		210320.478	262900.59		420640.956	736121.673	
Number of 5,300 m^3 vaults		40	50		79	139	

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		6.45E+05	8.07E+05	9.68E+05	1.29E+06	2.26E+06	
additional frit required (equals increased glass) MT		3.64E+05	5.26E+05	6.87E+05	1.01E+06	1.98E+06	
total frit required, MT		6.45E+05	8.07E+05	9.68E+05	1.29E+06	2.26E+06	
glass density (MT/m^3)	2.63						
cullet packing fraction	0.7						
Waste volume (m^3)		3.51E+05	4.38E+05	5.26E+05	7.01E+05	1.23E+06	
Number of 5300 m^3 vaults		66	83	99	132	231	
LAW facility sizing							
Schedule, years	14						
Capacity MT/day	200						
Overall efficiency, %		63%	79%	95%	126%	221%	
Required capacity MT/day (assuming 14 yrs ops, 60% OE)		210.48	263.10	315.72	420.96	736.68	
Required operating duration yrs (assuming 200 MT/day, 60% OE)		14.73	18.42	22.10	29.47	51.57	
10 wt. % sodium oxide loading							
Blending factor		1	1.25		2	3.5	
Mass of glass required to achieve 10		968000	1210000		1936000	3388000	
Waste volume, m^3		525801.195	657251.4938		1051602.39	1840304.183	
Number of 5,300 m^3 vaults		99	124		198	347	
25 wt. % sodium oxide loading							
Blending factor		1	1.25		2	3.5	
Mass of glass required to achive 25 wt % Na2O		387200	484000		774400	1355200	
Waste Volume		210320.478	262900.5975		420640.956	736121.673	
Number of 5,300 m^3 vaults		40	50		79	139	

F.13 Backup for Table 9-19

Resource Requirements

Table F-37 gives the consumable resource requirements for the Tri-Party Agreement alternative data package. Where possible the information for resource usage was taken from the material balances in Appendix A. Exceptions are ion exchange media, decon chemicals, glycolic acid, raw and sanitary water, and electricity. How these values were obtained is defined in the Table 9-4 footnotes or backup. The raw material prices were taken from the "Chemical Marketing Reporter" or from the Facility Configuration Study.

Table F-38 gives the miscellaneous resource requirements for the Tri-Party Agreement alternative data package. All of the costs for the items were taken from the Facility Configuration Study except for solid waste. This value is based upon engineering judgement. The total cost for the LLW vaults in Table F-38 is a total cost which includes staffing for construction as well as consumable resources.

Table F-37. Operating Cost for Consumables.

		Unit	Pretreatment/LLW		HLW		Total	
Material	Units	Cost	Amount	Cost	Amount	Cost	Amount	Cost
Frit	Megagram	$3,860	52	$200,720		$0	52	$200,720
Flocculent	Megagram	$100	85	$8,500		$0	85	$8,500
Ion Exchange	Cubic Meter	$11,000	224	$2,464,000		$0	224	$2,464,000
NaNO2	Megagram	$210	54	$11,340		$0	54	$11,340
Sulfur	Megagram	$370	127,000	$46,990,000		$0	127,000	$46,990,000
DCPD*	Megagram	$150	3,360	$504,000		$0	3,360	$504,000
CPD**	Megagram	$150	3,360	$504,000		$0	3,360	$504,000
NaOH	Megagram	$250	26,200	$6,550,000		$0	26,200	$6,550,000
HNO3	Megagram	$160	4,190	$670,400		$0	4,190	$670,400
NH3	Megagram	$350	8,480	$2,968,000	277	$96,950	8,757	$3,064,950
Decon Chemicals	Megagram	$401	2,114	$847,714	3,171	$1,271,571	5,285	$2,119,285
Kerosene	Megagram	$150	57,800	$8,670,000		$0	57,800	$8,670,000
SiO2	Megagram	$40	229,000	$9,160,000	11,300	$452,000	240,300	$9,612,000
Al2O3	Megagram	$500	13,200	$6,600,000		$0	13,200	$6,600,000
CaO	Megagram	$60	38,700	$2,322,000		$0	38,700	$2,322,000

Table F-37. Operating Cost for Consumables.

Material	Unit	Unit Cost	Pretreatment/HLW Amount	Pretreatment/HLW Cost	HLW Amount	HLW Cost	Total Amount	Total Cost
B2O3	Megagram	$1,000		$0	1,750	$1,750,000	1,750	$1,750,000
Li2O	Megagram	$5,000		$0	500	$2,500,000	500	$2,500,000
Glycolic Acid	Megagram	$1,740		$0	3,500	$6,090,000	3,500	$6,090,000
Sanitary Water	Cubic Meter	$0.03	797,000	$23,910	303,000	$9,090	1,100,000	$33,000
Raw Water	Cubic Meter	$0.03	9,878,900	$296,367	1,121,100	$33,633	11,000,000	$330,000
Steam	Megagram	$5		$0		$0		$0
Electricity	Megawatt-Hours	$30	5,310,000	$159,300,000	3,690,000	$110,700,000	9,000,000	$270,000,000
Subtotal				$248,090,951		$122,903,244		$370,994,195

Notes:

*Dicyclopentadiene
**Cyclopentadiene

HLW = high-level waste
LLW = low-level waste

Table F-38. Other Operating Costs.

		$/Unit	Pretreatment/HLW		HLW		Total	
Material	Unit	Cost	Amount	Cost	Amount	Cost	Amount	Cost
Solid Waste	Cubic Meter	$1,000	1,000	$1,000,000	1,000	$1,000,000	2,000	$2,000,000
Equipment	Per Year	14 year	$18,000,000	$252,000,000	$5,000,000	$70,000,000		$322,000,000
Vaults	Per	$5,000,000	45	$225,000,000			45	$225,000,000
Canisters	Per	$10,000			6,820	$68,200,000	6,820	$68,200,000
Containers	Per	$25,000			1,705	$42,625,000	1705	$42,625,000
Casks	Per	$60,000			1,705	$102,300,000	1705	$102,300,000
Pads	Per	$26,000,000			1	$26,000,000	1	$26,000,000
Subtotal				$478,000,000		$310,125,000		$788,125,000
Total From Table F-37				$248,090,951		$122,903,244		$370,994,195
Grand Total				$726,090,951		$433,028,244		$1,159,119,195
Grand Total Minus Equipment				$474,090,951		$363,028,244		$837,119,195

Consumables

Note:

HLW = high-level waste
LLW = low-level waste

20-

JACOBS ENGINEERING GROUP INC.

DATE 2/19/96 SUBJECT SHEET NO. 1-2

BY DLS CHKD. JOB NO.

EZ Site No Separation Vitrification proposed DEIS

previous HLW glass - 30% sodium oxide loading, 1.0 blend factor

from mass balance info
2.50E+05 MT glass formers
3.57E+05 MT glass product

proposed HLW glass - 20% sodium oxide loading 1.5 blend factor

from mass balance info
5.64E+05 MT glass formers
6.71E+05 MT glass product

ratio glass formers	ratio glass product
$\frac{5.64E+05}{2.50E+05} = 2.26$	$\frac{6.71E+05}{3.57E+05} = 1.88$

Δ cost for glass formers

category	previous $ (Thou)	ratio	Δ $ (Thou)
SiO_2	8,160	2.26	$10,282
Al_2O_3	5,000	2.26	6,300
CaO	2,130	2.26	2,684
Kerosene	7,815	1.88	6,877
electricity	140,700	1.88	123,816
			$149,959

~same operation period, so Δ labor = 0

FORM 91-005-1 (4/81)

JE JACOBS ENGINEERING GROUP INC.

DATE 2/19/96 SUBJECT SHEET NO. 2-2

BY DZS CHKD. JOB NO.

other op. cost Δ

587,426 canisters, 0.62 m^3 each
vs. 21,400 canisters, 10 m^3 each previous
Repository Fee: 360,000 x 587,426 = 211.5 Billion

Add

			Δ $ (thou)
Canisters	$10,000/each x 587,426	=	5,874,260
Containers	$25,000/each x 587,426/4	=	3,671,413
Casks	$60,000/each x 587,426/4	=	8,811,390
pads	26,000,000 each x 587,426/6820 (per 6820 canisters)	=	2,239,454

Subtract

Canisters	$20,000/each x 21,400	=	428,000
Containers			
Casks	$65,000/each x 21,400	=	1,391,000
pads	$26,000,000/each x 21,400/6,820 x 7.5	=	612,000 *

pads not listed in No Sep. data pkg but assume one 10 m^3 canister occupies ~7.5 times area as 0.62 m^3 canister

Δ other op. cost $18,165

Δ op. cost summary (no sep. vitrification)

	Δ $
Δ glass former/electricity/fuel etc.	$149,959,000
Δ other costs	18,165,000,000
total Δ op. cost	$18,315,000,000
previous op. cost	4,427,000,000
new op. cost	$22,742,000,000

* previously calculated in error @ $81,580,000

FORM 91-005-1 (4/81)

Backup to Table 6-20. Operating Costs.

Material	Unit	Unit Cost	Vitrification	
			Material	Cost
Decon Chemicals	Megagram	$401	2,114	$848,040
Solid Waste	Cubic Meter	$1,000	1,000	$1,000,000
Kerosene	Megagram	$150	52,100	$7,815,000
Ammonia	Megagram	$350	8,570	$2,999,500
Process Water	Cubic Meter	$0.03	972,907	$29,187
SiO_2	Megagram	$40	204,000	$8,160,000
Al_2O_3	Megagram	$500	10,000	$5,000,000
CaO	Megagram	$60	35,500	$2,130,000
B_2O_3	Megagram	$1,000		$0
Li_2O	Megagram	$5,000		$0
				$27,981,727
				$1,998,695
Sanitary Water	Cubic Meter	$0.03	949,390	$28,482
Raw Water	Cubic Meter	$0.03	3,605,940	$108,178
Steam	Megagram	$5		$0
Electricity	Megawatt Hours	$30	4,690,000	$140,700,000
				$140,836,660
				$10,059,761

Table 6-17. Process Module: Overall Cost (1995 Dollars).

Process Module	No Separations
Pumping/sluicing	*
Hydraulic retrieval	*
Sludge wash	0
Cesium removal	0
Other radionuclide removal	0
Low-level waste vitrification	0
Low-level waste disposal	0
High-level waste vitrification	$7.30E9
High-level waste disposal fee	$1.29E10
Emptied single-shell tank closure	*
Emptied double-shell tank closure	*
Total	$2.02E10

Notes:

*Outside the scope of this document.

For additional backup information, see Appendix B.

Table 6-18. Overall Cost Component (1995 Dollars).

Cost Component	No Separations
Capital	$2.61E9[1]
Operating	$1.63E10[2]
Monitoring and maintenance	$5.01E7[3]
Decontamination and decommissioning	$9.77E8[4]
Research and development	$2.80E8[5]
Total	$2.02E10[6]

Notes:

[1]Total capital cost includes 40 percent contingency. Contingency is excluded from operating monitoring and maintenance, decontamination and decommissioning, research and development cost, and high-level waste disposal.

[2]Total operating cost is calculated at annual operating cost (see Table 6-20). Operating costs include startup and actual hot operations.

[3]Total monitoring and maintenance cost is calculated in footnote 1 of Table 6-20. Monitoring and maintenance is for the HLW canisters stored onsite.

[4]Total decontamination and decommissioning cost is calculated as the sum of 30 percent of the capital cost plus three years of annual operating labor cost (Boomer et al.). Decontamination and decommissioning is defined as the extombment of the radioactively contaminated facilities located in the 200 East Area.

[5]Based on the research and development costs associated with the low-level waste Vitrification Facility (Boomer et al. 1994). Although high-level waste research and development costs are lower ($250,000,000), it is assumed that unknowns associated with no separations and the large equipment size will require additional testing.

[6]Costs associated with routine tank farm operations, estimated at $4,070 million (1995 dollars) are not included in these totals. In addition, costs associated with TWRS program management, characterization, tank farm upgrades, SST saltwell pumping, and tank farm safety issues resolution are not included.

For additional backup information, see Appendix B.

Boomer, K. D. and J. M. Colby, T. W. Crawford, J. S. Garfield, J. D. Galbraith, C. E. Golberg, C. E. Leach, D. E. Mitchell, F. D. Nankani, B. J. Slaathaug, L. M. Swanson, T. L. Waldo and C. M. Winkler, 1994, *Tank Waste Remediation System Facility Configuration Study*, WHC-SD-WM-ES-295, Rev. 0, Westinghouse Hanford Company, Richland, Washington.

Table 6-19. Capital Cost Component (1995 Dollars).

Capital Cost Component	No Separations
Labor	$1.07E9[1]
Materials and supplies	$4.61E8[1]
Equipment	$8.18E8[1]
Local purchases	$2.61E8[2]
Total	$2.61E9

Notes:

[1]See cost estimate in Appendix D.

[2]Assumed to be 18 percent of total materials and supplies and equipment purchases, based on Westinghouse Hanford Company 1994 procurement.

Table 6-20. Operating Cost Component (1995 Dollars).

Operating Cost Component	No Separations
Labor	$1.18E9[1]
Materials and supplies	$1.40E8[2]
High-level waste casks/canisters	$1.82E9[3]
Equipment	$2.10E8[4]
High-level waste disposal fee	$1.29E10[5]
Total	$1.63E10

Notes:

[1]From Table 6-3 Operational Personnel

(227E)($130,000/yr)(14 yr operations + 2 year startup + 1.5 yr decontamination and decommissioning)

(53 NE)($60,000/yr)(14 yr operations + 2 year startup + 1.5 yr decontamination and decommissioning)

(338 BU)($90,000/yr)(14 yr operations + 2 year startup + 1.5 yr D&D)

Total = $1.13E9

From Table 6-14 Monitoring and Maintenance Personnel

(1 E)($130,000/yr)(60 yr)

(1 NE)($60,000/yr)(60 yr)

(8 BU)($90,000/yr)(60 yr)

Total = $5.46E7

Grand Total = $1.18E9

[2]Includes cold chemicals and utilities at $10 million/year for 14 years (18% assumed to be purchased locally).

[3]Based on total cost requirement of 21,400 SS unshielded canisters and 21,400 concrete interim shielding casks. Canister/cask cost is from facility configuration study which assumes $65k for each cask and $20k for each canister.

[4]Based on replacement of melter at $15 million/year for 14 years (18% assumed to be purchased locally).

Table 6-20. Operating Cost Component (1995 Dollars).

Notes (Continued):

[f]Table D-8 (TRW 1995) estimates the repository fee for the No Separations Alternative (Case 7-5SC) would be $8,800 million higher than the estimated repository fee for Case 1C, using the TRW Total System Life Cycle Cost model developed for the Office of Civilian Radioactive Waste Management. Per informal communications with Mr. Don Nitti of TRW on May 31, 1995, Hanford's repository fee for case 1C is estimated as follows:

Two repository case total life cycle cost	=	$48.294 billion
Defense program share	=	15.7%
Hanford's share based on ratio of number of Hanford waste packages (2,465) to total defense program waste packages (4,588), from Table 2-4 (TRW 1995)	=	53.7%

Hanford's share of Case 1C:
($48.294 billion x 0.157 x 0.537) = $4.072 billion

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.

Table 6-21. Overall Schedule (Calendar Year Start/Completion Date).

Activity	No Separations
Construction	06/1997[(1)] - 12/2002
Operation	12/2004 - 12/2018[1]
Decontamination and decommissioning	01/2019 - 12/2023[2]
Monitoring and maintenance	1/2005 - 12/2027[3]
Research and development	1995 - 2005[4]

Notes:

[1]Assumes high-level waste no separations will start operating in place of the pretreatment facility.

[2]Assumes 5 years per facility for decontamination and decommissioning after 14 years of operation.

[3]Assumes that the high level-waste casks stored on the Hanford Site will required monitoring until they are transported to the deep geologic repository. Monitoring and maintenance of the HLW product is assumed to begin one month after start of operations and would continue until completion of shipping to the geologic repository. Shipment of HLW canisters to the repository is assumed to occur over the period 2017 through 2027 (TRW 1995, Table D-6).

[4]Based on the draft multi-year program plan and will continue for one year after the start of operation of the high-level waste facility.

Boomer, K. D. and J. M. Colby, T. W. Crawford, J. S. Garfield, J. D. Galbraith, C. E. Golberg, C. E. Leach, D. E. Mitchell, F. D. Nankani, B. J. Slaathaug, L. M. Swanson, T. L. Waldo and C. M. Winkler, 1994, *Tank Waste Remediation System Facility Configuration Study*, WHC-SD-WM-ES-295, Rev. 0, Westinghouse Hanford Company, Richland, Washington.

DOE, 1990, *Radioactive Waste Management*, DOE Order 5820.2A, U.S. Department of Energy, Washington, D.C.

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.

36-

Assumptions:							
1. HLW glass waste oxide loading basis to be 20 wt% sodium oxides							
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 % sodium oxide loading							
	Input		Frit	Output			
	Stream1		stream407	stream437			
	liquids	solids					
Volume kilo-liters	5.85E+05						
Specific Gravity	1.21E+00						
Cs and Ba, (MCi)	6.28E+01	5.28E+00		6.79E+01			
Sr and Y, (MCi)	2.10E+00	1.05E+02		1.07E+02			
Tc, (MCi)	2.61E-02	5.89E-03		3.18E-02			
Am, (MCi)	8.61E-03	9.51E-02		1.04E-01			
Np, (MCi)	1.03E-05	9.29E-05		1.03E-04			
Pu-239, (MCi)	1.67E-03	2.47E-02		2.64E-02			
Pu-240, (MCi)	4.14E-04	6.28E-03		6.70E-03			
Pu-241,(MCi)	1.49E-03	7.34E-02		7.48E-02			
Total TRU, (MCi)	1.22E-02	2.00E-01		2.12E-01			
Total MCi	6.49E+01	1.11E+02		1.76E+02			
Total Mass Flow (MT)	7.10E+05	1.94E+04	2.50E+05	3.57E+05			
Total Cr, (MT)	5.15E+01	1.32E+02		1.84E+02			
Total Na, (MT)	6.51E+04	1.24E+03		6.63E+04			
Total Si, (MT)	5.65E+00	5.24E+02	9.56E+04	9.61E+04			
Total P, (MT)	8.42E+02	7.80E+02		1.62E+03			
Total NO2-, (MT)	9.54E+03	7.38E+01					
Total NO3-, (MT)	1.06E+05	1.03E+03					
AG+	3.28E-01	1.38E+00					
AG2O				1.83E+00			
AL+3		2.37E+03					
AL2O3			1.00E+04	1.79E+04			
AL(OH)4-	4.83E+03						
AM+3	2.51E-03	2.77E-02					
AM2O3				3.32E-02			
AS+5	7.70E-01	4.98E-01					
AS2O5				1.95E+00			
B+3	5.19E-01	9.94E-01					
B2O3				4.87E+00			
BA+2	7.91E-01	3.09E+00					
BAO				4.33E+00			
BE+2	8.19E-02	7.61E-03					
BEO				2.48E-01			
BI+3	6.76E+01	1.96E+02					
BI2O3				2.94E+02			
C14	7.43E-04	4.53E-04					
CA+2	1.67E+01	1.33E+02					

CANCRINITE		2.70E+03					
CAO			3.55E+04	3.58E+04			
CD+2	2.09E+00	7.93E+00					
CDO				1.14E+01			
CE+3	2.37E+00	2.35E+02					
CE2O3				2.78E+02			
CL-	3.11E+02	3.49E+00					
CL2							
CO							
CO2							
CO3-2	3.37E+03	2.25E+02					
CR+3		1.32E+02					
CR2O3				2.68E+02			
CR(OH)4-	1.19E+02						
CS+	8.19E-01	9.25E-02					
CS2O				9.65E-01			
CU+2	1.77E-01	7.46E-01					
CUO				1.16E+00			
CUSO4							
F-	1.12E+03	5.97E+01					
F2							
FE+3	1.44E+01	7.63E+02					
FE2O3				1.23E+03			
H2							
H2O	5.07E+05						
H2S							
HG							
HG+2	9.49E-01	9.00E-03					
I-	5.46E+02	2.02E+01					
I2							
K+	2.19E-01	2.10E+01					
K2O				2.56E+01			
KEROSENE							
LA+3	2.19E-01	2.10E+01					
LA2O3				2.49E+01			
LI+	5.77E-03	2.46E-02					
LI2O				6.53E-02			
MG+2	9.65E-01	1.10E+01					
MGO				1.98E+01			
MNO2	2.17E+01	2.09E+02		2.31E+02			
MO+6	4.87E+00	8.01E-01					
MOO3				8.51E+00			
N2							
NA+	6.51E+04	7.77E+02					
NA2O				8.94E+04			
NH3	-						
NI+3	4.07E+00	6.57E+00					
NI2FECN6		5.00E+02					
NI2O3				1.50E+01			

32-

NIO				2.27E+02			
NO							
NO2							
NO2-	9.54E+03	7.38E+01					
NO3-	1.06E+05	1.03E+03					
NP+4	1.46E-02	1.32E-01					
NPO2				1.66E-01			
O2							
OH-	6.44E+03	5.00E+03					
PB+4	1.96E+00	3.28E+00					
PBO2				6.05E+00			
PO4-3	2.58E+03	2.39E+03					
P2O5				3.71E+03			
P2O5:24W		5.21E-01					
PU+4	2.88E-02	4.27E-01					
PUO2				5.16E-01			
S							
SI+4	5.65E+00	7.90E+01					
SIO2			2.04E+05	2.06E+05			
SO2							
SO4-2	2.01E+03	3.97E+01					
SR+2	3.75E-01	3.64E+01					
SRO				4.33E+01			
TCO2							
TCO4-	2.52E+00	5.68E-01					
TC2O7				2.94E+00			
TOC	1.42E+03	1.16E+02					
UO2+2	8.52E+01	1.58E+03					
UO3				1.76E+03			
V+5	6.20E-02	1.88E-01					
V2O5				4.46E-01			
W+6	7.47E-01						
WO2				4.41E-01			
WO3				9.42E-01			
ZN+2	3.59E+00	9.45E-01					
ZNO				5.65E+00			
ZR+4	4.48E-01	2.77E+02					
ZRO2				7.07E+02			
ZRO2:2H2	2.15E+01	4.09E+02					
WHC data package basis:							
mass waste oxides				1.08E+05	1.16E+5		
waste loading (wt%)				30%			
sodium oxide loading				25%			
20 wt. % sodium oxide loading							
Blending factor			1	1.25	1.5	2	3.5
Mass of glass required to achieve 20% sodium loading, M			4.47E+05	5.59E+05	6.71E+05	8.94E+05	1564500
additional frit required (equals increased glass) MT			9.00E+04	2.02E+05	3.14E+05	5.37E+05	1.21E+06

35-

total frit required, MT			3.40E+05	4.52E+05	5.64E+05	7.87E+05	1.46E+06
glass density (MT/m^3)	2.63						
cullet packing fraction	0.7						
Waste volume (m^3)			2.43E+05	3.04E+05	3.64E+05	4.86E+05	8.50E+05
Canister Volume (m^3)	0.62						
Number of Canisters (1x)			3.92E+05	4.90E+05	5.87E+05	7.83E+05	1.37E+06
Number of Canisters per HMPC		4					
Number of HMPCs			9.79E+04	1.22E+05	1.47E+05	1.96E+05	3.43E+05
Number of trips @ 10 HMPCs /trip			9.79E+03	1.22E+04	1.47E+04	1.96E+04	3.43E+04
Glass formulation:							
(ref Ext. Sep Data Pkg.	acceptable range	Calculated value					
SiO2	42 to 57 wt %		62.51%	66.33%	68.88%	72.06%	76.15%
B2O3	5 to 20 wt %		0.00%	0.00%	0.00%	0.00%	0.00%
Na20	5 to 20 wt %		20.00%	16.00%	13.33%	10.00%	5.71%
Li2O	1 to 7 wt %		0.00%	0.00%	0.00%	0.00%	0.00%
Fe2O3	2 to 15 wt %		0.28%	0.22%	0.18%	0.14%	0.08%
CaO	< or= 10 wt %		10.87%	11.53%	11.98%	12.53%	13.25%
MgO	< or = 8 wt %		0.00%	0.00%	0.00%	0.00%	0.00%
Al2O3	< or = 15 wt %		4.81%	4.65%	4.54%	4.40%	4.23%
ZrO2	< or = 13 wt %		0.16%	0.13%	0.11%	0.08%	0.05%
Cr2O3	< or = 0.5 wt %		0.06%	0.05%	0.04%	0.03%	0.02%
P2O5	< or = 3 wt %		0.83%	0.66%	0.55%	0.41%	0.24%
SO3	< or = 0.5 wt %						
Facility Sizing							
Schedule	14 yrs						
Capacity MT/day	200						
Overall efficiency, %			44%	55%	66%	87%	153%
Required capacity MT/day (assuming 14 yrs ops, 60% OE)				182	219	292	510
Required operating duration yrs (assuming 200 MT/day, 60% OE)				13	15	20	36
15 wt % sodium oxide loading							
Mass of glass required to achieve 15% wo loading MT			5.96E+05			Na2O loadin	15%
Volume (m^3) as cullet			3.24E+05				
Number of Canisters (1x)			5.22E+05				
40 wt % sodium oxide loading							
Mass of glass required to achieve 40% wo loading MT			2.24E+05			Na2O loadin	40%
Volume (m^3) as cullet			1.21E+05				
Number of Canisters (1x)			1.96E+05				

JACOBS ENGINEERING GROUP INC.

DATE 2/19/96 SUBJECT SHEET NO. 1-1

BY DLS CHKD. JOB NO.

Ex Situ No. 1 Separations Calcination Proposed DEIS

The only change for calcination is in operating costs for canisters, casks, pads, etc due to change in canister size from 1.0 m^3 to 0.62 m^3 each.

$$10{,}300 \text{ canisters (previous)} \times \frac{1.0\,m^3}{0.62\,m^3} = 166{,}129 \text{ canisters (new)}$$

Add

				Δ $
canisters	$10,000/each	× 166,129	=	$1,661,290,000
containers	$25,000/each	× 166,129/4	=	1,038,306,000
casks	$60,000/each	× 166,129/4	=	2,491,935,000
pads	$25,000,000/each	× nil	=	0 *

subtract

canisters	$20,000/each	× 10,300	=	206,000,000
containers				
casks	$65,000/each	× 10,300	=	669,500,000
				$4,315,000,000

(assume pad areas are about the same for each case for this estimate)

previous op cost 3,233,000,000

$7,548,000,000

Repository Fee = $360,000 × 166129 = $59.8 billion

* previously calculated in error @ $633,336,000

FORM 91-005-1 (4/81)

TWRS EIS
CALCULATION COVER SHEET

DISCIPLINE & TITLE Engineering / Number of Canisters, Trips, and Curie Concentrations in the HLW for rad/tran input. Perform for all Ex Situ alternatives.

ORIGINATOR Colin Henderson DATE 1/27/96

REVISION NO. 0

OBJECTIVE Using New baseline Assumption for waste loading and Canister size and Blending factor Calculate the Number of Canisters, trips and Isotopic Concentration in the HLW product

METHODOLOGY Use WHC Rev 0 data packages to determine Curies/m³ in the Old Case waste and Ratio By the change in volume to determine Conc for new base Case. Combination alt. calculated based on % recovered on an isotope by isotope basis.

ASSUMPTIONS Noted.

(Continue on another sheet if necessary)

J C Henderson
SIGNATURE

CALCULATION & RESULTS ATTACHED

JACOBS\FORMS\CALCVR.SET

1. HLW glass for any of the ex situ alternatives involving separations is calculated at 20 wt % waste oxides. The waste oxides exclude silica and sodium.
2. The HLW for the No Separations case is calculated at 20 wt % sodium oxide.
Note: EA glass limits are 17% Na_2O and 4.3% Li_2O and each Li_2O is equivalent to 2 Na_2O so the EA glass is equivalent to 25% Na_2O without any Li_2O. The privatization RFP states that the HLW glass will be 25 wt % waste oxides not counting the Na_2O or SiO_2.
3. The LAW glass composition is calculated at 15 wt % Na_2O.
4. The canister size for all HLW is set at 0.62 m^3 (1X canister)
5. The material balances contained in the WHC data packages were used to calculate the waste oxides for the HLW and LAW streams.
6. Sensitivity analysis will be done for the Intermediate Separations alternative at 15 wt %, and 40 wt % waste oxide loading.
7. The material balance for the Intermediate Separations case was used for the Phased Implementation alternative and was modified to account for additional radionuclide separations.
8. For purposes of interim onsite storage and transportation to the repository 4 of the 1x cans are assumed to be placed into an HMPC or similar packaging and would be repackaged at the repository.

Pg 2/10.

No Separations WHC data package values					
			Vitrification		
Radionuclide Inventory			No Separations		
			HLW Glass (WHC data pkg)		
			Total Curies		
Am-241			1.04E+05		
Am-243			3.32E+01		
Cm-244			1.18E+02		
Cs-137			3.49E+07		
Ni-63			2.69E+05		
Np-237			6.97E+01		
Pu-238			1.08E+03		
Pu-239			2.64E+04		
Pu-240			6.70E+03		
Pu-241			7.49E+04		
Ru-106			3.79E-02		
Sm-151			6.30E+05		
Sn-126			6.27E+02		
Sr-90			4.36E+07		
Tc-99			3.21E+04		
U-233			1.21E-02		
U-234			2.12E-01		
U-235			2.06E+01		
U-238			4.81E+02		
Zr-93			3.94E+03		
Total (m3)			1.36E+05		
Note: Curies from decay daughter products not included					

No Separations Alternative New Base Case (1/26/96)					
	20 wt% sodium oxide loading, 1.5 blending factor				
			Vitrification		Calcination
			Radionuclide		Radionuclide
			Concentration		Concentration
			Curies /m^3		Curies /m^3
Am-241			2.86E-01		1.55E+00
Am-243		3.32E1 ÷ 364E5 =	9.12E-05	SK	4.94E-04
Cm-244			3.24E-04		1.76E-03
Cs-137			9.58E+01		5.19E+02
Ni-63			7.39E-01		4.00E+00
Np-237			1.91E-04		1.04E-03
Pu-238			2.97E-03		1.61E-02
Pu-239			7.25E-02		3.93E-01
Pu-240			1.84E-02		9.97E-02
Pu-241			2.06E-01		1.11E+00
Ru-106			1.04E-07		5.64E-07
Sm-151			1.73E+00		9.38E+00
Sn-126			1.72E-03		9.33E-03
Sr-90			1.20E+02		6.49E+02
Tc-99			8.81E-02		4.78E-01
U-233			3.32E-08		1.80E-07
U-234			5.82E-07		3.15E-06
U-235			5.66E-05		3.07E-04
U-238			1.32E-03		7.16E-03
Zr-93			1.08E-02		5.86E-02
Total (m3)			3.64E+05		6.72E+04
Number of 0.62 m^3 canisters			5.87E+05		108388
Number of 0.62 m^3 canisters per HMPC			4		4
Number of trips to the repository			14686	14679	2710
Based on 10 HMPCs per train					
Note: Curies from decay daughter products not included					

10,300 canisters × 10 m³ each (old) / 0.62 m³ each (new)

= 166,129 canisters

Intermediate Separations WHC data package values		
Radionuclide Inventory	Low-Level Waste Glass Ci/m3	High-Level Waste Glass Ci/m3
Am-241	3.90E-02	1.00E+01
Am-243	1.30E-05	3.20E-03
C-14		
Cm-244	4.70E-06	5.90E-03
Cs-135	4.80E-06	1.50E-02
Cs-137	1.20E+00	3.70E+03
I-129		
Ni-63	2.60E-02	2.80E+01
Np-237	3.20E-05	6.60E-03
Pu-238	3.10E-04	1.10E-01
Pu-239	7.60E-03	2.60E+00
Pu-240	1.90E-03	6.70E-01
Pu-241	6.70E-03	7.80E+00
Ra-226		
Ru-106	8.50E-09	3.80E-06
Sm-151	3.10E-02	6.60E+01
Sn-126	7.20E-04	5.00E-02
Sr-90	4.30E+00	5.60E+03
Tc-99	1.20E-01	6.30E-01
Th-230	2.30E-12	4.10E-09
U-233	2.80E-09	1.20E-06
U-234	4.90E-08	2.10E-05
U-235	4.80E-06	2.10E-03
U-238	1.10E-04	4.80E-02
Zr-93	1.60E-05	4.10E-01
Total (m3)3	2.20E+05	9.40E+03
Note: Curies from decay daughter products not included		

5/10

Intermediate Separations New Base Case (1/26/96)			
20 wt% waste oxide loading, 1.5 blending factor			
		Sensitivity @	Sensitivity@
	Base Case	15 wt% loading	40 wt% loading
Radionuclide Inventory	HLW	HLW	HLW
	glass	glass	glass
	Ci/m^3	Ci/m^3	Ci/m^3
Am-241	4.54E+00	3.41E+00	9.08E+00
Am-243	1.45E-03	1.09E-03	2.91E-03
C-14	0.00E+00	0.00E+00	0.00E+00
Cm-244	2.68E-03	2.01E-03	5.36E-03
Cs-135	6.81E-03	5.11E-03	1.36E-02
Cs-137	1.68E+03	1.26E+03	3.36E+03
I-129	0.00E+00	0.00E+00	0.00E+00
Ni-63	1.27E+01	9.54E+00	2.54E+01
Np-237	3.00E-03	2.25E-03	5.99E-03
Pu-238	5.00E-02	3.75E-02	9.99E-02
Pu-239	1.18E+00	8.86E-01	2.36E+00
Pu-240	3.04E-01	2.28E-01	6.09E-01
Pu-241	3.54E+00	2.66E+00	7.08E+00
Ra-226	0.00E+00	0.00E+00	0.00E+00
Ru-106	1.73E-06	1.29E-06	3.45E-06
Sm-151	3.00E+01	2.25E+01	5.99E+01
Sn-126	2.27E-02	1.70E-02	4.54E-02
Sr-90	2.54E+03	1.91E+03	5.09E+03
Tc-99	2.86E-01	2.15E-01	5.72E-01
Th-230	1.86E-09	1.40E-09	3.72E-09
U-233	5.45E-07	4.09E-07	1.09E-06
U-234	9.54E-06	7.15E-06	1.91E-05
U-235	9.54E-04	7.15E-04	1.91E-03
U-238	2.18E-02	1.63E-02	4.36E-02
Zr-93	1.86E-01	1.40E-01	3.72E-01
Total (m3)3	2.07E+04	2.76E+04	1.03E+04
Number of 0.62 m^3 canisters	3.34E+04	4.45E+04	1.67E+04
Number of 0.62 m^3 can/HMPC	4	4	4
Number of HMPCs	8347	11129	4173
Number of trips to the repository at 10 HMPCs per trip	835	1113	418
Note: Curies from decay daughter products not included			

TS 6/10

Extensive Separations Data Package values		
Note: data package values modified by ECN to Rev 0 data package		
Radionuclide Inventory	HLW Glass	LLW Glass
	Base Case (A-1)	Base Case (A-1A)
	Ci/m3	Ci/m3
Am-241	2.09E+02	7.34E-04
Am-243	6.69E-02	2.35E-07
C-14	0.00E+00	0.00E+00
Cm-244	2.30E-01	4.56E-06
Cs-135	2.91E-01	9.16E-07
Cs-137	7.02E+04	2.21E-01
I-129	0.00E+00	0.00E+00
Ni-63	8.47E+00	1.83E+00
Np-237	1.40E-01	1.87E-05
Pu-238	2.15E+00	7.80E-05
Pu-239	5.25E+01	1.90E-03
Pu-240	1.33E+01	4.84E-04
Pu-241	1.49E+02	5.41E-03
Ra-226	5.40E-10	7.20E-16
Ru-106	7.58E-05	1.01E-10
Sm-151		1.68E-03
Sn-126	1.25	1.67E-06
Sr-90	1.07E+05	3.72E-02
Tc-99	6.43E+01	1.06E-03
Th-230	7.80E-08	1.04E-13
U-233	3.68E-08	5.19E-11
U-234	6.76E-07	9.10E-10
U-235	6.57E-05	8.84E-08
U-238	1.53E-03	2.06E-06
Zr-93	9.59E-02	2.68E-02
total m3	496	1.47E+05
		solid
Note: Curies from decay daughter products not included		

7/10

Extensive Separations alternative New Base Case (1/26/96)

20 wt% waste oxide loading, 1.5 blending factor

Extensive Separations Data Package values

Radionuclide Inventory	HLW Glass Base Case (A-1) Ci/m3
Am-241	1.06E+02
Am-243	3.41E-02
C-14	0.00E+00
Cm-244	1.17E-01
Cs-135	1.48E-01
Cs-137	3.58E+04
I-129	0.00E+00
Ni-63	4.31E+00
Np-237	7.13E-02
Pu-238	1.09E+00
Pu-239	2.67E+01
Pu-240	6.77E+00
Pu-241	7.59E+01
Ra-226	2.75E-10
Ru-106	3.86E-05
Sm-151	0.00E+00
Sn-126	6.37E-01
Sr-90	5.45E+04
Tc-99	3.27E+01
Th-230	3.97E-08
U-233	1.87E-08
U-234	3.44E-07
U-235	3.35E-05
U-238	7.79E-04
Zr-93	4.88E-02
total m3	9.74E+02

Number of 0.62 m^3 canisters	1571
Number of 0.62 m^3 can/HMPC	4
Number of HMPCs	393
Number of trips to the repository @ 10 HMPCs/trip	40

Note: Curies from decay daughter products not included

PS 8/10

Phased Implementation alternative New Base Case (1/26/96)

20 wt % waste oxide loading, 1.5 blending factor

Radionuclide Inventory	Base Case HLW glass Ci/m^3
Am-241	5.01E+00
Am-243	1.60E-03
C-14	0.00E+00
Cm-244	2.68E-03
Cs-135	6.81E-03
Cs-137	1.68E+03
I-129	0.00E+00
Ni-63	1.27E+01
Np-237	3.00E-03
Pu-238	5.15E-02
Pu-239	1.26E+00
Pu-240	3.19E-01
Pu-241	3.57E+00
Ra-226	0.00E+00
Ru-106	1.73E-06
Sm-151	3.00E+01
Sn-126	2.27E-02
Sr-90	2.56E+03
Tc-99	1.54E+00
Th-230	1.86E-09
U-233	5.45E-07
U-234	9.54E-06
U-235	9.54E-04
U-238	2.18E-02
Zr-93	1.86E-01
Total (m3)	2.07E+04
Number of 0.62 m^3 canisters	33386.30179

Number of 0.62 m^3 canisters	33387
Number of 0.62 m^3 can/HMPC	4
Number of HMPCs	8347
Number of trips to the repository @ 10 HMPC/trip	835

Note: Curies from decay daughter products not included

Ex Situ / In Situ Combination Alternative New Base Case (1/26/96)

20 wt% waste oxide loading, 1.5 blending factor

Radionuclide Inventory	HLW glass Ci/m^3	Sel Ret. Recovery fraction
Am-241	6.97E+00	7.67E-01
Am-243	2.67E-03	9.20E-01
C-14	0.00E+00	9.00E-01
Cm-244	5.04E-03	9.40E-01
Cs-135	1.16E-02	8.50E-01
Cs-137	2.96E+03	8.80E-01
I-129	0.00E+00	9.00E-01
Ni-63	2.03E+01	8.00E-01
Np-237	5.58E-03	9.32E-01
Pu-238	3.97E-02	3.97E-01
Pu-239	1.48E+00	6.27E-01
Pu-240	3.69E-01	6.07E-01
Pu-241	4.01E+00	5.65E-01
Ra-226	0.00E+00	8.30E-01
Ru-106	1.28E-06	3.70E-01
Sm-151	4.32E+01	7.20E-01
Sn-126	3.32E-02	7.30E-01
Sr-90	3.56E+03	7.00E-01
Tc-99	5.15E-01	9.00E-01
Th-230	3.05E-09	8.20E-01
U-233	8.72E-07	8.00E-01
U-234	1.54E-05	8.10E-01
U-235	1.74E-03	9.10E-01
U-238	3.92E-02	9.00E-01
Zr-93	2.49E-01	6.70E-01
Total (m3)	1.03E+04	

Number of 0.62 m^3 canisters	(16694) 16613	
Number of 0.62 m^3 can/HMPC	4	
Number of HMPCs	4174	4154
Number of trips to the repository	4 to HMPC per trip 418	416

Note the combination alt. retrieval fraction is calculated from the % of SST and DST inventory recovered as follows: recovery fraction = (curies recovered from SSTs ÷ Curies from DSTs) divided by (total curies in the SSTs ÷ total curies in DSTs)

The combination alternative volume of HLW glass is 1/2 of the Intermediate Separations

Note: Curies from decay daughter products not included

Extensive Separations
Proposed DEIS

previous HLW glass – 34% waste oxide loading, 1.0 blend factor

from mass balance info
8.73 E +02 MT glass formers
1.32 E +03 MT glass product

proposed HLW glass – 20% waste oxide loading, 1.5 blend factor

from mass balance info
2.11 E +03 MT glass formers
#Canisters = 1570 2.56 E +03 MT glass product

ratio glass formers: $\frac{2.11E+03}{8.73E+02} = 2.42$

ratio glass product: $\frac{2.56E+03}{1.32E+03} = 1.94$

previous LAW glass – 25% sodium oxide loading, 1.0 blend factor

from mass balance info
2.65 E +05 MT glass formers
3.86 E +05 MT glass product

proposed LAW glass – 15% sodium oxide loading, 1.25 blend factor

from mass balance info
6.83 E +05 MT glass formers
8.04 E +05 MT glass product

ratio glass formers: $\frac{6.83 E+05}{2.65 E+05} = 2.58$

ratio glass product: $\frac{8.04 E+05}{3.86 E+05} = 2.08$

Since no breakdown of glass formers between HLW & LAW is provided in Ext. Sep. Data Pkg. and since HLW glass formers cost is small compared to LAW glass formers, ratio all glass formers costs from LAW ratio only.

• Δ cost for glass formers

(see attached Ext. Sep.)

category	previous $ (thousands)	ratio	Δ $ (thou)
B_2O_3	57,500	2.58	$90,850
Li_2O	10,500	2.58	16,590
SiO_2	11,480	2.58	18,138
MgO	2,050	2.58	3,239
CaO	246	2.58	388
Kerosene	10,525	2.08	11,367
Sulfur	62,927	2.08	67,961
DCPD	672	2.08	725
CPD	672	2.08	725
Electricity	498,000	1.8	398,400
			$608,383

(same electricity ratio new/prev. used for inter. sep.)

~ Same duration of operation as before

Therefore Δ labor = 0

JACOBS ENGINEERING GROUP INC.

DATE 2/19/96 SUBJECT SHEET NO. 3-3

BY DJS CHKD. JOB NO.

△ Other Op. Costs

	$ previous	ratio	$ △ (Thous)
Vaults	190,000	83/38 = 2.18	$224,200
Canisters	4,480	1577/448 = 3.51	11,245
overpacks	6,720	3.51	16,867
			$252,312

△ summary on op. costs

LAW/HLW combined op. costs	$608,383,000
other costs	252,312,000
△ total	$860,695,000
previous op. cost	4,556,000,000
new op. cost	$5,416,695,000

Repository Fee = 1570 CAUX 360K = $565 million

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							
not counting the SiO2 or the Na2O							
	Input Stream			LAW			HLW	
	STREAM 1			407	437		1314	1344
	solids	liquids		FRIT	GLASS		FRIT	GLASS
Volume kilo-liters		5.84E+05						
Specific Gravity		1.21E+00						
Cs and Ba, (MCi)	7.60E+00	6.72E+01			6.86E-02			7.46E+01
Sr and Y, (MCi)	1.37E+02	1.41E+00			1.40E-02			1.37E+02
Tc, (MCi)	5.89E-03	2.61E-02			1.53E-04			3.17E-02
Am, (MCi)								
Np, (MCi)								
Pu-239, (MCi)								
Pu-240, (MCi)								
Pu-241,(MCi)								
Total TRU, (MCi)	1.92E-01	1.52E-02			1.20E-03			2.06E-01
Total MCi	1.45E+02	6.87E+01			8.39E-02			2.12E+02
Total Mass Flow (MT)	2.37E+04	7.06E+05		2.65E+05	3.86E+05		8.73E+02	1.32E+03
Total Cr, (MT)								
Total Na, (MT)								
Total Si, (MT)								
Total P, (MT)								
Total NO2-, (MT)								
Total NO3-, (MT)								
AG+	1.38E+00	3.28E-01						
AG2O					4.07E-01			1.43E+00
AL+3	2.37E+03							
AL2O3				1.16E+04	1.93E+04			1.94E+02
AL(OH)4-		4.83E+03						
AM+3	2.77E-02	2.51E-03						
AM2O3					3.41E-05			3.32E-02
APM-								3.44E-03
AS+5	4.98E-01	7.70E-01						
AS2O5					4.33E-01			1.51E+00
B+3	9.94E-01	5.19E-01						
B2O3					4.82E+00		1.22E+02	1.22E+02
BA+2	3.09E+00	7.91E-01						
BAO					8.76E-01			3.46E+00
BE+2	7.61E-03	8.19E-02						
BEO					5.53E-02			1.93E-01
BI+3	1.96E+02	6.76E+01						
BI2O3					2.90E+02			3.45E+00
C14	4.53E-04	7.43E-04						

CA+2	1.33E+02	1.67E+01					
CANCRINITE	2.70E+03						
CAO			3.84E+04	3.86E+04			2.34E+00
CD+2	7.93E+00	2.09E+00					
CDO				1.13E+01			1.26E-01
CE+3	2.35E+02	2.37E+00					
CE2O3				2.75E+02			3.40E+00
CL-	3.49E+00	3.11E+02					
CL2							
CO							
CO2							
CO3-2	2.25E+02	3.37E+03					
CR+3	1.32E+02						
CR2O3				2.67E+02			1.38E+00
CR(OH)4-		1.19E+02					
CS+	9.25E-02	8.19E-01					
CS2O				8.85E-04			9.64E-01
CU+2	7.46E-01	1.77E-01					
CUO				2.57E-01			8.99E-01
CUSO4							
F-	5.97E+01	1.12E+03					
F2							
FE+3	7.63E+02	1.44E+01					
FE2O3				3.74E+03			4.24E+01
H2							
H2O		5.07E+05		2.11E-04			1.10E+00
H2S							
HG							
HG+2	9.00E-03	9.49E-01					
HGO				2.07E+00			
I-	2.02E+01	5.46E+02					
I2							
K+	2.10E+01	2.19E-01					
K2O				2.55E+01			2.34E-02
KEROSENE							
LA+3	2.10E+01	2.19E-01					
LA2O3				2.46E+01			3.04E-01
LI+	2.46E-02	5.77E-03					
LI2O				6.53E-02		1.32E+01	1.32E+01
MG+2	1.10E+01	9.65E-01					
MGO				1.96E+01			2.20E-01
MNO2	2.09E+02	2.17E+01		2.31E+02			1.08E-01
MO+6	8.01E-01	4.87E+00					
MOO3				1.03E+01			9.24E-02
N2							
NA+	3.21E+03	6.26E+04					
NA2O				9.65E+04		2.40E+01	6.59E+01
NH3							
NI+3	6.57E+00	4.07E+00					

NI2FECN6	5.00E+02							
NI2O3					2.62E+02			2.82E+00
NIO					1.06E-03			1.20E+00
NO								
NO2								
NO2-	7.38E+01	9.54E+03						
NO3-	1.03E+03	1.06E+05						
NP+4	1.32E-01	1.46E-02						
NPO2					6.52E-03			1.66E-01
O2								
OH-	6.80E+03	4.64E+03						
PB+4	3.28E+00	1.96E+00						
PBO2					1.35E+00			4.71E+00
PO4-3	2.39E+03	2.58E+03						
P2O5					3.68E+03			3.96E+01
P2O5:24W	5.21E-01							
PU+4	4.27E-01	2.88E-02						
PUO2					5.42E-03			5.11E-01
S								
SI+4	7.90E+01	5.65E+00						
SIO2				2.15E+05	2.16E+05		7.13E+02	7.52E+02
SO2								
SO3					6.22E+03			1.92E-03
SO4-2	3.97E+01	2.01E+03						
SR+2	3.64E+01	3.75E-01						
SRO					4.41E-03			4.33E+01
TCO2								
TCO4-	5.68E-01	2.52E+00						
TC2O7					1.41E-02			2.92E+00
TIO2					3.16E-02			3.51E-04
TOC	1.16E+02	1.42E+03						
UO2+2	1.58E+03	8.52E+01						
UO3								2.77E+00
U3O8					1.08E+00			1.15E-02
V+5	1.88E-01	6.20E-02						
V2O5					9.92E-02			3.47E-01
W+6		7.47E-01						
WO2					1.09E-06			2.26E-04
WO3					2.10E-01			7.33E-01
ZN+2	9.45E-01	3.59E+00						
ZNO					3.17E+01			4.31E-01
ZR+4	2.77E+02	4.48E-01						
ZRO2					6.99E+02			8.55E+00
ZRO2:2H2	4.09E+02	2.15E+01						

Mass LAW waste oxides					121198.787		
LAW waste loading (waste oxides)					31%		
LAW waste loading (sodium oxide)					25%		
Mass HLW waste oxides							3.42E+02
HLW waste loading							26%
HLW							
20 wt. % waste oxide loading							
Blending factor				1	1.25	1.5	2	3.5
Mass of glass required to achieve 20% wo loading, MT				1707.54219	2134.42773	2561.313278	3415.08437	5976.397648
additional frit required (equals increased glass) MT				3.88E+02	8.14E+02	1.24E+03	2.10E+03	4.66E+03
total frit required, MT				1.26E+03	1.69E+03	2.11E+03	2.97E+03	5.53E+03
glass density (MT/m^3)	2.63							
cullet packing fraction	0.7	(LAW only)						
Waste volume (m^3)				6.49E+02	8.12E+02	9.74E+02	1.30E+03	2.27E+03
Canister Volume (m^3)	0.62							
Number of Canisters (1x)				1.05E+03	1.31E+03	1.57E+03	2.09E+03	3.67E+03
Nu. of Canisters /HMPC	4							
Number of HMPCs				2.62E+02	3.27E+02	3.93E+02	5.24E+02	9.16E+02
Number of trips @ 10 HMPCs /trip				26	33	39	52	92
Glass formulation:								
(ref Ext. Sep Data Pkg.)	acceptable range			1	1.25	1.5	2	3.5
SiO2	42 to 57 wt %			62.58%	66.39%	68.94%	72.12%	76.21%
B2O3	5 to 20 wt %			10.32%	11.06%	11.55%	12.16%	12.95%
Na2O	5 to 20 wt %			4.48%	4.14%	3.91%	3.62%	3.25%
Li2O	1 to 7 wt %			1.11%	1.19%	1.24%	1.31%	1.39%
Fe2O3	2 to 15 wt %			2.48%	0.00%	0.00%	0.00%	0.00%
CaO	< or= 10 wt %			0.14%	0.11%	0.09%	0.07%	0.04%
MgO	< or = 8 wt %			0.01%	0.01%	0.01%	0.01%	0.00%
Al2O3	< or = 15 wt %			11.36%	9.09%	7.57%	5.68%	3.25%
ZrO2	< or = 13 wt %			0.50%	0.40%	0.33%	0.25%	0.14%
Cr2O3	< or = 0.5 wt %			0.08%	0.06%	0.05%	0.04%	0.02%
P2O5	< or = 3 wt %			2.32%	1.86%	1.55%	1.16%	0.66%
SO3	< or = 0.5 wt %			0.00%	0.00%	0.00%	0.00%	0.00%
HLW Facility Sizing								
Schedule	14 yrs							
Capacity MT/day	1							
Overall efficiency, %				33%	42%	50%	67%	117%
Required capacity MT/day (assuming 14 yrs ops, 60% OE)				0.56	0.70	0.84	1.11	1.95
Required operating duration yrs (assuming 1 MT/day, 60% OE)					9.75	11.70	15.59	27.29

15 wt % waste oxide loading							
Mass of glass required to achieve 15% wo loading MT				2.28E+03	2.85E+03	3.42E+03	4.55E+03	7.97E+03
Volume (m^3)				8.66E+02	1.08E+03	1.30E+03	1.73E+03	3.03E+03
Number of Canisters (1x)				1.40E+03	1.75E+03	2.09E+03	2.79E+03	4.89E+03
40 wt % waste oxide loading								
Mass of glass required to achieve 40% wo loading MT				8.54E+02	1.07E+03	1.28E+03	1.71E+03	2.99E+03
Volume (m^3)				3.25E+02	4.06E+02	4.87E+02	6.49E+02	1.14E+03
Number of Canisters (1x)				5.24E+02	6.54E+02	7.85E+02	1.05E+03	1.83E+03

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			6.43E+05	8.04E+05	9.65E+05	1.29E+06	2.25E+06
additional frit required (equals increased glass) MT			2.57E+05	4.18E+05	5.79E+05	9.01E+05	1.87E+06
total frit required, MT			5.22E+05	6.83E+05	8.44E+05	1.17E+06	2.13E+06
glass density (MT/m^3)	2.63						
cullet packing fraction	0.7						
Waste volume (m^3)			3.49E+05	4.37E+05	5.24E+05	6.99E+05	1.22E+06
Number of 5300 m^3 vaults			66	82	99	132	231
LAW facility sizing							
Schedule, years	19						
Capacity MT/day	200						
Overall efficiency, %			46%	58%	70%	93%	162%
Required capacity MT/day (assuming 19 yrs ops, 60% OE)			154.61	193.26	231.92	309.22	541.14
Required operating duration yrs (assuming 200 MT/day, 60%			14.69	18.36	22.03	29.38	51.41
10 wt. % sodium oxide loading							
Blending factor			1	1.25	1.5	2	3.5
Mass of glass required to achieve 10			9.65E+05	1.21E+06	1.45E+06	1.93E+06	3.38E+06
Waste volume, m^3			5.24E+05	6.55E+05	7.86E+05	1.05E+06	1.83E+06
Number of 5,300 m^3 vaults			99	124	148	198	346
25 wt. % sodium oxide loading							
Blending factor			1	1.25	1.5	2	3.5
Mass of glass required to achive 25 wt % Na2O			3.86E+05	4.83E+05	5.79E+05	7.72E+05	1.35E+06
Waste Volume			2.10E+05	2.62E+05	3.15E+05	4.19E+05	7.34E+05
Number of 5,300 m^3 vaults			40	49	59	79	138

Table F-8. Backup to Table 9-16. Process Modules: Overall Cost.

	Construction	Operating Labor	Operating Equipment	Materials and Supplies			LLW Vault	HLW Canisters	R&D	Repository Fee	Total
				Start-up[1]	D&D[2]	Operation					
Radionuclide removal	$2,778	$1,159	$126	$92	$728	$569			$282		$5,733
Central facilities	$638										$638
LLW vitrification	$749	$308	$224	$24	$193	$151			$268		$1917
LLW disposal		$14	$14	$1	$9	$7	$190		$14		$248
HLW vitrification	$672	$320	$28	$25	$201	$157			$282		$1,685
HLW transportation		$3		$0	$2	$1					$6
HLW disposal								$11		$491	$502
Total	$4,837	$1,803	$392	$143	$1,132	$885	$190	$11	$846	$491	$10,730

Note:

D&D = decontamination and decommissioning
HLW = high-level waste
LLW = low-level waste
R&D = Research and Development

[1]Start-up and operation materials and supplies are allocated based on operation labor.

[2]Decontamination and decommissioning materials and supplies are allocated based on construction cost.

Table F-9. Backup to Table 9-18. Capital Costs (1995 Dollars).

Components	Extensive Pretreatment Facility	Centralized Facilities	LLW Vitrification Facility[1]	HLW Vitrification Facility[2]	Total All Facilities
Labor	1,210,606,000	318,524,000	2,678,586,000	272,903,000	2,778,350,000
Materials and supplies	479,276,000	202,194,000	98,837,000	147,518,000	748,665,000
Equipment	1,088,477,000	117,735,000	381,972,000	251,358,000	671,779,000
Total	2,778,359,000	638,453,000	748,665,0000	671,779,000	4,837,256,000

Notes:

HLW = high-level waste
LLW = low-level waste

[1]Low-level waste vitrification (low source), Option 2A.

[2]High-level waste vitrification facility is combined with extensive pretreatment.

Table F-10a. Backup to Table 9-19. Operating Cost Component (Millions of 1995 Dollars) Extensive Pretreatment, Annual Consumables for Extensive Pretreatment with High-level Vitrification Detached Low-Level Waste Vitrification--Option 2A. (2 sheets).

Utility/Chemical description	Unit Cost ($/each)	Quantity Units	Cost
Glass Former			
B^2O^3	$1,000	57,500	$57,500,000
Fe^2O^3	$500	14	$7,000
LiO^2	$5,000	2,100	$10,500,00
SiO^2	$40	287,000	$11,480,000
MgO	$500	4,100	$2,050,000
CaO	$60	4,100	$246,000
Nitric acid 50 percent (Mg)	$160	465,000	$74,400,000
NaOH, 505 (Mg)	$250	150,000	$37,500,000
Flocculant (Mg)	$1,100	150	$165,000
Glycolic acid, 50 percent (Mg)	$1,740	7,700	$13,398,000
Oxalic acid (Mg)	$860	11,900	$10,234,000
Ammonia (Mg)	$350	9,240	$3,234,000
Ion exchange media (m^3)	$10,600	4,910	$52,046,000
FeSA (Mg)	$660	4,720	$3,115,200
Aluminum nitrate (Mg)	$460	112	$51,520
CMPO (Mg)	$6,530	5	$32,650
TBP (Mg)	$6,530	755	$4,930,150
NPH (Mg)	$440	703	$309,320
Sodium Carbonate (Mg)	$170	180	$30,600
Crown ether (Mg)	$6,530	284	$1,854,520
Formic acid, 96 percent (Mg)	$1,210	1,470	$1,778,700
HF (Mg)	$500	740	$370,000
Sodium oxalate (Mg)	$500	20,900	$10,450,000
Sodium bicarbonate (Mg)	$500	12,500	$6,250,000
Zinc nitrate (Mg)	$500	47	$23,500
Na^3 DTPA (Mg)	$500	196	$98,000
APM (Mg)	$500	10	$5,000
Hydroxylamine nitrate (Mg)	$500	95	$47,500
DCPD (Mg)	$150	4,480	$672,000
CPD (Mg)	$150	4,480	$672,000

Table F-10a. Backup to Table 9-19. Operating Cost Component (Millions of 1995 Dollars) Extensive Pretreatment, Annual Consumables for Extensive Pretreatment with High-level Vitrification Detached Low-Level Waste Vitrification—Option 2A. (2 sheets).

Utility/Chemical description	Unit Cost ($/each)	Quantity Units	Cost
Decontamination chemicals (Mg)	$401	14,000	$5,614,000
Sulfur (Mg)	$370	170,100	$62,937,000
Grout powders (Mg)	$100	0	$0
Kerosene (Mg)	$150	70,170	$10,525,500
Raw water (m^3)	$0.03	30,000,000	$900,000
Sanitary water (m^3)	$0.03	1,100,000	$33,000
Electricity (MWh)	$30	16,600,000	$498,000,000
Subtotal			$881,460,160
Solid waste (m^3)	$1,000	4,000	$4,000,000
Equipment (per year x 14 years)	$28,000,000	14	$392,000,000
Vaults	$5,000,000	38	$190,000,000
Canisters	$10,000	448	$4,480,000
Containers	$25,000	0	$0
Overpacks	$60,000	112	$6,720,000
Subtotal			$597,200,00
Total			$1,478,660,160
Total minus equipment			$1,086,660,160
Start-up costs (materials)			$143,000,000
Decontamination and decommmissioning (material)			$1,132,000,000
Total			$2,753,660,160
Total minus equipment			$2,361,660,160

Notes:

HLW = high-level waste
LLW = low-level waste
m^3 = cubic meters
Mg = megagrams

Annual equipment purchase estimated by K. D. Boomer.

Pretreatment	=	$ 9 million per year (size increase)
HLW vitrification	=	$ 2 million per year (melter)
LLW vitrification	=	$ 16 million per year (melter)
Sub-total	=	$ 27 mm per year
Miscellaneous	=	$ 1 million per year
Total	=	$28 million per year

Table F-10B. Backup to Table 9-19. Operating Cost Component (Millions of 1995 Dollars).

Staffing Category	Years	Staff Per Year	Total Staff Years	Total Staff Hours
Extensive separations	15	620	9,300	1.7E+07
LLW vitrification	15	160	2,400	4.3E+06
HLW vitrification	15	160	2,400	4.3E+06
Indirect staffing	19	29	551	1.0E+06
Pretreatment start-up	1.5	626	939	1.7E+06
LLW vitrification start-up	1.5	157	236	4.3E+05
HLW start-up	1.5	157	236	4.3E+05
Pretreatment decontamination and decommissioning	2	626	1,252	2.3E+06
LLW vitrification decontamination and decommissioning	2	157	314	5.7E+05
HLW decontamination and decommissioning	2	157	314	5.7E+05
HLW monitoring and maintenance	12	10	120	2.2E+05
HLW transportation	–	30	30	5.4E+04
Total				3.3E+07

Notes:

HLW = high-level waste
LLW = low-level waste

All staff hours are based on a staff-year of 1,812 hours.

EXTENSIVE SEPARATIONS PRETREATMENT ALTERNATIVE ENGINEERING DATA PACKAGE FOR THE TANK WASTE REMEDIATION SYSTEM ENVIRONMENTAL IMPACT STATEMENT

G. Jansen
B. J. Knutson
G. K. Allen
Westinghouse Hanford Company

L. Lauerhass
Pacific Northwest Laboratory

RECEIVED
6 1995
0617

ABSTRACT

In accordance with the National Environmental Policy Act of 1969, an environmental impact statement is required for disposal of the radioactive waste stored in 177 underground storage tanks at the Hanford Site.

This document is the engineering data package for the Extensive Separations Pretreatment alternative. It includes waste treatment operations that would take place between waste retrieval and transfer and closure of single-shell tanks and double-shell tanks. The purpose of this alternative would be to process the tank wastes and to reduce the amount of high-level waste to less than 625 cubic meters (equivalent to 1,000 glass canisters measuring 0.61 meters [m] diameter by 3.05 m long at 0.62 cubic meters each) and to reduce the curie

Table 9-16. Process Module: Overall Cost (Millions of 1995 Dollars).

Process Module	Extensive Separation Alternative
Radionuclide removal	$6,098
Low-level waste vitrification	1,917
Low-level waste disposal	248
High-level waste vitrification	1,685
High-level waste transportation[1]	7
High-level waste disposal	3,404
Centralized facilities	638
Total	$13,997

Note:

[1]Cost for high-level waste transportation and disposal are based upon 1000 canisters in 250 multi-purpose canisters.

[2]These cost results apply to the integrated combination of HLW Option 1 and LLW Option A (Option 1A). This combination of cesium and strontium capsule overpacking and LLW glass is the same combination of options as that assumed in the Tri-Party Agreement preferred alternative.

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.

Table 9-17. Overall Cost Component (Millions of 1995 Dollars). (2 sheets)

Cost Component	Extensive Separation Alternative
Capital	$5,202[1]
Operating	4,556[2]
Research and development	846[3]
Repository fee	3,393[4]
Total	$13,997

Notes:

[1]Total capital cost includes 40 percent contingency. Contingency is excluded from other costs. Also see Table 9-18 for additional explanation.

[2]Includes start-up, decontamination and decommissioning, and monitoring and maintenance costs for process facilities. Does not include costs associated with routine tank farm operations (estimated at $4,340 million in 1995 dollars). Also does not include costs associated with TWRS program management characterization, tank farm upgrades, single-shell tank saltwell pumping, and tank farm safety.

[3]Based on *Tank Waste Remediation System Integrated Technology Plan* WHC 1994), June 10, 1994 draft. The Research and Development costs depicted above are estimates based upon the pro ratio of capital costs with the Tri-Party Agreement Alternative.

[4]Table D-8, TRW 1995, estimates the repository fee for the Extensive Separations Alternative (Case 3-5SC) would be $679 million lower than the estimated repository fee for Case 1C, using the TRW Total System Life Cycle Cost (TSLCC) model developed for the Office of Civilian Radioactive Waste Management. Per informal communications with Mr. don Nitti of TRW on 5/31/95 and 7/13/95, Hanford's repository fee for Case 1C is estimated as follows:

Two repository case total life cycle cost	=	$48.294 billion
Defense program share	=	15.7%
Hanford's share based on ratio of number of Hanford waste packages (2,465) to total defense program waste packages (4,588), from Table 2-4 of TRW 1995	=	53.7%
Hanford's share of Case 1C: ($48.294 billion x 0.157 x 0.537)	=	$4.072 billion

per p.9-33, this case requires 1000 canisters or 250 MPC (4 canisters per MPC or 250 waste packages

but those canisters, per TRW report I are .68 x 4.57 cm = 1.26 m³

4.072 - .679 = $3.393 billion

Table 9-17. Overall Cost Component (Millions of 1995 Dollars). (2 sheets)

Notes: Continued

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.

WHC, 1994, *Tank Waste Remediation System Multi-Year Program Plan*, WHC-SP-1101, Westinghouse Hanford Company, Richland, Washington.

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.

Table 9-18. Capital Cost Component (Millions of 1995 Dollars)[2].

Capital Cost Component	Extensive Separation Alternative
Labor	$2,225
Materials and supplies	998
Equipment	1,682
Local purchases[1]	297
Total	$5,202

Notes:

[1]Local purchases - 15 percent of materials and supplies are assumed to be local purchases.

[2]Costs in this table reflect Option 1A as described in Section 2.0. This includes construction of the detached LLW vitrification facility and vaults. However, it does not include filling of the vaults with LLW glass/SPC. These costs are included in Table 9-19. Section 9.1 and Table 9-26 provide additional capital costs for Option 2A for the Cs/Sr cut-up cell. Section 9.2 and Table 9-27 provide the adjustments necessary to reflect capital costs for Option 2B, as described in Section 2.0. Costs of filling the grout tubes in Option 2B is covered in Table 9-19. Costs in this table also include a rough order of magnitude estimate of 365 million dollars for caustic recycling and thermal denitration. These process steps were not included in the original flowsheet upon which the detailed cost estimate for the balance of the facility was based (see Section 4.8.1).

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.

64

Table 9-19. Operating Cost Component (Millions of 1995 Dollars)[1].

Operating Cost Component	Extensive Separation Alternative
Labor	$1,803
Materials and supplies[2]	$2,007
Equipment[2]	$333
Local purchases[2]	$413
Total	$4,556

Notes:

[1]Includes filling of low-level waste vaults for vitrified LLW (Option 1A) as well as start-up, decontamination and decommissioning, and monitoring and maintenance costs. For grouted LLW (Option 2B), operating costs would be higher (see Section 9.2 and Tables 9-27 and 9-28).

[2]Local purchases are based on 15 percent of materials and supplies and equipment.

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.

Table 9-20. Overall Schedule[5].

Activity	Extensive Separation Alternative
Construction	12/97 - 12/2006[1]
Operation	1/2004 - 9/2019[2]
Decontamination and decommissioning	10/2019 - 10/2024[3]
Monitoring and maintenance	3/2019 - 9/2029[4]
Research and development	1995 - 2018

Notes:

[1]See the *Tank Waste Remediation System Facility Configuration Study* (Boomer et al. 1994), pages 63 and 114.

[2]See Boomer et al. 1994, pages 33, 63, and 114.

[3]Five years of decontamination and decommissioning assumed after completion of all processing and vitrification.

[4]Based upon 1,000 canisters, 250 multi-purpose canisters; shipments to repository beginning in 2020 and ending in 2029 per canister pickup schedule in Table D-6, Case 3-5 SC, TRW 1995. (See Table 9-7 for related information.)

[5]The assumed construction schedule and the 14 year facility operations schedule are highly optimistic for the extensive separations alternative. There is considerably higher technical risk for extensive separations than for the other TWRS-EIS alternatives evaluated. Consequently, there is higher schedule risk associated with this alternative than with the other alternatives.

Boomer, K. D., J. M. Colby, T. W. Crawford, J. S. Garfield, C. E. Golberg, C. E. Leach, D. E. Mitchell, F. D. Nankani, E. J. Slaathaug, L. M. Swanson, T. L. Waldo, and C. M. Winkler. 1994, *Tank Waste Remediation System Facility Configuration Study*, WHC-SD-WM-ES-295, Westinghouse Hanford Company, Richland, Washington. See Appendix F also.

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..

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.

Table F-8. Backup to Table 9-16. Process Modules: Overall Cost.

[illegible]	Construction	Operating Labor	Operating Equipment	Materials and Supplies: Start-up	Materials and Supplies: D&D	Materials and Supplies: Operation	HLW Vault	HLW Canisters	R&D	Repository Fees	Total
Radionuclide removal	$2,778	$1,159	$126	$92	$728	$569			$282		$5,733
Central facilities	$638										$638
LLW vitrification	$749	$308	$224	$24	$193	$151			$268		$1917
LLW disposal		$14	$14	$1	$9	$7	$190		$14		$248
HLW vitrification	$672	$320	$28	$25	$201	$157			$282		$1,685
HLW transportation		$3		$0	$2	$1					$6
HLW disposal								$11		$491	$502
Total	$4,837	$1,803	$392	$143	$1,132	$885	$190	$11	$846	$491	$10,730

Note:

D&D = decontamination and decommissioning
HLW = high-level waste
LLW = low-level waste
R&D = Research and Development

[1]Start-up and operation materials and supplies are allocated based on operation labor.

[2]Decontamination and decommissioning materials and supplies are allocated based on construction cost.

66.-

Table F-9. Backup to Table 9-18. Capital Costs (1995 Dollars).

Components	Extensive Pretreatment Facility	Centralized Facilities	LLW Vitrification Facility[1]	HLW Vitrification Facility[2]	Total All Facilities
Labor	1,210,606,000	318,524,000	2,678,586,000	272,903,000	2,778,350,000
Materials and supplies	479,276,000	202,194,000	98,837,000	147,518,000	748,665,000
Equipment	1,088,477,000	117,735,000	381,972,000	251,358,000	671,779,000
Total	2,778,359,000	638,453,000	748,665,0000	671,779,000	4,837,256,000

Notes:

HLW = high-level waste
LLW = low-level waste

[1]Low-level waste vitrification (low source), Option 2A.

[2]High-level waste vitrification facility is combined with extensive pretreatment.

68 -

Table F-10a. Backup to Table 9-19. Operating Cost Component (Millions of 1995 Dollars; Extensive Pretreatment, Annual Consumables for Extensive Pretreatment with High-level Vitrification Detached Low-Level Waste Vitrification—Option 2A. (2 sheets).

Utility/Chemical description	Unit Cost ($/each)	Quantity Units	Cost
Glass Former			
B^2O^3	$1,000	57,500	$57,500,000
Fe^2O^3	$500	14	$7,000
LiO^2	$5,000	2,100	$10,500,00
SiO^2	$40	287,000	$11,480,000
MgO	$500	4,100	$2,050,000
CaO	$60	4,100	$246,000
Nitric acid 50 percent (Mg)	$160	465,000	$74,400,000
NaOH, 505 (Mg)	$250	150,000	$37,500,000
Flocculant (Mg)	$1,100	150	$165,000
Glycolic acid, 50 percent (Mg)	$1,740	7,700	$13,398,000
Oxalic acid (Mg)	$860	11,900	$10,234,000
Ammonia (Mg)	$350	9,240	$3,234,000
Ion exchange media (m^3)	$10,600	4,910	$52,046,000
FeSA (Mg)	$660	4,720	$3,115,200
Aluminum nitrate (Mg)	$460	112	$51,520
CMPO (Mg)	$6,530	5	$32,650
TBP (Mg)	$6,530	755	$4,930,150
NPH (Mg)	$440	703	$309,320
Sodium Carbonate (Mg)	$170	180	$30,600
Crown ether (Mg)	$6,530	284	$1,854,520
Formic acid, 96 percent (Mg)	$1,210	1,470	$1,778,700
HF (Mg)	$500	740	$370,000
Sodium oxalate (Mg)	$500	20,900	$10,450,000
Sodium bicarbonate (Mg)	$500	12,500	$6,250,000
Zinc nitrate (Mg)	$500	47	$23,500
Na^3 DTPA (Mg)	$500	196	$98,000
APM (Mg)	$500	10	$5,000
Hydroxylamine nitrate (Mg)	$500	95	$47,500
DCPD (Mg)	$150	4,480	$672,000
CPD (Mg)	$150	4,480	$672,000

Table F-10a. Backup to Table 9-19. Operating Cost Component (Millions of 1995 Dollars) Extensive Pretreatment, Annual Consumables for Extensive Pretreatment with High-level Vitrification Detached Low-Level Waste Vitrification—Option 2A. (2 sheets).

Utility/chemical description	Unit Cost ($/each)	Quantity/Units	Cost
Decontamination chemicals (Mg)	$401	14,000	$5,614,000
Sulfur (Mg)	$370	170,100	$62,937,000
Grout powders (Mg)	$100	0	$0
Kerosene (Mg)	$150	70,170	$10,525,500
Raw water (m^3)	$0.03	30,000,000	$900,000
Sanitary water (m^3)	$0.03	1,100,000	$33,000
Electricity (MWh)	$30	16,600,000	$498,000,000
Subtotal			$881,460,160
Solid waste (m^3)	$1,000	4,000	$4,000,000
Equipment (per year x 14 years)	$28,000,000	14	$392,000,000
Vaults	$5,000,000	38	$190,000,000
Canisters	$10,000	448	$4,480,000
Containers	$25,000	0	$0
Overpacks	$60,000	112	$6,720,000
Subtotal			$597,200,00
Total			$1,478,660,160
Total minus equipment			$1,086,660,160
Start-up costs (materials)			$143,000,000
Decontamination and decommmissioning (material)			$1,132,000,000
Total			$2,753,660,160
Total minus equipment			$2,361,660,160

Notes:

HLW = high-level waste
LLW = low-level waste
m^3 = cubic meters
Mg = megagrams

Annual equipment purchase estimated by K. D. Boomer.

Pretreatment	=	$ 9 million per year (size increase)
HLW vitrification	=	$ 2 million per year (melter)
LLW vitrification	=	$ 16 million per year (melter)
Sub-total	=	$ 27 mm per year
Miscellaneous	=	$ 1 million per year
Total	=	$28 million per year

Table F-10B. Backup to Table 9-19. Operating Cost Component (Millions of 1995 Dollars).

Staffing Category	Years	Staff Per Year	Total Staff Years	Total Staff Hours
Extensive separations	15	620	9,300	1.7E+07
LLW vitrification	15	160	2,400	4.3E+06
HLW vitrification	15	160	2,400	4.3E+06
Indirect staffing	19	29	551	1.0E+06
Pretreatment start-up	1.5	626	939	1.7E+06
LLW vitrification start-up	1.5	157	236	4.3E+05
HLW start-up	1.5	157	236	4.3E+05
Pretreatment decontamination and decommissioning	2	626	1,252	2.3E+06
LLW vitrification decontamination and decommissioning	2	157	314	5.7E+05
HLW decontamination and decommissioning	2	157	314	5.7E+05
HLW monitoring and maintenance	12	10	120	2.2E+05
HLW transportation	–	30	30	5.4E+04
Total				3.3E+07

Notes:

HLW = high-level waste
LLW = low-level waste

All staff hours are based on a staff-year of 1,812 hours.

71

Table F-10C. Backup to Table 9-19. Operating Cost Component (Millions of 1995 Dollars).

Operation Mode	Exempt	Nonexempt	Bargaining Unit	Total	Cost Per Year
Pretreatment	202	40	378	620	$63
LLW vitrification	52	10	98	160	$16
HLW vitrification	52	10	98	160	$16
Total	306	60	574	940	$95

Notes:

HLW = high-level waste
LLW = low-level waste

Table F-10D. Backup to Table 9-19. Operating Cost Component (Millions of 1995 Dollars).

Staffing Category	Total cost
Extensive separations	$940
LLW vitrification	$243
HLW vitrification	$243
Indirect staffing[1]	$33
Pretreatment start-up[2]	$94
LLW vitrification start-up[2]	$24
HLW start-up[2]	$24
Pretreatment decontamination and decommissioning[3]	$125
LLW vitrification decontamination and decommissioning[3]	$32
HLW decontamination and decommissioning	$32
HLW monitoring and maintenance[3, 4]	$8
HLW transportation[5]	$3
Total	$1,803

Notes:

[1]For indirect staffing, it was assumed that all workers would be nonexempt.

[2]The total start-up cost for each facility is arbitrarily set to the annual staffing requirements. These start-up requirements have been set to 1 1/2 years of the annual. This leaves 1 1/2 years of staff cost ($95 million + $24 million + $24 million = $143 million) for start-up materials and supplies.

($63 million x 1.5 yrs = $95 million) ($16 million x 1.5 yrs = $24 million) ($16 million x 1.5 yrs = $24 million).

[3]Decontamination and decommissioning for each facility is arbitrarily set equal to three years of staff cost plus thirty percent of the total capital cost minus the contingency. The staffing requirements have been set to two years of the annual. This leaves one year of staff cost ($63 million + $16 million + $16 million = $95 million) plus thirty percent of the capital for material and supplies.

The total capital is equal to the capital plus a forty percent contingency; therefore, the capital value to be used for the decontamination and decommissioning cost for materials and supplies is equal to:
Capital $4,837 million per 140 percent = $3,455 million

The cost based upon the capital would be as follows: capital decontamination and decommissioning = $3,455 million x 30 percent = $1,037 million. Thus, the total decontamination and decommissioning cost for materials and supplies is set to $1,132 million.

Table F-10D. Backup to Table 9-19. Operating Cost Component (Millions of 1995 Dollars).

Notes (continued):

[f]For monitoring and maintenance, the following was assumed: exempt would be 10 percent, bargaining unit 10 percent, and nonexempt 80 percent.

[g]For HLW transportation, the following was assumed: exempt would be 36 percent, bargaining unit 36 percent, and nonexempt 28 percent.

All exempt and bargaining unit employees are assumed to be radiation workers. All nonexempt employees are nonradiation workers.

Table F-11. Backup to Table 9-20. Overall Schedule.

Construction			
Option	Start	Finish	Facility Configuration Study
Pretreatment + HLW vitrification Standalone LLW vitrification Overall	July 2001 December 1997 December 1997	December 2006 July 2005 December 2006	page 114 page 63
Operation			
Pretreatment HLW vitrification LLW vitrification Overall	January 2004 March 2005 September 2005 January 2004	January 2018 March 2019 September 2019 September 2019	pages 114, 33 pages 114, 33 pages 63, 33
Decontamination and decommissioning for all facilities is assumed to start after the completion of process duration, that is, 5 years.			
	October 2019	October 2024	
Monitoring and maintenance is for HLW canisters. Monitoring and maintenance is assumed to start with the completion of HLW vitrification. Monitoring and maintenance is assumed to finish when the last multi-purpose canisters is shipped to the repository. Shipments to the repository start in 2035[1]. Based on discussions with K. D. Boomer, 1,000 canisters are assumed, 250 multi-purpose canisters. 10 multi-purpose canisters would be transported per week (Slaathaug 1995, Table 9-7, footnote 5). Duration of shipments = 250 multi-purpose canisters/10 = 25 weeks.			
	March 2019	September 2035	[1]page 151
Research and Development			
	1995	2018	

Notes:

HLW = high-level waste
LLW = low-level waste

JACOBS ENGINEERING GROUP INC.

DATE 2/19/96 SUBJECT SHEET NO. 1-1

BY DLS CHKD. JOB NO.

In Situ / Ex Situ Combination

Proposed DEIS

50% of Intermediate Separations Case is processed Ex Situ in this alternative, therefore 1/2 the canisters, containers, casks, vaults, etc and 1/2 the extra operating costs.

Intermediate Separations total op. cost Δ = $1,608,635,000
× 1/2
$804,318,000

previous exsitu/insitu base op. cost $1,834,000,000

New Treatment Op. Costs $2,638,318,000

Repository fees calculated for 1/2 the Inter. Sep. Case or $\frac{33386}{2}$ = 16,693 canisters per graph yields

$5.0 billion

FORM 91-005-1 (4/87)

JACOBS ENGINEERING GROUP INC.

DATE 2/7/96 SUBJECT SHEET NO. 76

BY DSteen CHKD. JOB NO.

	Onsite Disposal Volume (m^3)	Offsite Disposal Volume (m^3)
Inter. Sep	438,000	20,700
No Sep. Vit.	0	364,000
No Sep. Calc.	0	96,000
Ext. Sep.	437,000	9714
Ex Situ/In Situ Combo.	324,600	10,350
Phased Imple	438,000	20,700

105,600 m^3 In Situ
219,000 m^3 Ex Situ ($\frac{1}{2}$ Inter Sep)
324,600 m^3 total

above per C. Henderson
new mass balance tables
for proposed DEIS

Repository Fee = 360 K/can X 16700 = $6.012 billion

FORM 91-005-1 (4/81)

Ex Situ alternative comparison

	Waste Loading weight %	Blending Factor	Canister Count (HLW) or, Number of LAW Vaults	Canister Size Vault Size (m^3)	Overall Processing Plant Efficiency	Duration of Operations (years)	Trips to Repository 10 rail cars/train 2 can/HMPC	Trips to Repository 10 rail cars/train 4 can/HMPC
No Separations (soda-lime)								
WHC Data Pkg.	30%	1	21400	9.32 actual (6.52 [illegible]) 10	36%	14	2140	
Proposed DEIS	20%	1.5	587426	0.62	60%	15	29371	14686
Intermediate Separations								
HLW								
WHC Data Pkg.	45%	1	(1705 4 pkg) 6800	1.26	25%	14	340	170
Proposed DEIS	20%	1.5	33386	0.62	60%	12	1669	835
LAW								
WHC Data Pkg	25%	1	40	5300	36%	14		
Proposed DEIS	15%	1.25	83	5300	60%	19		
Extensive Separations								
HLW (borosilicate)								
WHC Data Pkg.	34%	1	448 502	0.62	26%	14	25	13
Proposed DEIS	20%	1.5	1571	0.62	50%	14	79	39
LAW (borosilicate)								
WHC Data Pkg.	25%	1	38 40	5300	36%	19		
Proposed DEIS	15%	1.25	83	5300	60%	19		

calc. 10,300 @ 10 m³ Phased 26

166,129 @ 0.62m³

phased impl ~ same as inter. sep. or 33,386 canisters

77

TWRS EIS
CALCULATION COVER SHEET

DISCIPLINE & TITLE ENGINEERING - COST ESTIMATE - PROPOSED DRAFT EIS (Rev C) PHASED IMPLEMENTATION

ORIGINATOR D. STEIN DATE 2/27/96

REVISION NO. 2

OBJECTIVE ESTIMATE COSTS FOR PHASED IMPLEMENTATION BASED ON PROPOSED DRAFT EIS BASIS

METHODOLOGY COMPARE PLANT SIZES TO TPA + EXT. SEP. AND FACTOR AND USE ENGR. JUDGEMENT

ASSUMPTIONS "Six-Tenths" factor rule for estimating plant costs is applicable

(Continue on another sheet if necessary)

D. Stein
SIGNATURE

CALCULATION & RESULTS ATTACHED

JACOBS\FORMS\CALCVR.SHT

Cost Estimate for Phase 1 (Phased Implementation)

Assumptions:

R+D Costs

Assumed to be "zero" as a separate line item as phase 1 is itself an R+D program.

Repository Fee

Assumed to be "zero" as HLW will be stored on-site in canisters for future disposal by others. Fee not included here.

Capital Cost

To be estimated from TPA report where applicable using the "six tenths factor" rule.

$$\text{Cost of plant A} = \text{Cost of plant B}\left(\frac{\text{capacity A}}{\text{capacity B}}\right)^{0.6}$$

Operating Cost

To be estimated from TPA report by factoring and using staffing estimate comparisons

Closure Cost

To be factored from TPA based on capital cost ratio.

JACOBS ENGINEERING GROUP INC.

DATE 12/7/95 SUBJECT SHEET NO. 2-15

BY DLS CHKD. JOB NO.

Information and data available

Both Extensive Retrieval (Ex Situ) which is based on The TPA report and Extensive Separations utilize 200 MT/D pretreatment and LLW vitrification plants TPA utilizes a 20 MT/D HLW vitrification plant and Ex. Sep., a 1 MT/D HLW vit. plant.

The pretreatment plants are significantly different in radionuclide separations with phased implementation assumed to be somewhere in between them.

Capital Costs

Since emissions, staffing resources, etc. have already been estimated based on TPA info factoring capital costs will, where possible, also be based on TPA plants.

Table 9-16 backup (Table E-36), which is attached, will be used as it contains cost for TPA in various categories.

* The 200 T/D plants (LLW vit., centralized facilities + pretreatment) are assumed to be two identical 100 T/D trains. Then the cost of each 100 T/D train is assumed to be 1/2 the cost of the total 200 T/D plant. The cost of the 100 T/D plant

FORM 81-006-1 (4/81)

will be used to estimate the cost of the 20 T/D plant using the six tenths factor rule.

* The pretreatment plant will be assumed to be roughly 1/3 between Intermediate Sep. (TRA) and Ext. Sep. (closed to Inter. Sep.) and will cost 1/3 between the two.

20 MT/D LLW vitrification plant

$C_{200} = \$1300$ million with $C_{100} = \frac{1}{2} C_{200}$

Then, $C_{100} = \$650$ million

Then, $C_{20} = \frac{C_{100}}{\left(\frac{100}{20}\right)^{0.6}} = \frac{650}{(5)^{0.6}} = \frac{650}{2.62}$

$C_{20} = \$248$ million

20 MT/D Centralized Facilities plant

$C_{200} = 520$ million with $C_{100} = \frac{1}{2} C_{200}$

Then, $C_{100} = \$260$ million

Then, $C_{20} = \frac{C_{100}}{\left(\frac{100}{20}\right)^{0.6}} = \frac{260}{2.62}$

$C_{20} = \$99$ million

1 MT/D HLW vitrification plant

C_{20} = \$1400 million

$$C_1 = \frac{1400}{\left(\frac{20}{1}\right)^{0.6}} = \frac{1400}{6.03}$$

C_1 = \$232 million

20 MT/D Pretreatment plant

Assume separations to be 1/3 of the way between intermediate sep. & extensive sep.

Info available from Table B10 Cost Summary shows Ext. Ret (Ex Situ) capital at \$5880 million and Ext. Sep capital at \$7482 million. If capital for different sized HLW vit. plants is deducted then the difference should be a measure of difference in pretreat costs

5880 − 1400 = \$4480 million
total — HLW vit 20 T/D — Ext. Ret (Ex Situ) or Inter Sep

vs.

7482 − 232 = \$7250 million
total — HLW vit 1 T/D estimated — Ext. Sep

Then, 7250 − 4480 = 2770 million more for Ext. Sep pretreat than the 380 million for Inter. Sep. pretreat. If we assume each alternative to have the same Cesium portion, then Ext. Sep. total pretreat is estimated to cost 2770 + 380 = 3150

AT 1/3 between Inter. Sep + EXT. Sep, phase 1 pretreat 200 T/D plant is estimated to cost:

$$C_{200} = \left(2770 \times \frac{1}{3}\right) + 380 = \$1303 \text{ million}$$

then $C_{100} = \frac{1}{2} C_{200} = \$652$ million

Then, $C_{20} = \frac{C_{100}}{\left(\frac{100}{20}\right)^{0.6}} = \frac{652}{2.62}$

$C_{20} = \$249$ million

Capital Cost Summary (Phase 1)

	LLW/pretreat	LLW/pretreat + HLW	total
LLW vit	248	248	496
pretreat	249	249	498
central	99	99	198
HLW vit	—	232	232
	596	828	1424

Total capital for phase 1 is $1424 million

JACOBS ENGINEERING GROUP INC

DATE 12/7 SUBJECT

BY DLS CHKD

SHEET NO. 6-15

JOB NO.

Operating Costs

Based on Table F-36 (attached)
Op Costs components based on ratio of various categories to capital equip, start-up, and D&D were estimated.

Operations costs factored at 10% for pretreatment & LLW vitri based on 10% capacity 20 MT/D vs. 200 MT/D

Operations costs factored at 5% for HLW vitri based on 5% capacity 1 MT/D vs 20 MT/D

LLW containers & costs estimated as follows: 32 m^3 container
3.17 m x 3.17 m x 3.17 m
area $(3.17)^2$ x 6 sides x 0.01 m thick ⇒ 0.6 m^3 steel
x 7.5 sp.gr ⇒ 4.5 MT/each
x 469 containers x $2500/each
$1.2 million

say $2 million

HLW canisters here x 5% estimated total for dried HLW from pretreat & HLW vitr. for both plants
$239 million x .05 = $12 million
divide up $4 million for each pretreat plant & $4 million HLW vitr. plant

JACOBS ENGINEERING GROUP INC.

DATE 12/7 SUBJECT

BY DLS CHKD.

SHEET NO. 85 7-15

JOB NO.

Estimate total labor separate based on staffing numbers

Staff years for Operation

	years	staff per yr	staff yrs
(for both plants) Pretreat/LLW	4	536	2144
(for both plants plus HLW plant) Pretreat/LLW/HLW	6	578	3468
D&D	2	961	1922
			7534 staff yrs

for TPA Dual Op. $723 million for 7080 staff yrs or $102,000/staff yr

Therefore

7534 staff yrs x $102,000/staff yr =

$768 million operating labor

Closure Cost

$\frac{\text{Capital phase 1}}{\text{capital ext. retrieval}}$ x Closure cost ext. ret = $\frac{1424}{5880}$ x 170

= $41 million

FORM 81-005-1 (4/81)

JACOBS ENGINEERING GROUP INC.

DATE 12/7 SUBJECT SHEET NO. 8-15

BY DLS CHKD. JOB NO.

Operating Cost (not including labor)

capital		equip	startup	D+D	oper	LLW can	HLW can	tot
249	pretreat	37	15	62	37	—	4	155
99	central	—	—	—	—	—	—	—
248	LLW vit.	37	15	62	37	2	—	153
232	HLW vit.	35	14	58	6	—	4	117

pretreat 155 x 2 plants = 310
central — x 2 plants = —
LLW vit 153 x 2 plants = 306
HLW vit 117 x 1 plant = 117
$733 million

Total operating cost = 733 + 768
portable above labor

Total op cost = $1501 million

FORM 81-005-1 (4/87)

JACOBS ENGINEERING GROUP INC.

DATE 2/26/96 SUBJECT SHEET NO. 9-15

BY DLS CHKD. JOB NO.

Continued op. cost of demo plants in phase 2

- operate pretreat/LAW/central for additional 10 yrs (same as phase 1)
- do not operate HLW in phase 2 (too small)

operating cost (not including labor)

	equip	startup	D+D	oper	total
pretreat	37	—	—	37	74
central	—	—	—	—	—
LAW vit.	37	—	—	37	74
HLW vit	—	—	—	—	—

pretreat	74 x 2 plants	=	148
central	— x 2 plants	=	—
LAW vit.	74 x 2 plants	=	148
HLW vit.	—	=	—
			$296 million

	labor	years	staff/yr	staff yrs
(for both plants)	pretreat/LAW	10	536	5360

5360 staff yrs x $102,000/staff yr = $547 million

op. cost of demo plants in phase 2

296 + 547 = $843 million

FORM 91-005-1 (4/81)

JACOBS ENGINEERING GROUP INC.

DATE 2/26/96 SUBJECT SHEET NO. 10-15

BY DLS CHKD. JOB NO.

Phase 1 Summary

capital cost	$ 1425	million
operating cost	$ 1500	million
closure costs	$ 41	million
continued operation in phase 2	$ 843	million

FORM 81-003-1 (4/87)

12 MT/D HLW, 185 MT/D LAW

Capital Cost for Phase 2 Large Plants

(1) Consistent with phase 1 demo plants estimate, assume separations in pretreatment are 1/3 between inter. sep + ext. sep.

so $\frac{1}{3} \times \$2770$ million (difference between inter sep + ext. sep) = \$923 million more than inter. sep. pretreatment cost of \$380 million for a total of \$1303 million

(2) Central facilities would be approximately the same as inter. sep. at \$520 million even though it needs to support only 185 MT/D LAW and 12 MT/D HLW.

(3) LAW vitrification would be approximately the same as inter. sep at \$1300 million

(4) HLW vitrification would be approximately 1/2 that of HLW 25 MT/D or $\frac{1400}{2}$ = \$700 million

(5) The result would be a total capital cost of 1303 + 520 + 1300 + 700 = \$3823 million
(pretreat) (central) (LAW) (HLW)

(6) Assuming a 20% reduction in capital cost as a result of information gathered and optimization from phase 1 demo plants (this is approximately the same as assuming a 20% contingency here vs. 40% previously), yields \$3823 million × (100 − 20)% = \$3058 million

JACOBS ENGINEERING GROUP INC.

DATE 2/26/96 SUBJECT SHEET NO. 90 12-15

BY DJS CHKD. JOB NO.

Operating Cost for Phase 2 Large Plants
(less operating labor)

Capital	plant	equip	startup	D&D	oper.	LAW vault	HLW can	total
1042	pretreat	156	58	288	153	—	—	655
416	central	—	—	—	—	—	—	—
1040	LAW vit	43	54	265	141	225	—	828
560	HLW vit.	28	31	154	50	—	239	502
3058								$1985 million

above per similar Table F-36 for inter. Sep. (attached)

Operating Labor for Phase 2 Large Plants

assume op. labor force is about the same as for the demo plants which comprise 2 separate facilities (this should be conservative):

		years	staff years
pretreat/LAW/HLW dual operation	578 staff/yr	13	7514
HLW only (72% of dual per inter sep case)	417 staff/yr	4	1668
D&D (same as demo plants)	961 staff/yr	2	1922
			11,104

This is → staff yrs approx. 70% of staff yrs estimated for inter sep. case. This appears to be reasonable, again taking into account lower production rates here, shorter op. years and efficiency due to info obtained in demo plants.

11,104 staff yrs × $102,000/staff yr = $1.133 million
(as per IPA)

FORM 91-005-T (4/87)

91

Total op. cost base = $1985 + 1133 = $3118 million

Δ op. cost per inter. sep for 45% waste oxide loading, 1.5 blend factor for HLW and 15% Na_2O loading, 1.25 blend factor for LAW, small canisters (61 x 310 cm) (excluding labor Δ) This Δ takes into account all extra op. costs for the total alternative which would process same waste and product same products as inter. sep.

$1493 million *

total phase 2 large plants op. cost $4611 million

* Δ HLW $140 million
Δ LAW 175 million
Δ other op. cost (vaults, canisters etc) 1,178 million
$1493 million

assume closure cost = $170 million (same as inter. sep.)

Phase 2 Summary

Capital cost	$ 3058 million
Operating cost	$ 4611 million
Closure cost	$ 170 million

From previous phased impl. (no change)

WR+T capital	$ 2280 million
WR+T operating	$ 3990 million

JACOBS ENGINEERING GROUP INC.

DATE 2/26/96 SUBJECT SHEET NO. 14-15

BY QLS CHKD. JOB NO.

92

Phased Implementation Summary

	Phase 1	Phase 2	Total Phased
Current Op.	4900	3700	8600
Total R+D	0	190	190
Capital			
WR+T	—	2280	2280
Treat.	1425	3058	4483
Closure	41	170	211
Total Capital	1466	5508	6974
Operating			
WR+T	—	3990	3990
Treat.	1500	4611	6111
Demo plants in phase 2	—	843	843
Total Operating	1500	9444	10944
		~~12020~~	$12020
Repository Fee	—	~~6500~~	~~6500~~
			$38,728
Total	7866 million	25342 million	~~33208~~ million

FORM 91-005-1 (4/81)

F.11 Backup for Table 9-16

Capital Cost

Operating Cost

Table F-36. Total Cost by Unit Operation.

[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Sludge wash	$43	$129	$6	$2	$12	$6			$9		$207
Cesium removal	$380	$276	$57	$21	$105	$56			$83		$975
Centralized facilities	$520										$520
LLW vitrification	$1,300	$624	$179	$68	$332	$176			$264		$2,934
LLW disposal		$16	$9	$4	$17	$9	$225		$14		$294
HLW vitrification	$1,400	$639	$70	$78	$384	$126			$260		$2,957
HLW transportation		$31									$24
HLW disposal								$239		$5,619	$5,858
Total	$3,643	$1,716	$322	$173	$886	$373	$225	$239	$630	$5,619	$13,826

Notes:

Table values are in millions of 1995 dollars.

93

TWRS EIS
CALCULATION COVER SHEET

DISCIPLINE & TITLE ENGINEERING – Calculation of Data Revisions for Draft TWRS-EIS

ORIGINATOR Ronald D. Weed DATE 2-15-96

REVISION NO. 0

OBJECTIVE Revise tabulated data in tables contained within Appendix B and other chapters of the EIS.

METHODOLOGY applied input data to obtain the new values for inclusion in the revised draft and as input for other tabulated calculations

ASSUMPTIONS See calculation. Sheet 1 of 48 contains a listing of the tables covered with in this calculation.

(Continue on another sheet if necessary)

Ronald D. Weed
SIGNATURE CHK: CH. 3/21/96.

CALCULATION & RESULTS ATTACHED

Cover Sheet – 1
pages – 48
appended material pages – A-1 through A-50

JACOBS\FORMS\CALCVR.SHT

JACOBS ENGINEERING GROUP INC.

DATE 2-15-96 SUBJECT SHEET NO. 1 of 48

BY RDW CHKD. JOB NO. 01K4701

Items calculated within this calculation

	Page
1. Table B.10.0.3	
A. Ex Situ no Separations alternative - vitrification	02
B. Ex Situ Extensive Separations alternative	07
C. Ex Situ Intermediate Separations alternative	10
D. Ex Situ/In Situ Combination alternative	15
E. Ex Situ no Separations alternative - calcination	19
F. Phased Implementation alternative - Phase II	22
2. Comparative bases for Intermediate Separations Cases 1, 2, 3	
G. HLW - 15 wt% waste oxide; LAW - 10 wt% sodium oxide	28
H. HLW - 40 wt% waste oxide; LAW - 25 wt% Sodium oxide	33
3. Table B.10.0.3 for Borrow material and committed land use.	
I. Alternatives	39
1. Long Term management alternative	39
2. In situ Filled and Cap alternative	39
3. In situ vitrification alternative	39
4. Ex Situ Intermediate Separations alternative	39
5. Ex Situ No Separations alternative - vitrification	40
6. Ex Situ no Separations alternative - Calcination	40
7. Ex Situ Extensive separations alternative	41
8. Phased Implementation - Phase I	41
9. Ex situ In situ Combination alternative	42
10. Phased Implementation - Phase II	42
4. Table 5.1.1	
J. Table 5.1.1 Key Geology and Soil Input Parameters all alternatives	43
5. Tables in Chapter 3 and appendix B	
K. Tables - data calculation	46
1. Tables 3.6.1 and B.6.2.1	46
2. Tables 3.6.2 and B.6.2.2	47
3. Tables 3.6.3 and B.6.2.3	47
6. Data for Table 5.16.1 was taken from the revised data of table B.10.0.3.	48

FORM 91-005-1 (4/81)

Because of required changes in the % Na_2O and/or the waste oxides loading of the glass, the blending factor applied and the standardization for a specific size glass containment cannister, a number of the values for certain processes tabulated in Table B.10.0.3 must be recalculated. This calculation provides the method by which new input data and the required changes are used to obtain the new revised numbers for this table.

1. No action alternative - no change
2. Long-Term management alternative - no change
3. In Situ Fill and Cap alternative - no change
4. In Situ Vitrification alternative - No change
5. Ex Situ Intermediate Separations alternative - Changes Required
6. Ex Situ No Separations alternative (Vitrification) - changes Required
7. Ex Situ No Separations alternative (Calcination) - no changes.
8. Ex Situ Extensive Separations alternative - Changes Required
9. Ex Situ / In Situ Combination alternative - Changes Required.
10. Phased Implementation alternative, Phase I - Changes Required
11. Phased Implementation alternative, Phase II - Change Required.

A. The following calculations are performed for item 6 above: The Ex-Situ No Separations alternative - Vitrification.

1. The total committed land use assumed to remain the same and the Borrow Pit Disturbed area remained unchanged.

2. Raw water usage for operations increased

a. Ratio increase 6.71 E+05 MTons glass / 3.58 E+05 MTons glass = 1.87

Raw water usage is for Cooling Tower makeup for loss through evaporation, bleedoff, and drift and is based on the cooling tower duty.

New Value = (1.87)(4.62 E+05) = 8.64 E+05 m^3 for operations

Construction and Storm usage remains unchanged

Raw water total = 8.64 E+05 m^3

3. Sanitary water usage

Sanitary water use includes potable water, process water, demineralized water, utility station water and water for HVAC air humidification

Ratio increase for glass quantity from above = 1.87

Operations usage of sanitary water increase is calculated by using 2.06 E+06 m^3.

(2.06E+06 m^3)(1.87) = 3.85 E+06 m^3

Construction and closure usage remains unchanged.

Total Sanitary water usage = (3.85 E+06) + (4.13 E+04) + (2.39 E+05) m^3
= 4.13 E+06 m^3

Total water usage = (8.64 E+05 m^3) + 4.13 E+06 m^3
= 4.99 E+06 m^3

4. operations requirement for Electrical Energy

The operations electrical load includes electric heaters, electric steam generators, compressors, blowers, agitators, pumps, HVAC, cranes, MS manipulators, lighting and other miscellaneous equipment.

The increased usage would be proportional to the increased throughput of materials for the increased output of glass product for disposal.

∴ (Ratio increase) (Electrical usage) = New postulated usage.
(1.87) (4.69 E+03) = 8.77 E+03 Gwh for operations.

The Construction and closure usage assumed to remain the same.
Total Electrical usage = (8.77 E+03) + (3.0 E+1) = 8.8 E+03 Gwh

5. The Gasoline usage was not affected by this increase in Glass waste product.

6. The Diesel usage would increase due to the handling of an increased number of glass product canisters, HMPCs, and shielding units for interim storage.

Number of Canisters 587000 / 21400 = 27.4 ratio
Number of HMPCs 147,000 / 21400 = 6.87 ratio
Number of shielding units = 147,000 / 21400 = 6.87 ratio

Overall ratio = [(147000) + (147,000) + (587,000)] ÷ [(21400)(3)] = 881,000 / 64200

= 13.72

∴ Diesel usage increase = (13.72)(1.02 E+03) m^3

= 1.40 E+4

total Diesel usage = (3.50 E+03) + (5.22 E+04) + (1.19 E+04) = 6.76 E+04 m^3

7. The Kerosene increased usage is proportional to the increase in the final glass output.

∴ Increased usage = (Kerosene originally)(Ratio increase)
= (5.64 E+04)(1.87) m^3
= 1.06 E+05 m^3

8. Materials: Concrete requirements increase because of the increase in shielding casks. additional Concrete is required for interim storage pad area.

a. Concrete increase for Shielding Casks
= (Δ Casks)(90.7 Mg each)
= (125,600)(90.7 Mg Each) = 11391920 Mg

b. Concrete for storage pad increase
= (125,600)(6.6) = 828960 m^2

(147,000)(6.6)
= 970200 m^2

4 (452)(146) = 65992
5 (452)(146) = 65992
6 (452)(102) = 46104
178088

= 730563 m^2

1 (423)(350) = 148050
2 (255)(325) = 133875
3 (160)(525) = 84000
Σ = 365925

Σ+Σ = 544013 m^2

8. b. Continued

Amount of Concrete = (area) (Thickness) t = assumed at 0.2 meters

= (828960) (0.2) = 165792 m^3 Concrete.

Chasse Concrete assumed to remain unchanged

∴ Total Concrete = operations + Construction quantities + Chasse

= 1.14 E+07 Mg + 1.66 E+05 m^3 + 1.9 E+04 m^3

Concrete ≈ 1.6 Mg/m^3

= 7.13 E+06 m^3 + 1.66 E+05 m^3 + 1.9 E+04 m^3

+ 2.04 E+06 m^3 + 2.66 E+05 m^3

= 9.17 E+06 m^3 + 1.9 E+04 + 4.32 E+05 m^3

= 9.62 E+06 m^3

9. Carbon Steel increase in usage due to the increase in waste glass product.

a. Operations Canisters Stainless Steel.

(# of Canisters) (0.75 Mg/Canister)

(587,000) (0.75) = 440250 Mg = 4.4 E+05 MTons

This number replaces the Canister value given in the table for operations.

b. Construction Steel for Storage Pads.

assumed rebar diameter of 0.0125 meters and a spacing of 0.2 meters.

	(L) (#)	
Rebar (452) (146/0.2)	= (452) (730)	= 40.49 m^3
(452) (146/0.2)	= (452) (730)	= 40.49 m^3
(452) (102/0.2)	= (452) (510)	= 28.28 m^3
(525) (255/0.2)	= (525) (1275)	= 82.13 m^3
(525) (160/0.2)	= (525) (800)	= 51.53
(525) (139/0.2)	= (525) (695)	= 44.77
(525) (139/0.2)	= (525) (695)	= 44.77
(350) (423/0.2)	= 350) (2115)	= 90.83
(146) (452/0.2)	= (146) (2260)	= 40.49
(146) (452/0.2)	= (146) (2260)	= 40.49
(102) (452/0.2)	= (102) (2260)	= 28.28
(423) (350/0.2)	= (423) (1750)	= 90.83

$(139)(525/0.2) = (139)(2625) = 44.77$

$(139)(525/0.2) = (139)(2625) = 44.77$

$(160)(525/0.2) = (160)(2625) = 51.53$

$(255)(525/0.2) = (255)(2625) = 82.13$

$A = (0.0125)^2 \pi/4 = 0.0001227\ m^2$ $\Sigma \times 2 = 53160$

$\times 1m = 53160$

$(L)(A)(\#) = vol(m^3)$

$\Sigma = 846.58\ m^3$

added for End bending. $6.52\ m^3$

Σ_T $853.1\ m^3$

$\rho = 7\ Mg/m^3$ $(853.1)(7) = 5971.7$ mTons.

Const. total steel = value + 5.97 E+03 mTons

= 6.12 E+04 + 5.97 E+03 mTons = 6.72 E+04 mTons.

Total Steel = ops + Const + closure

= (1.39 E+05) + 6.72 E+04 + NA

= 2.06 E+05 mTons.

10. The Glass Reformers increased by a fraction to account for the additional waste glass product created by the reduced loading factor and the mixing factor.

Ratio = 1.87

Increased Value = (1.87)(2.5 E+05) mT = 4.68 E+05 mTons.

11. The process chemicals increased by the amount of additional oxygen required for the melters in proportion to the increased waste glass produced.

Ration = 1.87

O_2 = (1.87)(1.85 E+05) = 3.46 E+05 Mg = 3.46 mTons.

Process chemicals = 1.95 E+05 − 1.85 E+05 + 3.46 E+05

= 3.56 E+05 mTons.

12. The remaining items in this column remain unchanged.

JACOBS ENGINEERING GROUP INC.

DATE 2-15-96 SUBJECT SHEET NO. 7 of 48

BY RDW CHKD. JOB NO. OIK 47101

B The following calculations are performed for item 8 listed on page 2 above: The Ex Situ Extensive Separations alternative.

1. The total committed land use assumed to remain the same and the Borrow Pit disturbed area remained unchanged. Permanent land use goes up to account for the increased number of HLW Vaults. CH 2/2/96

2. Raw water usage for operational increase

LAW: new mass of glass = 9.65 E+05 mTons

new volume of glass = 5.24 E+05 m^3 at 2.6 m^3 = 201539

New Number of Vaults (5300 m^3) = 99 2000 = 100 vaults.

old mass of glass = 3.86 E+05 mTons

old volume of glass = 1.47 E+05 m^3

old number of Vaults (5300 m^3) = 39

HLW: new mass of glass = 2561 mTons

new volume of glass = 9.74 E+02 m^3

new number of Canisters = 1571

old mass of glass = 1304.48 mTons

old volume of glass = 496 m^3

old number of Canisters = 1000

Calculate Combined ratio

$R = (9.65\,E{+}05 + 2.561\,E{+}03)/(1.304\,E{+}3) + (3.86\,E{+}05)$

$= (9.68\,E{+}05)/(3.87\,E{+}05) = 2.50$

Raw water increased usage = (3.0 E+07) (2.50) = 7.5 E+07 m^3 ←

Total R. Water = 7.5 E+07 m^3 ←

3 Sanitary water usage increases for the increased Waste product

Sanitary Water increased usage = (3.21 E+06) (2.50) = 8.03 E+06 m^3 ←

total Sanitary Water = 8.03 E+06 + 2.05 E+05 + 5.29 E+05

= 8.76 E+06 m^3 ←

total Water usage = 8.76 E+06 m^3 + 7.5 E+07 m^3 = 8.38 E+07 m^3 ←

FORM 91-005-1 (4/81)

4. Increased Energy use

Ratio × Value = Increased use of energy.

(2.50)(1.66E+04) = 4.15 E+04 Gwh

total Energy = (4.15 E+04) + (8.9 E+01) = 4.16 E+04 Gwh

5. Diesel fuel increase for operations.

HLW Canister Increase 1570 − 1000 = 570

= 143 HMPCs

= 143 Concrete Shielding Packs.

LAW (Canister 1.8 × 1.2 × 1.2 meters) = 4.2 m³ (2.6 m³)

vault = 5300 m³ ÷ 4.2 m³ = 1263 boxes/vault. (2038)

at 99 vaults = 125,037 boxes.

Volume of waste = 5.24 E+05 m³

÷ 4.2 = 1.24762 E+05 boxes

1.25332 ÷ 10³ = 1.25E+02

(23.53)(1.02E+03) = 2.4 E+04 m³

Total = (2.9 E+04) + (2.4 E+04) + (6.72 E+04) = 1.2 E+05 m³

6. The Gasoline usage was affected by the change.

for vault construction = 5.46E+01 m³

7. The Kerosene use has increased.

(Ratio)(Value) = (2.50)(9.36E+04 m³) = 2.34 E+05 m³

8. Materials for Concrete increased for both the HLW and the LAW.

HLW: Increase in Concrete shield packs. = 143

Increase in storage pad = (143)(6.6) = 944 m²

use 1000 m² pad 20 × 50

operations Concrete = (143)(90.7) = 12970 Mg

Construction Concrete = (1000 m²)(0.2 m thick) = 200 m³

Concrete ρ = 1.6 Mg/m³ ops Concrete = 12970 ÷ 1.6 = 8106 m³

ops Concrete = 1.5E+05 + 8.1E+03 = 1.58 E+05 m³

Const Concrete = 5.0E+05 + 2.0E+02 = 5.0 E+05 m³

Total Concrete = (1.58E+05) + (1.9E+04) + (5.0 E+05) = 8.48 E+05 m³

9 Carbon Steel increase due to changes in the Loading in the glass product and in providing boxes for the LAW in estimable consideration

HLW: (570 Canisters) (0.75 Mg/Can) = 4.34E+02 MTons Stainless Steel
(1570 ") (0.75 ") = 1.2 E+03 MTons stainless steel ←

LAW: 60 vaults increase.
operations Concrete increase = (4300 m³/vault)(60 vaults)
= 2.58 E+05 m³
added to item for Shield plugs etc = (2.58E+05) + (1.5E+05) + (8.1E+03)
= 4.16 E+05 m³ ←
Carbon Steel per vault = 500 Mg/vault
(at 60 vaults) (500) Mg = 30000 Mg CS Rebar
= 3.0 E+04 MTons.

Steel for (1.8)(1.2)(1.2) meter boxes 0.0125 meters Thick plate
volume of Steel = 0.144 m³ at 7 Mg/m³

Number of boxes = (99 vaults)(1263 boxes/vault) = 125037
Steel = (125037)(0.144)(7) = 126037.29 Mg. = 1.26 E+05 MTons.

additional Rebar for Storage pad of 1000 m² (20 x 50 m)

Rebar = (20)(250) A = $\pi \frac{d^2}{4}$ = 0.0001227 m² for assumed rebar.
(50)(100)

= 0.6135 m³ + 0.6135 m³
= (1.227)(7) = 8.5 MTons of Steel rebar.

Carbon Steel for ops = (1.62 E+04) + (3.0 E+04) + (1.26 E+05) MTons
= 1.72 E+05 MTons ←

Carbon Steel for Const = (1.4 E+05) + (8.5 E+00) = 1.4 E+05 ←

10 Increase in Glass Former
(Ratio) (value in Table) = (2.50)(3.55E+05)
= 8.88 E+05 MT ←

11 Calculate process chemical change
added oxygen to calculation in line with other comparative alternatives.

Peroxide ratio = 2.5 Oxygen for H_2 separation = 1.85E+05

Oxygen = (2.5) (1.85E+05) = 4.63 E+05 kg
= 4.63 E+05 mTons.

process Chemicals = (4.3E+05) + (8.86E+05) = 1.32E+06 mTons

12. Calculate the increase in materials for the Sulfur cement unit in the LAW process.
(LAW Ratio) (Volume given)

LAW Ratio = 9.65E+05/3.86E+05 = 2.5

Sulfur = (2.5)(1.7E+05) = 4.25E+05 mTons

DCP = (2.5)(4.46E+03) = 1.12E+04 mTons

oligomer = (2.5)(4.46E+03) = 1.12E+04 mTons

13. The remaining items in this column were assumed to remain unchanged.

C. The following calculations are performed for Item 5 in the listing above on page 2: Ex Situ Intermediate Separations alternative.

1. The total land use area committed was assumed to remain unchanged and the borrow pit disturbed area remained unchanged. No Land use Commitments were Calculated Separately.

2. Calculate the increase in Raw waste mass
LAW: new mass of glass = 9.68E+05 mTons
new volume of glass = 5.26E+05 m^3
new number of 5300 m^3 Vaults = 99

old mass of glass = 5.79E+05 mTons.
old volume of glass = 2.20E+05 m^3
old number of 5300 m^3 vaults 39

JACOBS ENGINEERING GROUP INC.

DATE 2-15-96 SUBJECT SHEET NO. 11 of 48

BY [illegible] CHKD. JOB NO. 21K47101

HLW: new mass of glass = 5.44E+04 m Tons
new volume of glass = 2.07E+04 m^3
new number of Canisters = 3.34E+04 0.62 m^3 Canisters

old mass of glass = 2.47E+04 m Tons
old volume of glass = 9.4E+03 m^3
old number of Canisters = 6.82E+03 1.56 m^3 Canisters

Calculate LAW ratio = 9.68E+05 / 5.79E+05 = 1.7

Calculate HLW ratio = 5.44E+04 / 2.47E+04 = 2.2

Calculate combined ratio = $\frac{(9.68E+05) + (5.44E+04)}{(5.79E+05) + (2.47E+04)}$
= 102.24 / 60.37 = 1.7
= 1.7

Raw water usage = (1.7)(1.07E+07)
= 1.82E+07 m^3

Total Raw Water = 1.82E+07 m^3

3. Calculate incremental sanitary water usage

Sanitary water usage = (3.1E+06)(1.7) m^3
= 5.27E+06 m^3

Total Sanitary water usage = (6.0E+04) + (5.27E+06) + (5.0E+05)
= 5.83E+06 m^3

total water usage = (5.83E+06) + (1.82E+07)
= 2.40E+07 m^3

4. Calculate incremental electrical energy use

Electrical Energy usage = (1.7)(9.0E+03) + (2.54)(7.4E+01)
= (1.53E+04) + (1.88E+02)
= 1.55E+04

FORM 91-005-1 (4/81)

Total Electricity = (1.55E+04)+(7.4E+01) = 1.56 E+04 Gwh

5. The gasoline usage for construction of extra vaults.

(60)(240)(3.788) ÷ 10^3 = 5.46 E+01 m^3

6. Calculate the increased diesel usage estimated for the changes in the waste glass product.

additional Cannisters
additional HMPCs
additional Shielding casks.
additional vaults.

vaults = (60)(25530)(3.788) ÷ 10^3
= 5.8 E+03 m^3

handling of extra Cannisters, boxes and shielding equipment.

(1.7)(1.02 E+03) = 1.734 E+03 m^3

ops Diesel = (5.8 E+03 m^3) + (1.734 E+03 m^3)
= 7.53 E+03 m^3

total Diesel = (6.62 E+04) + (7.53 E+03) + (2.1 E+04)
= 9.47 E+04 m^3

7. Calculate the increased kerosene usage

(Ratio)(original value)
= (1.7)(5.8 E+04) m^3
= 9.86 E+04 m^3

8. Calculate additional concrete requirements

60 new vaults = (60)(4300 m^3) = 2.58 E+05 m^3 $\left(\frac{44}{60}\right)$ =

new scheel Casks = total# − old# = (8350) − (1705)
= (6645)(90.7) = 6.03 E+05 Mg
= (6.03 E+05) ÷ (1.6 Mg/m^3) = 3.77 E+05 m^3
= 3.77 E+05 m^3

storage pad increase

new area = (6.6)(8350) = 55,110 m^2
old area = (6.6)(1705) = 11,253 m^2
additional area = 43857 m^2 = 400 m × 110 m = 44000 m^2

assumed Concrete 0.2 meters thick.

Volume = (44 000)(0.2) = 8.9 E+03 m^3

operations Concrete = (2.58 E+05 m^3) + (3.07 E+05 m^3) + (5.4 E+05 m^3)
= 1.175 E+06 m^3

Construction Concrete = (5.4 E+05) + (8.8 E+03) m^3
= 5.49 E+05 m^3

• total Concrete = (1.9 E+04) + (5.49 E+05) + (1.175 E+06)
= 1.74 E+06 m^3

9. Calculate increased Carbon Steel requirements.

Carbon Steel for increased storage pad. 400 m x 110 m

assumed steel spacing of 0.2 meter centers. and 0.0125 meter

(110)(2000)

(400)(550)

area of rebar = 0.0001227 m^2

(110)(2000)(0.0001227) = 26.994 m^3

(400)(550)(0.0001227) = 26.994 m^3

Σ = 53.988 m^3

Σ = 54 m^3

ρ = 7 Mg/m^3 = 3.78 E+02 mTons.

Carbon Steel boxes.

Volume of steel per box = 0.144 m^3

Number of boxes = (99 vaults)(1263 per vault) = 125037

Steel = (125037)(0.144 m^3) = 18005.328 m^3

ρ = 7 Mg/m^3 = 1.26 E+05

Carbon Steel for Extra vaults.

(99)(500) = 49,500 Mg = 4.95 E+04 mT

(44)(500) = 2.2 E+04 mT

Carbon Steel for operations

= (4.9 E+04) + (2.57 E+03) = 5.16 E+04 mTons

Carbon Steel for Construction

= (1.07 E+05) + (7.72 E+00) = 1.07 E+05

Carbon Steel total.

$= (1.07E+05) + (5.16E+04) + (1.9E+04)$

$= 1.78E+05$ m Tons.

10. Calculate Stainless steel requirements for operations Cannisters.

Number of Cannisters $= 3.34E+04$ @ $0.62\ m^3$

amount of Stainless Steel $= (3.3400)(0.75) = 25050$ Mg

$= 2.51E+04$ m Tons.

Stainless steel total $= (2.51E+04) + (1.9E+04)$

$= 4.41E+04$ m Tons.

11. Calculate increase in Glass formers due to changes in loading which increases amount of glass required.

(ratio) (glass formers originally required)

$= (1.7)(2.94E+05)$

$= 5.0E+05$ m tons.

12. Calculate Increase in process chemicals. only oxygen needs to change and must be added.

original ratio to no separations Kerosene $= 5.8/5.64 = 1.03$

original Oxygen required $= (1.03)(1.85E+05\ Mg) = 1.91E+05$ Mg

Increased need for oxygen $= (1.91E+05\ Mg)(1.7) = 3.25E+05$ Mg

$= 3.25E+05$ m Tons

Process Chemicals $= (3.25E+05) + (1.90E+05)$

$= 5.15E+05$ M Tons.

13. Changes in the sulfur cement materials

Sulfur $= (1.30E+05\ m\ Tons)(1.7) = 2.21E+05$ m Tons.

DCP $(3.4E+03\ m\ Tons)(1.7) = 5.78E+03$ m Tons

Oligomer $(3.4E+03\ m\ Tons)(1.7) = 5.78E+03$ m Tons

14. The remaining items in this column were assumed to remain unchanged.

NOTE:

Because of a change to the assumed 1.5 blending factor for IAW to a blending factor of 1.25 the number of vaults used have changed. Conditions for Intermediate Separations and extension Separations are required for Concrete requirements, for rebar requirements and for Steel box requirements.

Intermediate Separations process & Extension Separations process.

Number vaults used = 99 number of vaults needed = 83

Subtract 16 vaults.

Concrete = (16)(4300) = 68800 m^3

Rebar = (16)(500 Mg) = 8000 Mg.

Boxes = (16)(1263)(0.144) = 2909.952 m^3

$\rho = 7\ mg/m^3$ = 2.04 E+04 mTons.

For Intermediate Separations

operations Concrete = (1.175 E+06) − (6.88 E+03)

= 1.11 E+06 m^3

operations C/S = (5.16 E+04) − (2.04 E+04) − (8.0 E+03)

= 2.32 E+04 mTons.

For Extension Separations case

operations Concrete = (4.16 E+05) − (6.88 E+04)

= 3.47 E+05 m^3

operations CS = (1.72 E+05) − (8.0 E+03) − (2.04 E+04)

= 1.44 E+05 mTons

D. The following calculations are performed for Item 9 in the listing above on page 2: Ex Situ / In Situ combination alternative.

1. ~~The total committed land was assumed to remain the same and the borrow pit disturbed area remained unchanged.~~ Land use Revisions calculated Separately.

JACOBS ENGINEERING GROUP INC.

DATE 2-15-96 SUBJECT SHEET NO. 16 of 48

BY RDW CHKD. JOB NO. 01K47101

LAW: New mass of glass = 4.84 E+05 MTons
new volume of glass = 1.32 E+05 m^3
new number of 5300 m^3 Vaults = 42

old mass of glass = 2.9 E+05 MTons
old volume of glass = 1.10 E+05 m^3
old number of 5300 m^3 Vaults = 20

Values assumed at 50% of the intermediate separations alternative.

HLW: new mass of glass = 2.72 E+04 MTons
new volume of glass = 1.04 E+04 m^3
new number of Canisters = 1.67 E+04 0.62 m^3 Canister

old mass of glass = 1.24 E+04 MTons
old volume of glass = 4.7 E+03 m^3
old number of Canisters = 3.41 E+03 1.56 m^3 Canister

Calculate LAW ratio = 1.7
Calculate HLW ratio = 2.4
Calculate Combined ratio = 1.7

2. Calculate Raw water usage
Raw water usage = (1.7)(5.5 E+06) = 9.35 E+06 m^3

total Raw water = (5.5 E+06) + (9.35 E+06) = 1.49 E+07 m^3

3. Calculate Sanitary water

Sanitary water = (1.7)(3.08 E+06 m^3) = 5.24 E+06 m^3

total Sanitary water = (5.24 E+06) + (4.19 E+05) + (4.90 E+04)
= 5.71 E+06 m^3

total water = (5.71 E+06) + (1.49 E+07) m^3
= 2.06 E+07 m^3

FORM 91-005-1 (4/81)

JACOBS ENGINEERING GROUP INC.

DATE 2-15-96 SUBJECT SHEET NO. 17 of 48

BY RDW CHKD. JOB NO. 01K47101

4. Calculate Estimated Electrical increase from loading changes

(Ratio) (electrical) = (1.7) (4.5 E+03)

= 7.65 E+03 Gwh.

Total Electrical = (7.65 E+03) + (3.8 E+01)

= 7.69E+03 Gwh

5. Calculate gasoline usage for construction of extra vaults during operation.

42 - 20 = 22 new vaults.

(22)(240)(3.788) = 2.0 E+04 Liters

10^3 Liters = m^3 = 2.0 E+01 m^3

6. Calculate Diesel usage increase

for vaults = (22) (25530)(3.788)(10^{-3}) = 2.13 E+03 m^3

for handling equipment = (1.7) (4.17 E+03) = 7.09 E+03 m^3

for operations = (7.09 E+03) + (2.13 E+03)

= 9.22 E+03 m^3

Diesel total = (9.22 E+03) + (5.8 E+04) + (4.54 E+05)

= 5.21 E+05 m^3

7. Calculate Kerosene usage

(Ratio) (original amount)

= (1.7) (2.9 E+04)

= 4.93 E+04 m^3

8. Calculate the increased requirement for concrete for the LAW and HLW increased quantities.

LAW: (22 vaults)(4300 m^3/vault) = 9.46 E+04 m^3

HLW: Shielding casks: 4175 - 853 = 3322

(3322)(90.7 Mg) = 301305.4

ρ = 1.6 Mg/m^3 301305.4 ÷ 1.6 = 1.88 E+05 m^3

Concrete storage pad increase = (3322)(6.6) = 21925 m^2

= 220m x 100m = 22000 m^2

FORM 91-005-1 (4/81)

assumed Concrete 0.2 meter thick

$V = (22{,}000)(0.2) = 4400\ m^3$

$= 4.4E+03\ m^3$

operations Concrete $= (9.5E+04) + (9.46E+04) + (1.88E+05)$

$= 3.68E+05\ m^3$

Construction Concrete $= (4.4E+03\ m^3) + (2.7E+05)$

$= 2.74E+05\ m^3$

total Concrete $= (2.74E+05) + (3.68E+05) + (1.9E+04)$

$= 6.61E+05\ m^3$

9. Calculate the operations and Construction increase for Carbon Steel requirements.

vaults $= (22)(500\ Mg) = 11000\ Mg$

$= 1.1E+04$ mTons.

Pad 220 x 110 m ARea

$= (220)(550)(0.0001227) = 14.8\ m^3$

$= (110)(1100)(0.0001227) = 14.8\ m^3$

$\rho = 7\ Mg/m^3$ $\Sigma = 29.7\ m^3$

$= (29.7)(7) = 2.08E+02$ MTons.

ops Carbon Steel $= (9.6E+03) + (1.1E+04)$

$= 2.06E+04$ metric Tons

Const Carbon Steel $= (5.34E+04) + (2.08E+02)$

$= 5.36E+04$ mTons

total Carbon Steel $= (5.36E+04) + (2.06E+04)$

$= 7.42E+04$ mTons.

10 Calculate Stainless usage by operations for this alternative.

Number of Canisters of Stainless steel = 16700

$= (16700)(0.75) = 12525\ Mg$

$= 1.25E+04$ mTons.

total Stainless Steel = (1.25 E+04) + (9.5 E+03)
= 2.2 E+04 mTons

11. Calculate carbon steel for 1.8 x 1.2 x 1.2 m retrievable boxes for LAW.

(42)(1263)(0.144) = 7.64 E+03 m^3

$\rho = 7 Mg/m^3$ = (7.64 E+03)(7) = 5.35 E+04 mTons.

total ofo CS = (2.06 E+04) + (5.35 E+04)
= 7.41 E+04

total CS = (7.41 E+04) + (5.36 E+04)
= 1.28 E+05 mtons

12. Calculate the increased requirement of the glass formers.

(1.7)(1.47 E+05) = 2.50 E+05 mtons.

13. Calculate the process chemicals and tabulate the increase.

Oxygen increase = (3.25 E+05 mtons)(0.5)
= 1.63 E+05 mTons of oxygen.

Process chemicals = (1.63 E+05) + (9.55 E+04)
= 2.59 E+05 mTons.

14. Calculate the sulfur cement increases required for the changes.

sulfur = (2.21 E+05)(0.5) = 1.105 E+05 mTons.
DCP = (5.78 E+03)(0.5) = 2.89 E+03 mtons.
oligomer = (5.78 E+03)(0.5) = 2.89 E+03 mTons.

E. The following calculations are performed for Item 7 in the listing above on page 2: Ex Situ no separations alternative - Calcination.

The number of canisters increased to 108388 at 0.62 m^3 (1.66 E+05)

new number. HMPCs = 27097 (41500)
new number shielding Casks = 27097 (41500)
old number HMPCs = 10300
old number shielding Casks = 10300

JACOBS ENGINEERING GROUP INC.

DATE 2-15-96 SUBJECT SHEET NO. 20 of 48

BY RDW CHKD. JOB NO. OIK 47101

1. assumed the items listed below remained the same for this alternative
   a. Land permanently committed
   b. Land temporary committed
   c. Borrow pit not Disturbed
   d. Water total not increased
   e. Sanitary water not increased
   f. Raw water not increased
   g. Energy use remained the same
   h. Gasoline use remained the same

2. Calculate the operations diesel usage based on handling additional HMPCs and shielding covers.

Δ HMPCs = 16797 + 16797 shields (31200)

= 33594 (62400)

Ratio = 33594 / 20600 = 1.63 (3.03)

Diesel increase = (1.02 E+02) + (1.02 E+02)(1.63) (3.1 E+02

= (1.02 E+02) + (1.66 E+02)

= 2.68 E+02 m^3 (4.12 E+02 m^3)

total Diesel usage = (2.68 E+02) + (5.22 E+04) + (1.19 E+04)

= 6.44 E+04 m^3 (1.124 E+05 m^3)

3. Kerosene usage will not change.

4. Calculate the concrete storage for additional shielding casks and the additional storage pad needed.

(2829840) kg

Concrete for shielding units = (90.7)(16797) = 1523488 Mg

= 1523488 ÷ 1.6 = 9.52 E+05 m^3

= 9.52 E+05 m^3 (1.77 E+06 m^3)

storage pad = (16797)(6.6 m^2) = 110860.2 m^2 (205920 m^2)

= 525 x 212 m = 111300 m^2

volume @ 0.2 meter thick = 2.23 E+04 m^3 [(325)(303) 206325 m^2]

(41265 m^3)

FORM 91-005-1 (4/81)

operational Concrete = 9.52 E+05 m³
= (9.52 E+05) + (9.8 E+05)
= 1.93 E+06 m³ (2.75E+06)

Construction Concrete = 2.23 E+04 m³
= (2.23 E+04) + (2.66 E+05)
= 2.88 E+05 m³ (3.07E+05)

total Concrete = (2.88 E+05) + (1.93 E+06) + (1.9 E+04)
= 2.24 E+06 m³
(3.08E+06 m³)

5 Calculate the Construction Carbon Steel increase for rebar for the increased storage pad area.

Estimated size = 525 m × 212 m. rebar 0.0125 m diameter
Spacing 0.2 m centers.
area = 0.0001227 m²
ρ = 7 Mg/m³ 1 Mg = 1 ton

(525 1965 886 mT)
(393 886 mT)
(1772 m tons)

= (525)(1060)(0.0001227)(7) = 478 metric tons.

= (212)(2625)(0.0001227)(7) = 478 metric tons

(1.77 E+03 m tons)

Σ = 9.56 E+02 m tons.

Construction = (9.56 E+02) + (6.12 E+04)
(6.3 E+04)
= 6.22 E+04 m tons.

Total = (7.04 E+04) + (6.22 E+04)
(1.334 E+05 m tons)
= 1.33 E+05 metric tons.

6. Calculate Stainless steel required for the new cannisters as an operational expense.

Cannisters = 0.62 m³ factor = 0.75 Mg/cannister.
Number of Cannisters = 108388

Stainless steel = (108388)(0.75) = 81291 metric tons
= 8.13 E+04 metric tons.

(1.25 E+05 m tons)

total Stainless Steel = (1.26E+04) + (8.13E+04)
= 9.39E+04 metric tons

(1.38E+05)

7. The following items were assumed to remain constant for this process.
   a. Glass formers
   b. Process chemicals
   c. Sulfur cement
   d. Ion Exchange media
   e. Borrow site silt
   f. Borrow site sand and gravel
   g. Borrow site basalt
   h. asphalt

F. The following calculations are performed for Item 11 in the listing above on page 2: Phased Implementation alternative - Phase II.

1. The following items were assumed unchanged in this alternative.
   a. Land permanently committed
   b. Land temporarily committed
   c. Borrow pit disturbed area

   } LAND USE WAS CALCULATED SEPARATELY DOES NOT IMPACT THIS Calculation.

2. Calculate the sanitary water usage increase for the changes in glass loading requirements.

HLW: new mass of glass = 5.45E+04 MT
new volume of glass = 2.07E+04 m^3
new number of Canisters 0.61 m^3 = 33400
New number of HMPCs = 8350
New number of Shielding Casks = 8350

old mass of glass = 2.47E+04 MT
old volume of glass = 9.4E+03 m^3
old number of Canisters = 6.82E+03 0.56 m^3
old number of HMPCs = 1705
old number of Shielding Casks. = 1705

LAW: new mass of Glass = 8.07 E+05 mtons.
new volume of Glass = 4.38 E+05 m^3
new number of Canisters (4.2 m^3) = 104829
new number of vaults = 83
old mass of Glass = 4.83 E+05 mtons.
old volume of Glass = 1.83 E+05 m^3
Old number of Canisters (4.2) m^3 = 39

HLW ratio = 5.45 E+04 / 2.47 E+04 = 2.2

LAW ratio = 8.07 E+05 / 4.83 E+05 = 1.67

$$\text{Combined HLW + LAW Ratio} = \frac{(5.45\ E+04) + (8.07\ E+05)}{(2.47\ E+04) + (4.83\ E+05)}$$

$$= \frac{8.62\ E+05}{5.08\ E+05} = 1.7$$

$$= 1.7$$

Sanitary water increase = (1.7)(2.77 E+06)
= 4.71 E+06 m^3

total sanitary water = (6.03 E+04) + (4.71 E+06) + (2.54 E+05) m^3
= 5.02 E+06 m^3

3. Calculate raw water usage increase for the increased glass product because of reduced waste oxide loading and blending factor.

Raw water = (1.7)(7.7 E+06) = 1.31 E+07 m^3

total raw water = (1.31 E+07) + (N/R) + (N/R)
= 1.31 E+07 m^3

Total water usage = (1.31 E+07 m^3) + (5.02 E+06 m^3)

= 1.81 E+07 m^3

4. Calculate the increased Energy usage for this alternative.

$$Kwh = (1.7)(6.1E+03) = 1.04E+04\ Kwh$$

$$total = (1.04E+04) + (3.73E+01) = 1.044E+04\ Kwh$$

5. Calculate Gasoline requirements for storage vault construction. Vault construction is considered an operational item.

240 gallons of Gasoline per vault.

$$(83)(240)(3.788) = 75457\ Litres$$

$$@\ 10^3\ Litres/m^3 = 7.55E+01\ m^3$$

$$Total\ Gasoline = (7.55E+01) + (3.91E+02) + (4.71E+03)$$
$$= 5.18E+03\ m^3$$

6. Calculate increased Diesel usage due to handling an increased number of containers, shipping casks and shielding casks.

Ratio $8350 \div 1705 = 4.9$

$$Diesel\ Increase\ operation = (4.9)(1.22E+03\ m^3)$$
$$= 6.0E+03\ m^3$$

$$total\ Diesel\ increase = (6.0E+03) + (1.8E+04) + (1.3E+04)\ m^3$$
$$= 3.7E+04\ m^3$$

7. Calculate the increased Kerosene usage

(Ratio) (Present value)

$$= (1.7)(3.0E+04\ m^3)$$
$$= 5.1E+04\ m^3$$

8. Calculate the increased Concrete requirements for this alternative. Increased storage vaults and storage pads are required. Increased shielding casks are also required.

JACOBS ENGINEERING GROUP INC.

DATE 2-15-96 SUBJECT SHEET NO. 25 of 48

BY RDJ CHKD. JOB NO. 01K27101

LAW: 44 new vaults are required at 4300 m^3 concrete each.

$(44)(4300) = 189200\ m^3$

HLW: new shielding units at 90.7 Mg each for 6645

$(6645)(90.7) = 602701.5$ Mg.

$\rho = 1.6\ Mg/m^3$ $= (602701.5)/1.6 = 376688.43\ m^3$

Concrete for new storage pad.

$(6645)(6.6) = 43857\ m^2$

$= (440)(100)\ m^2$

$= 44000\ m^2$ assumed equal to 0.2 m thick

$vol = (44000\ m^2)(0.2) = 8800\ m^3$

Operations Concrete = vaults + shield units

$= (1.89E+05\ m^3) + (3.77E+05\ m^3)$

$= 5.66E+05\ m^3$ ←

Construction Concrete = new pad

$= 8.8E+03\ m^3$ ←

Concrete Total for operations $= (1.7E+04) + (5.66E+05)\ m^3$

$= 5.83E+05\ m^3$ ←

Concrete Total for Construction $= (1.9E+04) + (8.8E+03)$

$= 3.78E+04\ m^3$ ←

total Concrete $= (1.9E+04) + (3.78E+04) + (5.83E+05)$

$= 6.4E+05\ m^3$ ←

9. Calculate the carbon steel requirements for the increase in the number of vaults, the storage pad and the 4.2 m^3 boxes for the LAW material.

FORM 91-005-1 (4/81)

Steel rebar for the storage pad, 440 m x 100 m
steel spacing 0.2 meter centers with 0.0125 m diameter rebar.

$A = 0.0001227\ m^2$ $\rho = 7\ Mg/m^3$

$= (440)(100 \div 0.2)(0.0001227)(7) = 189$ m Tons

$= (100)(440 \div 0.2)(0.0001227)(7) = 189$ m tons

$= 378$ metric tons.

Steel for the 44 vaults

$= (44)(500\ Mg) = 22000\ Mg$

$= 22000$ metric tons.

Steel for 4.2 m^3 boxes Steel $= 0.144\ m^3/box$ $\rho = 7\ Mg/m^3$

$(83\ vaults)(1263\ boxes)(0.144)(7) = 105667.63$ m Tons.

$= 1.06E+05$ m Tons.

Total Carbon Steel for operations $= (2.0E+04) + (1.06E+05) + (2.2E+04)$

$= 1.48E+05$ metric Tons. ←

total Carbon Steel for Construction $= (5.85E+04) + (3.78E+02)$

$= 5.89E+04$ m tons ←

total Carbon Steel $= (5.89E+04) + (1.48E+05) + (NA)$

$= 2.07E+05$ m Tons ←

10. Calculate the stainless steel for the HLW canisters required at 0.62 m^3 size. Each $= 0.75\ Mg$.

$= (33400)(0.75) = 25050\ Mg = 25050$ metric Tons

$= 2.51E+04$ m Tons. ←

Total Stainless Steel $= (1.15E+04) + (2.51E+04)$

$= 3.66E+04$ m Tons ←

11. Calculate the increased quantity of glass formers

$= (1.7)(2.8E+05) = 4.76E+05$ m Tons.

$= 4.76E+05$ m Tons ←

12. Calculate the increase in the process chemicals to include and add the oxygen requirements.

From the intermediate calculation the Oxygen required = 3.25 E+05 metric tons.

It was assumed that the same increased quantity was required for this alternative.

Total Process chemicals = (3.25 E+05) + (1.5 E+05)
= 4.75 E+05 m tons. ←

13. Calculate the changes in the Sulfur Cement requirements for this alternative.

Sulfur (1.2)(1.7) = 2.04 E+05 m tons ←

DCP (1.7)(3.4) = 5.78 E+03 m tons ←

Oligomer (1.7)(3.4) = 5.78 E+03 m tons. ←

14. Correction for Sulfur for the Phase 1 phased implementation

Ratio of phase I to Total = 87600/807000 = 0.11

Sulfur = (1.3 E+05) (0.11) = 1.43 E+04 m tons. ←

DCP = (3.4 E+03) (0.11) = 3.74 E+02 m tons ←

Oligomer = (3.4 E+03) (0.11) = 3.74 E+02 m tons ←

B. The following calculations are performed for the intermediate separations alternative using the following bases:

HLW - 15 wt% waste oxide loading.
- Blending factor of 1.5

LAW - 10 wt% sodium oxide loading
- Blending factor of 1.25

The changes as required for the intermediate separations case in Table B.10.0.3 for Resource Recovery will be determined so that a comparison for number of trips for trucks can be determined to compare to the already calculated data.

HLW:

new mass of glass	= 7.26E+04 MTons
new volume of glass	= 2.76E+04 m^3
new number of Canisters 0.62 m^3	= 4.45E+04
New number of HMPCs	= 11125
New number of Shield covers	= 11125
old mass of glass	= 2.47E+04 MTons
old volume of glass	= 9.4E+03 m^3
old number of Canisters - 1.36 m^3	= 6.82E+03
old number of HMPCs	= 1705
old number of shield covers	= 1705

LAW:

new mass of glass	= 1.21E+06 MTons
new volume of glass	= 6.57E+05 m^3
New number of 5300 m^3 vaults	= 124
old mass of glass	= 5.79E+05 MTons
old volume of glass	= 2.20E+05 m^3
old number of 5300 m^3 vaults	= 39

HLW ratio = (7.26E+04)/(2.47E+04) = 2.94

LAW ratio = (1.21E+06) / (5.74E+05) = 2.09

Combined ratio = [(7.26E+04) + (1.21E+06)] ÷ [(2.47E+04) + (5.79E+05)]
= (128.26E+04) ÷ (60.37E+04) = 2.13

JACOBS ENGINEERING GROUP INC.

DATE 2-15-96 SUBJECT SHEET NO. 29 of 48

BY R.JW CHKD. JOB NO. 21K47101

1. It was assumed at this point that the following entries would remain unchanged.
   a. Land permanently committed
   b. Land temporarily committed
   c. Borrow pit disturbed area

2. Calculate the increase in the sanitary water usage
   (Combined ratio) (operations sanitary water)
   $m^3 = (2.13)(3.1E+06\ m^3) = 6.60E+06\ m^3$
   Sanitary Water $= 6.60E+06\ m^3$

   Total Sanitary water $= (6.0E+04) + (6.60E+06) + (5.0E+05)$
   $= 7.16E+06\ m^3$

3. Calculate the increase in the raw water usage.
   (Comb. Ratio) (operations usage)
   Raw water $= (2.13)(1.07E+07) = 2.78E+07\ m^3$
   Raw water $= 2.78E+07\ m^3$

   Total Raw water $= NR + (2.78E+07) + NR$
   $= 2.78E+07\ m^3$

4. Calculate the total water usage
   total = RW Total + SW total
   $= (2.78E+07)(7.16E+06)$
   $= 3.5E+07\ m^3$

5. Calculate the increased energy use due to the reduced loading and the blending factor application.
   (Comb. ratio) (Energy usage for operations)
   Energy $= (2.13)(9.0E+03) = 1.92E+04$
   $= 1.92E+04$ Gwh

   total Energy $= (1.92E+04) + (7.4E+01) = 1.93E+04$
   $= 1.93E+04$ Gwh.

FORM 91-005-1 (4/81)

6. Calculate the Gasoline requirements for the construction of the LAW storage vaults.

(II Vaults) (Gasoline requirement)

(124 - 39) (240 gallons)

gasoline m^3 = (85) (240)(3.788)(10^{-3}) = 77.3 m^3

= 7.73 E+01 m^3

Total gasoline = (390)+(77.3) + (7600) = 8067.3

= 8.07 E+03 m^3

7. Calculate Diesel requirements for vault Construction and handling additional HMPCs and shielding covers.

Δ HMPCs = 9420

Δ Shield Covers = 9420

Ratio = 18840/3410

= 5.525

(H vaults) (Diesel requirement)

= (85)(3.788)(10^{-3})(25530) = 8.22 E+03 m^3

= 8.22 E+03 m^3

Handling HMPCs + Shield Covers

= (5.525)(1.02E+03) = 5.64 E+03 m^3

operations Diesel requirements = (5.64 E+03)+(8.22 E+03)

= 1.39 E+04 m^3

Total Diesel = (1.39 E+04) + (6.62 E+04) + (2.1 E+04)

= 1.01 E+05 m^3

8. Calculate the Kerosene requirements for the reduced loading and the blending factor applications.

(Conc Ratio) (Kerosene originally)

= (2-13)(5.08 E+04) = 1.08 E+05 m^3

= 1.08 E+05 m^3

9. Calculate the increased concrete requirements for the additional vaults, additional shielding covers, and additional storage pad for interim HLW storage.

additional storage pad requirement

additional HMPC units = 9420

additional area required = (9420)(6.6 m²) = 62 172 m²

use (500 m)(125 m) = 62 500 m²

use 0.2 meter thick concrete

Vol = (62 500)(0.2) = 12500 m³

= 1.25 E+04 m³

Concrete for additional HMPC concrete covers

= (9420)(90.7 mg) ÷ (1.6 mg/m³) = 5.34 E+05 m³

= 5.34 E+05 m³

Concrete for additional vaults

= (85)(4300 m³) = 3.66 E+05 m³

= 3.66 E+05 m³

Construction Concrete

= (1.25 E+04) + (5.4 E+05)

= 5.53 E+05 m³

operations concrete

= (5.34 E+05) + (3.66 E+05) + (1.7 E+05)

= 1.07 E+06 m³

total Concrete = (1.07 E+06) + (5.53 E+05) + (1.9 E+04)

= 1.64 E+06 m³

10. Calculate the carbon steel requirement for rebar for the storage pad, Rebar for the concrete vaults, and steel for the 4.2 m³ boxes for LAW waste for retrievability.

Steel for the vaults

= (85)(500 mg) = 4.25 E+04 Mg.

= 4.25 E+04 Tons of rebar.

10. continued

Steel for storage pad (500 m) (125 m)

used 0.2 meter (500) (125 ÷ 0.2) (0.0001227)(7) = 268.4 m tons.

Center-Center Spacing

used 0.0125 dia rebar. ρ = 7 mg/m³

(125) (500 ÷ 0.2) (0.0001227)(7) = 268.4 m tons

= 536.8 metric tons.

Steel for the 4.2 cubic meter LAW waste barges.

(1263)(124)(0.144 m³/hot)(7 mg/m³) = 157865 m tons

= 1.58 E+05 m Tons.

Construction Steel = (268.4 m tons) + (1.07 E+05)

= 1.07 E+05 m tons

operations Steel = (1.58 E+05) + (4.25 E+04) + (NR)

= 2.01 E+05 metric tons.

total Carbon Steel = (2.01 E+05) + (1.07 E+05) + (1.9 E+04)

= 3.27 E+05 m tons

11. Calculate the stainless steel requirement for the 0.62 m³ canisters required for the HLW glass

(4.45 E+04)(0.75) = 3.34 E+04 m tons.

0.62 m³ Canisters = 3.34 E+04 m tons.

total Stainless Steel = (3.34 E+04) + (1.9 E+04)

= 5.24 E+04 m tons

12. Calculate the increase in glass forming for the reduced loading in the glass.

(2.13)(2.94 E+05) = 6.26 E+05

= 6.26 E+05 m Tons.

13. Calculate the increased process chemicals for this case. Assume that oxygen was the major increase and since it was not originally included it has been calculated for inclusion now.

From page 14 item 12, oxygen = 1.91 E+05 Mg.

Annual oxygen = (1.91 E+05)(2.13) = 4.07 E+05

= 4.07 E+05 m tons.

• Process Chemicals = (4.07 E+05) + (1.90 E+05)

= 5.97 E+05 m tons

Note

to add O_2 to the original case

= (1.90 E+05) + (1.91 E+05)

= 3.81 E+05 m tons.

14. Calculate the quantities of material needed for the sulfur cement based on the changes in the SAW glass loading.

Sulfur = (1.3 E+05)(2.13) = 2.77 E+05 m Tons. ←

Dicyclopentadiene = (3.4 E+03)(2.13 = 7.24 E+03 m tons. ←

Oligomer = (3.4 E+03)(2.13) = 7.24 E+03 m tons. ←

A. The following calculations are performed for the intermediate separations alternative using the following bases:

HSW - 40 weight % waste oxides loading

- Blending factor of 1.5.

SAW - 25 Weight % Na_2O loading

- Blending factor of 1.25

The changes as required for the intermediate separations case in Table B10.0.3 for Resource Summary will be determined so that a comparison for number of trips

for trucks and rail cars can be determined, including the number of on-site trips, to compare to the already calculated data.

1. It was assumed at this point that the following entries would remain unchanged.
   a. Land permanently committed
   b. Land temporarily committed
   c. Borrow pit disturbed area

2. Calculate the process ratio change.

HLW - new mass of glass = 2.72 E+04 MTons
- new volume of glass = 1.03 E+04 m^3
new number of canisters (0.62 m^3) = 1.67 E+04
new number of HMPCs = 4175
new number of shielding covers = 4175

$\rho = 2.63$ Mg/m^3

old mass of glass = 2.47 E+04 MTons
old volume of glass = 9.4 E+03 m^3
old number of canisters 1.26 m^3 = 6.82 E+03
old number of HMPCs = 1705
old number of shielding covers = 1705

LAW - new mass of glass = 4.84 E+05 MTons
new volume of glass = 2.63 E+E+05 m^3
new number of vaults = 50

old mass of glass = 3.87 E+05 MTons
old volume of glass = 2.1 E+05 m^3
old number of vaults = 40

$\rho = 1.84$ Mg/m^3

Combined ratio = [(2.72 E+04) + (4.84 E+05)]/[(3.87 E+05) + (2.47 E+04)]

= (5.11 E+05)/(4.12 E+05)

= 1.24

HLW ratio = (2.72 E+04)/(2.47 E+04)
= 1.1

LAW ratio = (4.84 E+05)/(3.87 E+05)
= 1.25

3. Calculate the Sanitary water usage increase for the increased quantity of waste glass produced.

(Comb. Ratio) (tabulated value for operations)
= (1.24) (3.1 E+06) m^3
= 3.844 E+06 m^3

total Sanitary water = (3.844 E+06) + (6.0 E+04) + (5.0 E+05)
= 4.4 E+06 m^3

4. Calculate the raw water usage increase for the increased quantity of waste glass produced.

(Combined Ratio) (Raw water value for operations)
= (1.24) (1.07 E+07) m^3
= 1.33 E+07 m^3

total Raw water = 1.33 E+07 m^3

total water usage = (1.33 E+07) + (4.4 E+06) m^3
= 1.77 E+07 m^3

5. Calculate the increased Energy use for the increased glass product due to the loading and blending factor changes.

(Comb. Ratio) (Energy value for operations)
= (1.24) (9.0 E+03 Btuh)
= 1.12 E+04 Btuh.

total Energy = (1.12 E+04) + (7.4 E+01)
= 1.13 E+04 Btuh.

JACOBS ENGINEERING GROUP INC.

DATE 2-15-96 SUBJECT SHEET NO. 36 of 48

BY RDW CHKD. JOB NO. 01H4701

6. Calculate the increased Gasoline usage for construction of the additional LAW vaults.

LAW storage vaults = 50 - 40 = 10

$= (10)(240) = 2400$ gallons

$= (2400)(3.788)(10^{-3}) = 9.091.2$

$= 9.1\ m^3$

Total gasoline $= (9.1) + (3.9E+02) + (7.6E+03)$

$= 8.00\ E+03\ m^3$ ←

7. Calculate the Diesel fuel requirements for new vault construction and the increased handling requirements.

For new vaults $= (10)(25530) = 255{,}300$ gallons

$= (255300)(3.788)(10^{-3})$

$= 9.67E+02\ m^3$

Diesel fuel for handling additional storage articles.

Δ HMPC 2 = 2470

Δ Shield Covers = 2470

ops diesel fuel increase $= (1.24)(1.02E+03)$

$= 1.27\ E+03$

total ops diesel $= (1.27\ E+03) + (9.67\ E+02)$

$= 2.24\ E+03$ ←

total Diesel fuel $= (2.24\ E+03) + (6.62\ E+04) + (2.1\ E+04)$

$= 8.94\ E+04\ m^3$ ←

8. Calculate the increased Kerosene usage to account for the increase in the waste glass produced.

(Conc. Ratio) (Kerosene value)

$= (1.24)(5.8\ E+04)$

$= 7.2\ E+04\ m^3$ ←

FORM 91-005-1 (4/81)

9. Calculate the quantity of the concrete requirements for the new vaults, the additional shielding covers, and the additional storage pad requirements.

Storage Vaults = (10) (4300 Cubic meters)
= 43000 m^3
= 4.3 E+04 m^3

New Shielding Covers
= (2470) (90.7) Mg/each / (1.6)
= 1.4 E+05 m^3

$\rho = 1.6\ Mg/m^3$

new storage pad.
(2470) (6.6) = 16302 m^2
= pad (150m) (109m) = 16350 m^2
assumed Concrete 0.2 meters thick
= (16350) (0.2)
= 3.27 E+03 m^3

Concrete for operations = (1.7E+05) + (1.4 E+05) + (4.3 E+04)
= 3.53 E+05 m^3

Construction Concrete = (5.4 E+05) + (3.27 E+03)
= 5.43 E+05 m^3

total Concrete = (5.43 E+05) + (3.53 E+05) + (1.9E+04)
= 9.15 E+05 m^3

10. Calculate the carbon steel increase for this case where the loading in the glove changed and blending factors have been applied.

Carbon Steel rebar for the Storage Pad 150m x 109 m
= (150) (109 ÷ 0.2) (0.0001227) (1.6)
= 16.1 Mg. = 16.1 m tons.
= (109) (150 ÷ 0.2) (0.0001227) (1.6)
= 16.1 m tons.

rebar on 0.2 meter centers
Area of rebar = 0.0001227 m^2
diameter of rebar = 0.0125 m

total steel rebar for Slurry Pad = 32.2 m Tons.

Carbon steel for new vaults
= (10)(500 Mg) = 5000 Mg.
= 5.0E+03 m Tons.

Carbon Steel for TAW waste boxes 4.2 m³
= (50)(1263)(0.144)(7) = 6365.5.2 m tons.
= 6.37E+04 m tons.

Carbon Steel for Construction
= (32.2 m tons) + (1.07E+05)
= 1.07E+05 m t

Carbon Steel for operations = (NR) + (5.0E+03) + (6.37E+04)
= 6.87 E+04 m tons

total Carbon Steel = (1.9E+04) + (6.87E+04) + (1.07E+05)
= 1.95E+05 m tons

11. Calculate the stainless steel requirement for the 0.62 m³ container for the HLWaste
= (1.67E+04)(0.75) = 1.2525E+04 Mg.
operations SS = 1.3E+04 m Tons.

total SS = (1.3E+04) + (1.9E+04)
= 3.2E+04 m tons

12. Calculate the increased requirement for the glass formers for this revised alternative.
(1.24)(2.94E+05) = 3.65E+05
= 3.65E+05 m tons.

13. Calculate the process chemical increased requirement. oxygen is the only item in this group that increases.

oxygen from item 12 page 14 = 1.91 E+05 Mg.

$= (1.91E+05)(1.24)$

$= 2.37E+05$ Mg

oxygen $= 2.37E+05$ MT

total process chemicals $= (2.37E+05) + (1.90E+05)$

$= 4.27E+05$ MT

14. Calculate the quantities of material needed for the sulfur cement for the LAW.

Sulfur $= (1.24)(1.3E+03) = 1.61E+05$ M Tons ←

Dicyclopentadiene $= (1.24)(3.4E+03) = 4.22E+03$ M Tons ←

Oligomer $= (1.24)(3.4E+03) = 4.22E+03$ M Tons ←

I Changes to the following entries in Table B.10.0.3 were prepared by Colin Henderson except the operations and total for the borrow site sand and gravel.

1. Long Term management alternative
   a. Land permanently committed 8, 17
   b. Land incrementally committed 50, 50

2. In situ fill and cap alternative
   a. Land permanently committed: Const & ops - 17, closure 8
   b. Land incrementally committed: no change

3. In situ vitrification alternative
   a. Land permanently committed: const & ops - 17, closure 8

4. Ex situ intermediate separations alternative
   a. Land permanently committed: total - 49; ops & const - 37, closure - 12
   b. Land temporarily committed: Total - 115; ops & const - 91; closure - 24
   c. Borrow pit disturbed: McGee Ranch - 25
      pit 30 - 75
      Vernita Quarry - 31
   d. Borrow site silt: 6.75 E+05
   e. Borrow site sand and gravel: closure 1.5E+06
   f. Borrow site Basalt: 9.31E+05

JACOBS ENGINEERING GROUP INC.

DATE 6-15-96 SUBJECT SHEET NO. 40 of 48

BY RDW CHKD. JOB NO. 01K4701

g. Calculate the operations Borrow site sand and gravel

Sand for vaults and Pads = 2.67 E+05 m^3
Sand for Concrete shapes = 3.77 E+05 m^3
gravel for vaults and pads = 2.67 E+05 m^3
gravel for Concrete Shapes = 3.77 E+05 m^3
total = 12.88
operations = 1.29 E+06 m^3

Total = (1.29E+06) + (1.5E+06) + (3.17 E+05)
= 3.11 E+06 m^3

5. Ex situ no separations alternative - vitrification
a. Land permanently committed: Const + ops - 19; Closure - 8
b. Land temporarily committed: Total - 146; Const + ops - 146
c. Borrow pit disturbed area: Pit 30 - 47
d. Calculate the Borrow site sand and gravel for operations and construction

Construction - sand = 1.66 E+05 m^3
gravel = 1.66 E+05 m^3
total = 3.32 E+05 m^3
= 3.32 + 1.23 = 4.55 E+05 m^3

operations - sand = 7.13 E+06 m^3
gravel = 7.13 E+06 m^3
total = 1.43 E+07 m^3

Total sand and gravel = (Const) + (ops) + (Closure)
= (1.17E+06) + (4.55E+05) + (1.43E+07)
= 1.59 E+07 m^3

6. Ex situ no separations alternative - calcination
a. Land permanently committed: Const + ops - 19; closure - 8
b. Land temporarily committed: total - 101; Const + ops - 81
c. Calculate the Borrow site sand and gravel for operations and construction.

Construction - sand = 2.23 E+04 m^3
gravel = 2.23 E+04 m^3
total = 4.46 E+04 m^3

JE JACOBS ENGINEERING GROUP INC.

DATE 2-15-96 SUBJECT SHEET NO. 41 of 48

BY RJW CHKD. JOB NO. 01K47101

operations – Sand = 9.52E+05 m³
gravel = 9.52E+05 m³
total = 19.04 E+05 m³

operations total = 1.9 E+06 m³
Construction total = (4.46 E+04) + (1.23 E+05)
= 1.68 E+05 m³

total = (1.68 E+05) + (1.9 E+06) + (1.17 E+06)
= 3.24 E+06 m³

7. Ex Situ Extensive separations alternative
a. Land committed permanently: total – 46; ops & const – 34; closure 72
b. Land temporarily committed: total – 112, ops & const – 88; closure –
c. Borrow pit disturbed: McGee Ranch – 25, pit 30 – 68;
Vernita quarry – 31.
d. Borrow pit Silt – 6.45 E+05
e. Borrow pit Sand and gravel – closure – 1.5 E+06
f. Borrow pit Basalt – 9.31 E+05
g. Calculate the Borrow Site Sand and gravel for operations, construction and total.

Construction – Sand = 2.58 E+05
gravel = 2.58 E+05
Existing value = 3.72 E+05
total = 9.88 E+05 m³

operations – Sand = 8.11 E+03
gravel = 8.11 E+03
total = 1.622 E+04 m³

total = (1.5 E+06) + (1.622 E+04) + (8.88 E+05)
= 2.4 E+06 m³

8. phased implementation alternative – Phase I
a. Land temporarily committed – total – 32; Const & ops – 32
b. Borrow pit disturbed: McGee Ranch – 1, pit 30 – 1

JACOBS ENGINEERING GROUP INC.

DATE 2-15-96 SUBJECT SHEET NO. 42 of 48

BY PDW CHKD. JOB NO. 21447101

9. Ex Situ/In Situ combination alternative

a. Land permanently committed: total - 41; ops & Const - 31; Closure - 10

b. Land Temporarily committed: Total - 109; ops & Const - 87

c. Borrow pit Disturbed area: McGee Ranch - 21

Pit 30 - 48

Vernita Quarry - 26

d. Borrow site silt - 5.11 E+05 m^3

e. Borrow site Basalt - 7.85 E+05 m^3

f. Calculate the construction and operations concrete sand and gravel from the Borrow site.

operations - Sand = 1.88 E+05 m^3

gravel = 1.88 E+05 m^3

total = 3.76 E+05 m^3

Construction - Sand = 9.9 E+04 m^3

gravel = 9.9 E+04 m^3

Existing value = 4.1 E+05 m^3

total = 6.08 E+05 m^3

total = (9.4 E+05) + (6.05 E+05) + (3.76 E+05)

= 1.92 E+06 m^3

10. Phased Implementation alternative - Phase II.

a. Land permanently committed: Total - 53; Const & ops - 40; Closure - 12

b. Land Temporarily committed: total - 147; Const & ops - 123;

c. Borrow Pit Disturbed area: McGee Ranch - 25

Pit 30 - 74

Vernita Quarry - 31

d. Borrow site silt - 6.45 E+05

e. Borrow site Sand and gravel - Closure 1.5 E+06

f. Borrow site Basalt - 9.31 E+05

g. Calculate the Borrow site sand and gravel for operations and construction and obtain the new total value.

Operations - Sand = 3.77 E+05 m^3

gravel = 3.77 E+05 m^3

total = 7.54 E+05 m^3

FORM 91-005-1 (4/81)

JACOBS ENGINEERING GROUP INC.

DATE 2-15-96 SUBJECT SHEET NO. 43 of 48

BY RDW CHKD. JOB NO. 01K47101

construction - sand = 1.98E+05 m³
- gravel = 1.98E+05 m³
Existing value = 1.71E+05 m³
total = 5.67E+05 m³

total = (7.54E+05) + (1.36E+06) + (5.67E+05)
= 26.81E+05 = 2.7E+06

J. Calculation of value for table 5.1.1 Key Geology and soil impact parameter.

1. No action alternative
a. Remediation - Sand and gravel - none required
- silt - none required
- Rip rap - none required

b. total alternative
- Sand and gravel - none required
- silt - none required
- riprap - none required

remediation = Construction and operations added together.

total alternative = Remediation and closure added together.

2. Long Term Management alternative
a. Remediation - Sand and gravel - none required
- Silt - none required
- Rip Rap - none required.

b. total alternative
Sand and gravel - none required
Silt - none required
Rip Rap - none required.

3. In situ fill and Cap alternative
a. Remediation
Sand and gravel = 6.9E+05 m³ = (912000 yds³)
Silt = none Required
Rip Rap = none required

FORM 91-005-1 (4/81)

b. Total alternative

sand and gravel = 1.1E+06 m^3 = 1.5E+06 yds^3

Silt = 380000 m^3 = 500000 yds^3

Rip Rap = 640,000 m^3 = 840000 yds^3

4. In situ vitrification alternative

a. Remediation

Sand and Gravel = 540,000 m^3 = 714,000 yds^3

Silt - not required

Riprap - not required

b. Total alternative

Sand and gravel = 955,000 m^3 = 1.3E+06 yds^3

Silt = 380,000 m^3 = 500,000 yds^3

Rip Rap = 640,000 m^3 = 840,000 yds^3

5. Ex situ intermediate alternative

a. Remediation

Sand and gravel = 161,000 m^3 = 211000 yds^3

Silt = not required

Rip Rap = not required

b. Total alternative

Sand and gravel = 3.11E+06 m^3 = 4.1E+06 yds^3

Silt = 645,000 m^3 = 845,000 yds^3

Rip Rap = 931,000 m^3 = 1,220,000 yds^3

6. Ex situ no separations - vitrification alternative

a. Remediation

Sand and gravel = 1.48E+07 m^3 = 1.94E+07 yds^3

Silt = not required

Rip Rap = not Required

b. Total alternative

Sand and gravel = 1.59E+07 m^3 = 2.08E+07 yds^3

Silt = 377000 m^3 = 500,000 yds^3

Riprap = 638000 m^3 = 840,000

JACOBS ENGINEERING GROUP INC.

DATE 2-15-96 SUBJECT SHEET NO. 45 of 48

BY RJW CHKD. JOB NO. 01K47101

7 Ex Situ no Separations - calcination alternative

a. Remediation

Sand and gravel = 2.1E+06 m^3 = 2.75E+06 yds^3

Silt = not required

Rip Rap = not required

b. total alternative

Sand and gravel = 3.24E+06 m^3 = 4.24E+06 yds^3

Silt = 377000 m^3 = 500000 yds^3

Rip Rap = 638000 m^3 = 840,000 yds^3

8. Ex Situ Extensive Separations alternative

a. Remediation

Sand and gravel = 9.04E+05 m^3 = 1.18E+06 yds^3

Silt = not required

Rip Rap = not required

b. Total alternative

Sand and gravel = 2.4E+06 m^3 = 3.14E+06 yds^3

Silt = 6.45E+05 m^3 = 8.45E+05 yds^3

Rip Rap = 9.31E+05 m^3 = 1.22E+06 yds^3

9. Ex Situ In Situ Combination alternative

a. Remediation

Sand and gravel = 9.81E+05 m^3 = 1.29E+06 yds^3

Silt = not required

Rip Rap = not required

b. Total alternative

Sand and gravel = 1.92E+06 m^3 = 2.52E+06 yds^3

Silt = 5.11E+05 m^3 = 6.7E+05 yds^3

Rip Rap = 7.85E+05 m^3 = 1.03E+06 yds^3

10. phased implementation Phase I alternative

a. Remediation — No change except Sand and gravel = 1.2E+04 m^3

b. total alternative — No change except Sand and gravel = 1.2E+04 m^3

= 1.57E+04 yds^3

FORM 91-005-1 (4/81)

II Phased Implementation Phase II alternative.

a. Remediation.

Sand and gravel = 1.32E+06 m^3 = 1.73 E+06 yds^3

Silt = not required

Rip Rap = not required

b. Total alternative

Sand and Gravel = 2.7E+06 m^3 = 3.54 E+06 yds^3

Silt = 6.45E+05 m^3 = 8.45E+05 yds^3

Rip Rap = 9.31E+05 m^3 = 1.22E+06 yds^3

K. Calculations for changes in Tables 3.6.1 and B.6.2.1 titled Borrow Site Summary - materials used during construction and operations. also included are the changes to Tables 3.6.2 and B.6.2.2 and Tables 3.6.3 and B.6.2.3. all tables are on pages 3-103 or B-160 of the Draft EIS under modification January - February 1996.

1. Tables 3.6.1 and B.6.2.1

Calculate the m^3 and ft^3 of material for concrete taken from Borrow pit 30 for construction and operations.

a. Calculate intermediate separations

quantity = [(new quantity) ÷ (old quantity)] (value in table)

= [(1.67 E+06) ÷ (7.29 E+05)] (317,000) m^3

= 726,187 m^3 = 2.57E+07 ft^3

$ft^3 = (m^3)\left(\frac{yd^3}{m^3}\right)\left(\frac{ft^3}{yd^3}\right)$

$= (m^3)(1.31)(27)$

$= (m^3)(35.4)$

b. Calculate no separations - vitrification

quantity = (9.62/2.33)(123,000) m^3

= 507836.9 = 508000 m^3

= (508000)(35.4) = 17983200 ft^3

= 1.8E+07 ft^3

JE JACOBS ENGINEERING GROUP INC.

DATE 2-15-96 SUBJECT SHEET NO. 47 of 48

BY PDW CHKD. JOB NO. 01K47101

c. Ex Situ no Separations - Calcination

quantity = (2.24/1.27)(123000) m^3

= 217000 m^3

= (217000)(35.4) ft^3 = 7681800

= 7.7E+06

d. Ex Situ extensive Separations

quantity = (8.66/6.69)(372,000) m^3

= 481543 = 482,000 m^3

= (482,000)(35.4) = 17 06280 ft^3

= 1.71E+06 ft^3

e. Ex Situ/In Situ Combination

quantity = (6.61/3.74)(410000) m^3

= 724625.63 = 725 000 m^3

= (725000)(35.4) = 25665000 ft^3

= 2.57E+07 ft^3

f. Phased Implementation - phase 2

quantity = (64.0/6.5)(159000) m^3

= 1565538.4 = 1,570,000 m^3

= (1570000)(35.4) = 55578000 ft^3

= 5.56E+07 ft^3

2 Tables 3.6.2 and B.6.2.2

a. Ex Situ In Situ Combination

Value calculated by Colin Henderson in calc dated

1-30-96 = 384000 m^3

= (384000)(35.4) = 13593600 ft^3

= 1.36E+07 ft^3

3 Tables 3.6.3 and B.6.2.3

a. Item 2 - Ex Situ Intermediate Separations, Ex Situ Extensive Separations, or phased Implementation (phase 2)

Silt = 645,000 (2.3E+07)

Rip Rap = 931,000 (3.3E+07)

aggregate/Sand = 744,000 (2.7E+07)

Numbers from Colin Henderson Calc 1-30-96

JACOBS ENGINEERING GROUP INC.

DATE 2-15-96 SUBJECT SHEET NO. 48 of 48

BY RDW CHKD. JOB NO. 01K4701

b. Existing / Insitu Combination

Silt	= 511,000	= 1.8E+07
Riprap	= 785,000	= 2.8E+07
aggregate/Sand	= 580,000	= 2.1E+07
	= 490,000	= 1.7E+07
	= 700,000	= 2.5E+07

The data for Table 5.16.1 was taken from Table B.10.0.3 as it was revised.

FORM 91-005-1 (4/81)

Page A-1
PDW 2-15-96

Table B.10.0.3 Resource Summary, Tank Waste Alternatives

Resource	Phase	No Action Alternative	Long-Term Management	In Situ Fill and Cap Alternative	In Situ Vitrification Alternative	Ex Situ Intermediate Separations Alternative
Land, permanently committed (hectares) (Long-term commitment of radiologically contaminated area)	Total	17	25	25	25	40
	Construction/ Operation	0	N/A	N/A	N/A	7
	Closure	17	25	25	25	33
Land, incremental temporarily committed (hectares) (area disturbed during construction and operations)	Total	0	42	21	111	108
	Construction/ Operation	0	42	1	91	84
	Closure	0	N/A	20	20	24
Borrow Pit Disturbed Area (hectares) based on an excavation depth of 3 meters	McGee Ranch	N/A	N/A	16	16	21
	Pit 30	N/A	N/R	39	34	57
	Vernita Quarry	N/A	N/A	21	21	27
Water, Total (cubic meters)	Sanitary plus Raw Water	1.52E+06	1.52E+06	2.43E+06	1.71E+08	~~1.47E~~ 2.40 +07
Water, Sanitary (cubic meters)	Total	N/R	N/R	2.43E+06	1.71E+08	~~3.6E~~ 5.83 +06
	Construction	N/R	N/R	5.9E+05	1.7E+08	5.0E+05
	Operation	N/R	N/R	1.8E+06	1.2E+06	~~3.1E~~ 5.27 +06
	Closure	N/R	N/A	4.13E+04	3.8E+04	6.0E+04
Water, Raw (cubic meters)	Total	1.5E+06	1.52E+06	N/R	N/R	~~1.07E~~ 1.82 +07
	Construction	N/A	1.7E+04	N/R	N/R	N/R
	Operation	1.5E+06	1.5E+06	N/R	N/R	~~1.07E~~ 1.82 +07
	Closure	N/A	N/A	N/R	N/R	N/R
Energy Electricity (Gwh)	Total	1.1E+03	1.1E+03	1.8E+00	4.46E+03	~~9.07E+03~~ 1.36E+04
	Construction	N/A	4.4E-01	1.8E+00	5.6E+01	7.4E+01
	Operation	1.1E+03	1.1E+03	9.5E+02	4.4E+03	~~9.0E+03~~ 1.55E+04
	Closure	N/A	N/A	N/R	N/R	N/R
Gasoline (cubic meters)	Total	N/A	8.6E+04	4.0E+02	1.5E+04	8.0E+03
	Construction	N/A	8.6E+04	9.7E+01	1.5E+04	7.6E+03
	Operation	N/R	N/R	N/R	N/R	~~N/R~~ 5.46E+01
	Closure	N/A	N/A	3.0E+02	3.0E+02	3.9E+02

Page A-2
RJW 2-15-96

Table B.10.0.3 Resource Summary, Tank Waste Alternatives (cont'd)

Resource	Phase	No Action Alternative	Long-Term Management	In Situ Fill and Cap Alternative	In Situ Vitrification Alternative	Ex Situ Intermediate Separations Alternative
Diesel (cubic meters)	Total	2.2E+04	8.5E+04	5.96E+04	7.1E+04	9.47 ~~8.85~~E+04
	Construction	N/A	6.3E+04	1.3E+03	1.5E+04	2.1E+04
	Operation	2.2E+04	2.2E+04	6.1E+03	6.1E+03	7.53 ~~1.02~~E+03
	Closure	N/A	N/A	5.22E+04	4.5E+04	6.62E+04
Kerosene (cubic meters)	Operation	N/A	N/A	N/A	N/A	9.86 ~~5.8~~E+04
Materials: Concrete (cubic meters)	Total	N/A	3.5E+05	1.9E+04	1.3E+05 (1.67)	1.79E+06 ~~7.29E+05~~
	Construction	N/A	3.5E+05	N/R	1.3E+05	5.49 ~~5.4~~E+05
	Operation	N/A	N/A	N/R	N/R 1.11E+06	1.75E+06 ~~1.7E+05~~
	Closure	N/A	N/A	1.9E+04	N/R	1.9E+04
Carbon Steel (metric tons)	Total	1E+03	1.33E+04	N/R	2.6E+05	1.78 ~~1.64~~E+05
	Construction	N/A	1.23E+04	N/R	2.6E+05	1.07E+05
	Operation	1E+03	1.0E+03	N/R	2.6E+05	~~N/R~~ 5.16 E+04
	Closure	N/R	N/A	N/R	N/R	1.9E+04 ??
Stainless Steel (mt)	~~Construction~~ Total	N/A	2.2E+01	N/R	N/R	1.9E+04
Hastelloy/Inconel (mt)	Construction	N/R	N/R	N/R	N/R	2.3E+03
Glass Formers (mt)	Operation	N/A	N/A	N/A	1.1E+04	5.0 ~~2.94~~E+05
Process Chemicals (mt)	Operation	N/A	N/A	N/R	6.8E+03	5.15 ~~1.90~~E+05
Bulk sulfur cement sulfur (mt) dicyclopentadine (mt) oligomer (mt)	Operation	N/A	N/A	N/A	N/A	2.21 ~~1.30~~E+05 5.78 ~~3.4~~E+03 5.78 ~~3.4~~E+03
Ion exchange media (cubic meters)	Operation	N/A	N/A	N/A	N/R	2.2E+02
Borrow Site Silt (cubic meters)	Closure	N/A	N/A	3.77E+05	3.77E+05	5.26E+05
Borrow Site Sand and Gravel (cubic meters)	Total	N/A	N/A	1.1E+06	9.55E+05	3.11 ~~1.68~~E+06
	Construction	N/A	N/A	6.9E+05	N/R	3.17E+05
	Operation	N/A	N/A	(see construction)	5.4E+05	~~N/A~~ 1.29E+06
	Closure	N/A	N/A	4.15E+05	4.15E+05	1.36E+06
Borrow Site Basalt (cubic meters)	Closure	N/A	N/A	6.38E+05	6.38E+05	8.05E+05
Asphalt (cubic meters)	Closure	N/A	N/A	6.25E+04	6.25E+05	8.07E+04

Table B.10.0.3 Resource Summary, Tank Waste Alternatives (cont'd)

Resource	Phase	Ex Situ No Separations Alternative (Vitrification)	Ex Situ No Separations Alternative (Calcination)	Ex Situ Extensive Separations Alternative	Ex Situ/ In Situ Combination Alternative	Phased Implementation Alternative (Phase 1)	Phased Implementation Alternative (Phase 2)
Land, permanently committed (hectares) (Long-term commitment of radiologically contaminated area)	Total	27	27	40	37	0	43
	Construction/ Operation	2	2	7	8	0	10
	Closure	25	25	33	29	0	33
Land, incremental temporarily committed (hectares) (area disturbed during construction and operations)	Total	83	83	108	106	33	108
	Construction/ Operation	63	63	84	84	33	84
	Closure	20	20	24	22	0	24
Borrow Pit Disturbed Area (hectares) based on an excavation depth of 3 meters	McGee Ranch	16	16	21	18	0	21
	Pit 30	44	44	59	32	0	51
	Vernita Quarry	21	21	27	23	0	27
Water, Total (cubic meters)	Sanitary plus Raw Water	~~2.8E+06~~ 4.99	2.4E+06	~~3.39E+07~~ ~~8.83~~ 8.38	~~1.35E+07~~ 2.06	2.8E+06	~~1.08E+07~~ 1.81
Water, Sanitary (cubic meters)	Total	~~2.3E+06~~ 4.13	3.6E+05	~~3.9E+06~~ 8.76	~~2.5E+06~~ 5.71	6.3E+05	~~3.08E+06~~ 5.02
	Construction	2.39E+05	2.39E+05	5.29E+05	4.19E+05	3.9E+05	2.54E+05
	Operation	~~2.06E+06~~ 3.85	2.08E+06	~~3.21E+06~~ 8.03E+06	~~3.08E06~~ 5.24	2.2E+05	~~2.77E+06~~ 4.71
	Closure	4.13E+04	4.13E+04	2.05E+05	4.9E+04	1.6E+04	6.03E+04
Water, Raw (cubic meters)	Total	~~4.62E+05~~ 8.64	8.58E+04	~~3.0E+07~~ 7.5	~~4.1E+07~~ 1.49	2.2E+06	~~5.51E+06~~ 1.31E+07
	Construction	N/R	N/R	N/R	5.5E+06	N/R	N/R
	Operation	~~4.62E+05~~ 8.64	8.58E+04	~~3.0E+07~~ 7.5	~~5.5E+06~~ 9.35	2.2E+06	~~7.71E+06~~ 1.31E+07
	Closure	N/R	N/R	N/R	N/R	N/R	N/R

Rev 8-15-96

Table B.10.0.3 Resource Summary, Tank Waste Alternatives (cont'd)

Resource	Phase	Ex Situ No Separations Alternative (Vitrification)	Ex Situ No Separations Alternative (Calcination)	Ex Situ Extensive Separations Alternative	Ex Situ/ In Situ Combination Alternative	Phased Implementation Alternative (Phase 1)	Phased Implementation Alternative (Phase 2)
Energy Electricity (Gwh)	Total	8.8 ~~4.92E+03~~	4.72E+03	4.16 ~~1.67E+04~~	7.69 ~~4.54E+03~~	1.7E+03	1.044E+04 ~~6.14E+03~~
	Construction	3.0E+01	3.0E+01	8.9E+01	3.8E+01	5.0E+01	3.73E+01
	Operation	8.77 ~~4.69E+03~~	4.69E+03	4.15 ~~1.66E+04~~	7.05 ~~4.51E+03~~	1.6E+03	1.04E+04 ~~6.14E+03~~
	Closure	N/R	N/R	N/R	N/R	N/R	N/R
Gasoline (cubic meters)	Total	5.4E+03	5.4E+03	1.02 ~~1.0E+04~~	3.0E+05	6.8E+03	3.18 ~~5.1E+03~~
	Construction	5.1E+03	5.1E+03	9.7E+03	3.0E+05	6.5E+03	4.71E+03
	Operation	N/R	N/R	~~N/R~~ 5.46 E+01	~~N/R~~ 2.0E+01	N/R	~~N/R~~ 7.55E+01
	Closure	3.01E+02	3.01E+02	3.91E+02	3.36E+02	3.3E+02	3.91E+02
Diesel (cubic meters)	Total	~~6.76~~ 7.81E+04 ~~6.51E+04~~	6.44 ~~6.4E+04~~	1.2E+05 ~~9.72E+04~~	5.21 ~~5.16E+05~~	3.6E+04	3.7 ~~3.2E+04~~
	Construction	1.19E+04	1.19E+04	2.9E+04	4.54E+05	1.8E+04	1.3E+04
	Operation	~~3.50~~ 1.4E+04 ~~1.02E+03~~	2.68 ~~1.02E+02~~	2.4E+04 ~~1.02E+03~~	9.22 ~~4.17E+03~~	2.0E+02	6.0 ~~1.22E+03~~
	Closure	5.22E+04	5.22E+04	6.72E+04	5.8E+04	1.8E+04	1.8E+04
Kerosene (cubic meters)	Operation	~~5.64E+04~~ 1.06E+05	8.05E+04 1.05E+04	~~9.36E+04~~ 2.34E+05	~~2.91E+04~~ 4.93	9.8E+02	3.0E+04 5.1
Materials: Concrete (cubic meters)	Total	9.63 ~~2.33E+06~~	2.22 ~~1.27E+06~~	~~9.48~~ 9.35 ~~6.69E+05~~ 8.61e	6.61 ~~3.74E+05~~	2.4E+04	6.4E+05 ~~6.51E+04~~
	Construction	4.32 ~~2.66E+05~~	2.88 ~~2.66E+05~~	5.0E+05	2.94 ~~2.7E+05~~	2.4E+04	3.29 ~~2.9E+04~~
	Operation	~~2.13~~ 9.17 ~~2.04E+06~~	1.93E+06 ~~9.81E+05~~	~~1.58~~ ~~4.16~~ ~~1.51E+05~~ 3.47	3.63E+05 ~~8.51E+04~~	4.4E+02	~~1.7E+04~~ 5.93E+05
	Closure	1.9E+04	1.9E+04	1.9E+04	1.9E+04	0	1.9E+04

Page A-4
RW 8-15-96

Table B.10.0.3 Resource Summary, Tank Waste Alternatives (cont'd)

Resource	Phase	Ex Situ No Separations Alternative (Vitrification)	Ex Situ No Separations Alternative (Calcination)	Ex Situ Extensive Separations Alternative	Ex Situ/ In Situ Combination Alternative	Phased Implementation Alternative (Phase 1)	Phased Implementation Alternative (Phase 2)
Carbon Steel (metric tons)	Total	~~2.32E+05~~ 2.06E+05	~~1.32E+05~~ 1.33	~~1.98E+05~~ 2.84	~~8.21E+04~~ 1.28E+05	8.3E+04	~~7.85E+04~~ 2.07E+05
	Construction	~~6.12E+04~~ 6.72E+04	~~6.12E+04~~ 6.22	1.4E+05	~~5.35E+04~~ 5.36E+04	8.3E+04	~~5.85E+04~~ 5.89
	Operation	OK ~~1.46E+05~~ 1.46E+05 NK	7.04E+04	~~1.62E+04~~ 1.44E+05	~~9.6E+03~~ 7.41E+04	2.9E+02	~~2.0E+04~~ 1.48E+05
	Closure	N/A	N/A	N/A 2.22E+04	N/A	N/A	N/A 3.66E+04
Stainless Steel (mt)	TOTAL Construction	4.53E+05 1.26E+04	9.39E+04 1.26E+04	2.1E+04	9.5E+03	1.5E+04	1.15E+04
Hastelloy/Inconel (mt)	OPERATION Construction	4.4E+05 1.51E+03	8.13E+04 1.51E+03	1.2E+03 1.80E+03	1.25E+04 1.15E+03	2.6E+03	2.51E+04 1.15E+04
Glass Formers (mt)	Operation	~~2.5E+05~~ 4.68	N/A	~~3.55E+05~~ 8.88	~~1.47E+05~~ 2.50	1.3E+05	~~2.8E+05~~ 4.76
Process Chemicals (mt)	Operation	~~1.95E+05~~ 3.56	3.06E+05	~~8.86E+05~~ 1.32E+06	~~9.55E+04~~ 2.59E+05	5.8E+04	~~1.5E+05~~ 4.75
Bulk sulfur cement	Operation						
sulfur (mt)		N/A	N/A	~~1.7E+05~~ 4.25	~~6.5E+04~~ 1.11E+05	~~5.2E+04~~ 1.43E+04 3.74E+02	~~1.2E+05~~ 2.04E+05
dicyclopentadine (mt)		N/A	N/A 1.12E+04	~~4.46E+03~~	~~2.65E+03~~ 2.88	~~7.4E+02~~	~~3.4E+03~~ 5.78E+03
oligomer (mt)		N/A	N/A 1.12E+04	~~4.46E+03~~	~~1.70E+03~~ 2.84	~~6.8E+02~~ 3.74E+02	~~2.4E+03~~ 5.78E+03
Ion exchange media (cubic meters)	Operation	N/A	N/A	4.9E+03	1.1E+02	1.4E+01	1.4E+02
Borrow Site Silt (cubic meters)	Closure	3.77E+05	3.77E+05	5.35E+05	4.36E+05	0	5.26E+05
Borrow Site Sand and Gravel (cubic meters)	Total	~~1.29E+06~~ 1.58E+07	~~1.29E+06~~ 3.84	~~1.73E+06~~ 2.4	~~1.34E+06~~ 1.92	1.2E+04	~~1.5E+06~~ 2.7
	Construction	~~1.23E+05~~ 4.55	~~1.23E+05~~ 1.68	~~3.72E+05~~ 8.88	~~4.1E+05~~ 6.05	1.2E+04	~~1.71E+05~~ 5.67
	Operation	~~N/A~~ 1.43E+07	~~N/A~~ 1.9E+06	~~N/A~~ 1.62E+04	3.76E+05 (see also construction)	N/A	~~N/A~~ 7.54E+05
	Closure	1.17E+06	1.17E+06	1.36E+06	9.4E+05	N/A	1.36E+06
Borrow Site Basalt (cubic meters) [1]	Closure	6.38E+05	6.38E+05	8.05E+05	7.0E+05	N/A	8.05E+05

add a block for Total

add a block for operations under Stainless steel

Page A-5
RBW 2-15-96

Table B.10.0.3 Resource Summary, Tank Waste Alternatives (cont'd)

Resource	Phase	Ex Situ No Separations Alternative (Vitrification)	Ex Situ No Separations Alternative (Calcination)	Ex Situ Extensive Separations Alternative	Ex Situ/ In Situ Combination Alternative	Phased Implementation Alternative (Phase 1)	Phased Implementation Alternative (Phase 2)
Asphalt (cubic meters)	Closure	6.25E+04	6.25E+04	8.16E+04	6.98E+04	N/A	8.07E+04

Notes:
[1] Silt and Basalt Borrow materials are used only for barrier construction during closure.
N/A = Not Applicable
N/R = Not Reported

Page B-6
Rev 2-15-96

Page A-7
RDW 2-15-96

Table 3.6.1 Borrow Site Summary - Materials Used During Construction and Operations

Alternative	Borrow Type	Amount (m^3 [ft^3])	Location
No Action (Tank Waste)	N/A	N/A	N/A
Long-Term Management	N/A	N/A	N/A
In Situ Fill and Cap	Aggregate	690,000 (2.5E+07)	Pit 30
In Situ Vitrification	Sand	540,000 (1.9E+07)	Pit 30
Ex Situ Intermediate Separations	Aggregate 16.7 ~~17.4~~ 7.29 →	317,000 (1.1E+07)	Pit 30
Ex Situ No Separations - Vitrification - Calcination 1.29 1.27	 Aggregate 4.32 2.66 → Aggregate 6.02	200 000 (7.2 E+06) 123,000 (4.4E+06) 123,000 (4.4E+06)	 Pit 30 Pit 30
Ex Situ Extensive Separations	Aggregate 8.66 ~~9.55~~ 6.69	481343 (1.68) 372,000 (1.3E+07)	Pit 30
Ex Situ/In Situ Combination	Aggregate 4.73 3.74	518 650 (1.9) 410,000 (1.5E+07)	Pit 30
Phased Implementation (Phase 1 only)	Aggregate Ratio 1.0	12,000 (4.3E+05)	Pit 30
Phased Implementation (Phase 2)	Aggregate Ratio 4.1	159,000 (5.7E+06)	Pit 30

36187 ~~75~~ ~~7630~~ (~~2.63~~ E+ 2.52)

125460 (4.5E+06)

651900 (2.34 E+07)

Notes:
N/A = Not Applicable

Table 3.6.2 Borrow - Materials Used for Backfill of Empty Tanks for all Ex Situ Alternatives

Alternative	Method	Kind	Amount (m^3 [ft^3])	Location
Ex Situ (all)	Tank Stabilization	Aggregate	754,000 (2.7E+07)	Pit 30
Ex Situ/In Situ Combination	Tank Stabilization	Aggregate	452,000 (1.6E+07)	Pit 30
Phased Implementation (Phase 2)	Tank Stabilization	Aggregate	754,000 (2.7E+07)	Pit 30

Table 3.6.3 Borrow - Materials Used for Construction of Hanford Barriers

Alternative	Borrow Kind	Amount (m^3 [ft^3])	Location
In Situ Fill and Cap, In Situ Vitrification, Ex Situ No Separations [1]	Silt Riprap Aggregate/Sand	377,000 (1.3E+07) 638,000 (2.3E+07) 415,000 (1.5E+07)	McGee Ranch Vernita Quarry Pit 30
Ex Situ Intermediate Separations, Extensive Separations, or Phased Implementation (Phase 2) [2]	Silt Riprap Aggregate/Sand	530,000 (1.9E+07) 805,000 (2.9E+07) 606,000 (2.2E+07)	McGee Ranch Vernita Quarry Pit 30
Ex Situ/In Situ Combination	Silt Riprap Aggregate/Sand	436,000 (1.6E+07) 490,000 (1.7E+07) 700,000 (2.5E+07)	McGee Ranch Vernita Quarry Pit 30

Notes:
[1] Includes materials to construct barriers over tank farms.
[2] Includes materials to construct barriers over tank farms and the LAW disposal vaults.
N/A = Not Applicable

Marked Up for disturbed area Page A-8 RDW 2-15-9
& Volumes of Barrier Material for Closure. CSH. 2/3/96

Table B.10.0.3 Resource Summary, Tank Waste Alternatives

Resource	Phase	No Action Alternative	Long-Term Management	In Situ Fill and Cap Alternative	In Situ Vitrification Alternative	Ex Situ Intermediate Separations Alternative
Land, permanently committed (hectares) (Long-term commitment of radiologically contaminated area)	Total	17	25	25	25	~~40~~ 49
	Construction/ Operation	0	~~N/A~~ 8	~~N/A~~ 17	~~N/A~~ 17	~~7~~ 37
	Closure	17	~~25~~ 17	~~25~~ 8	~~25~~ 8	~~33~~ 12
Land, incremental temporarily committed (hectares) (area disturbed during construction and operations)	Total	0	~~42~~ 50	21	111	~~108~~ 115
	Construction/ Operation	0	~~42~~ 50	~~1~~ ~~26~~ 1	91	~~84~~ 91
	Closure	0	N/A	20	20	~~24~~ ~~28~~ 24
Borrow Pit Disturbed Area (hectares) based on an excavation depth of 3 meters	McGee Ranch	N/A	N/A	16	16	~~21~~ 25
	Pit 30	N/A	N/R	39	34	~~57~~ 75
	Vernita Quarry	N/A	N/A	21	21	~~27~~ 31
Water, Total (cubic meters)	Sanitary plus Raw Water	1.52E+06	1.52E+06	2.43E+06	1.71E+08	1.47E+07
Water, Sanitary (cubic meters)	Total	N/R	N/R	2.43E+06	1.71E+08	3.6E+06
	Construction	N/R	N/R	5.9E+05	1.7E+08	5.0E+05
	Operation	N/R	N/R	1.8E+06	1.2E+06	3.1E+06
	Closure	N/R	N/A	4.13E+04	3.8E+04	6.0E+04
Water, Raw (cubic meters)	Total	1.5E+06	1.52E+06	N/R	N/R	1.07E+07
	Construction	N/A	1.7E+04	N/R	N/R	N/R
	Operation	1.5E+06	1.5E+06	N/R	N/R	1.07E+07
	Closure	N/A	N/A	N/R	N/R	N/R
Energy Electricity (Gwh)	Total	1.1E+03	1.1E+03	1.8E+00	4.46E+03	9.07E+03
	Construction	N/A	4.4E-01	1.8E+00	5.6E+01	7.4E+01
	Operation	1.1E+03	1.1E+03	9.5E+02	4.4E+03	9.0E+03
	Closure	N/A	N/A	N/R	N/R	N/R
Gasoline (cubic meters)	Total	N/A	8.6E+04	4.0E+02	1.5E+04	8.0E+03
	Construction	N/A	8.6E+04	9.7E+01	1.5E+04	7.6E+03
	Operation	N/R	N/R	N/R	N/R	N/R
	Closure	N/A	N/A	3.0E+02	3.0E+02	3.9E+02

Page A-9
RJW 2-15-96

Table B.10.0.3 Resource Summary, Tank Waste Alternatives (cont'd)

Resource	Phase	No Action Alternative	Long-Term Management	In Situ Fill and Cap Alternative	In Situ Vitrification Alternative	Ex Situ Intermediate Separations Alternative
Diesel (cubic meters)	Total	2.2E+04	8.5E+04	5.96E+04	7.1E+04	8.82E+04
	Construction	N/A	6.3E+04	1.3E+03	1.5E+04	2.1E+04
	Operation	2.2E+04	2.2E+04	6.1E+03	6.1E+03	1.02E+03
	Closure	N/A	N/A	5.22E+04	4.5E+04	6.62E+04
Kerosene (cubic meters)	Operation	N/A	N/A	N/A	N/A	5.8E+04
Materials:• Concrete (cubic meters)	Total	N/A	3.5E+05	1.9E+04	1.3E+05	7.29E+05
	Construction	N/A	3.5E+05	N/R	1.3E+05	5.4E+05
	Operation	N/A	N/A	N/R	N/R	1.7E+05
	Closure	N/A	N/A	1.9E+04	N/R	1.9E+04
Carbon Steel (metric tons)	Total	1E+03	1.33E+04	N/R	2.6E+05	1.64E+05
	Construction	N/A	1.23E+04	N/R	2.6E+05	1.07E+05
	Operation	1E+03	1.0E+03	N/R	2.6E+05	N/R
	Closure	N/R	N/A	N/R	N/R	1.9E+04
Stainless Steel (mt)	Construction	N/A	2.2E+01	N/R	N/R	1.9E+04
Hastelloy/Inconel (mt)	Construction	N/R	N/R	N/R	N/R	2.3E+03
Glass Formers (mt)	Operation	N/A	N/A	N/A	1.1E+04	2.94E+05
Process Chemicals (mt)	Operation	N/A	N/A	N/R	6.8E+03	1.90E+05
Bulk sulfur cement sulfur (mt) dicyclopentadine (mt) oligomer (mt)	Operation	N/A	N/A	N/A	N/A	 1.30E+05 3.4E+03 3.4E+03
Ion exchange media (cubic meters)	Operation	N/A	N/A	N/A	N/R	2.2E+02
Borrow Site Silt (cubic meters)	Closure	N/A	N/A	3.77E+05	3.77E+05	~~5.26E+05~~ 6.45E+05
Borrow Site Sand and Gravel (cubic meters)	Total	N/A	N/A	1.1E+06	9.55E+05	1.68E+06
	Construction	N/A	N/A	6.9E+05	N/R	3.17E+05
	Operation	N/A	N/A	(see construction)	5.4E+05	N/A
	Closure	N/A	N/A	4.15E+05	4.15E+05	~~7.46E+06~~ ~~1.36E+06~~ 1.5E+6
Borrow Site Basalt (cubic meters)	Closure	N/A	N/A	6.38E+05	6.38E+05	~~8.05E+05~~ 9.31E+05
Asphalt (cubic meters)	Closure	N/A	N/A	6.25E+04	6.25E+05	8.07E+04

Table B.10.0.3 Resource Summary, Tank Waste Alternatives (cont'd)

Resource	Phase	Ex Situ No Separations Alternative (Vitrification)	Ex Situ No Separations Alternative (Calcination)	Ex Situ Extensive Separations Alternative	Ex Situ/ In Situ Combination Alternative	Phased Implementation Alternative (Phase 1)	Phased Implementation Alternative (Phase 2)
Land, permanently committed (hectares) (Long-term commitment of radiologically contaminated area)	Total	27	27	~~40~~ 46	~~37~~ 41	0	~~43~~ 52
	Construction/ Operation	~~2~~ 19	~~2~~ 19	~~7~~ 34	~~8~~ 31	0	~~10~~ 40
	Closure	~~25~~ 8	~~25~~ 8	~~33~~ 12	~~29~~ 10	0	~~33~~ 12
Land, incremental temporarily committed (hectares) (area disturbed during construction and operations)	Total	~~83~~ 166	~~83~~ 101 ~~167~~	~~108~~ 112	~~106~~ 109	~~33~~ 32	~~108~~ 147
	Construction/ Operation	~~63~~ 146	~~63~~ 81	~~84~~ 88	~~84~~ 87	~~33~~ 32	~~84~~ 123
	Closure	20	20	24	22	0	24
Borrow Pit Disturbed Area (hectares) based on an excavation depth of 3 meters	McGee Ranch	16	16	~~21~~ 25	~~18~~ 21	~~0~~ 1	~~21~~ 25
	Pit 30	~~44~~ 47	44	~~59~~ 68	~~32~~ 48	~~0~~ 1	~~51~~ 74
	Vernita Quarry	21	21	~~27~~ 31	~~23~~ 26	0	~~27~~ 31
Water, Total (cubic meters)	Sanitary plus Raw Water	2.8E+06	2.4E+06	3.39E+07	1.35E+07	2.8E+06	1.08E+07
Water, Sanitary (cubic meters)	Total	2.34E+06	3.6E+05	3.9E+06	2.5E+06	6.3E+05	3.08E+06
	Construction	2.39E+05	2.39E+05	5.29E+05	4.19E+05	3.9E+05	2.54E+05
	Operation	2.06E+06	2.08E+06	3.21E+06	3.08E06	2.2E+05	2.77E+06
	Closure	4.13E+04	4.13E+04	2.05E+05	4.9E+04	1.6E+04	6.03E+04
Water, Raw (cubic meters)	Total	4.62E+05	8.58E+04	3.0E+07	1.1E+07	2.2E+06	5.5E+06
	Construction	N/R	N/R	N/R	5.5E+06	N/R	N/R
	Operation	4.62E+05	8.58E+04	3.0E+07	5.5E+06	2.2E+06	7.7E+06
	Closure	N/R	N/R	N/R	N/R	N/R	N/R

Page K-10
Rev 0 8-15-96

Table B.10.0.3 Resource Summary, Tank Waste Alternatives (cont'd)

Resource	Phase	Ex Situ No Separations Alternative (Vitrification)	Ex Situ No Separations Alternative (Calcination)	Ex Situ Extensive Separations Alternative	Ex Situ/ In Situ Combination Alternative	Phased Implementation Alternative (Phase 1)	Phased Implementation Alternative (Phase 2)
Energy Electricity (Gwh)	Total	4.72E+03	4.72E+03	1.67E+04	4.54E+03	1.7E+03	6.14E+03
	Construction	3.0E+01	3.0E+01	8.9E+01	3.8E+01	5.0E+01	3.73E+01
	Operation	4.69E+03	4.69E+03	1.66E+04	4.5E+03	1.6E+03	6.1E+03
	Closure	N/R	N/R	N/R	N/R	N/R	N/R
Gasoline (cubic meters)	Total	5.4E+03	5.4E+03	1.0E+04	3.0E+05	6.8E+03	5.1E+03
	Construction	5.1E+03	5.1E+03	9.7E+03	3.0E+05	6.5E+03	4.71E+03
	Operation	N/R	N/R	N/R	N/R	N/R	N/R
	Closure	3.01E+02	3.01E+02	3.91E+02	3.36E+02	3.3E+02	3.91E+02
Diesel (cubic meters)	Total	6.51E+04	6.4E+04	9.72E+04	5.16E+05	3.6E+04	3.2E+04
	Construction	1.19E+04	1.19E+04	2.9E+04	4.54E+05	1.8E+04	1.3E+04
	Operation	1.02E+03	1.02E+02	1.02E+03	4.17E+03	2.0E+02	1.22E+03
	Closure	5.22E+04	5.22E+04	6.72E+04	5.8E+04	1.8E+04	1.8E+04
Kerosene (cubic meters)	Operation	5.64E+04	8.05E+04	9.36E+04	2.9E+04	9.8E+02	3.0E+04
Materials: Concrete (cubic meters)	Total	2.33E+06	1.27E+06	6.69E+05	3.74E+05	2.4E+04	6.5E+04
	Construction	2.66E+05	2.66E+05	5.0E+05	2.7E+05	2.4E+04	2.9E+04
	Operation	2.04E+06	9.8E+05	1.5E+05	8.5E+04	4.4E+02	1.7E+04
	Closure	1.9E+04	1.9E+04	1.9E+04	1.9E+04	0	1.9E+04

Page A-11
Rev 8-15-96

Table B.10.0.3 Resource Summary, Tank Waste Alternatives (cont'd)

Resource	Phase	Ex Situ No Separations Alternative (Vitrification)	Ex Situ No Separations Alternative (Calcination)	Ex Situ Extensive Separations Alternative	Ex Situ/ In Situ Combination Alternative	Phased Implementation Alternative (Phase 1)	Phased Implementation Alternative (Phase 2)
Carbon Steel (metric tons)	Total	2.32E+05	1.32E+05	1.98E+05	8.21E+04	8.3E+04	7.85E+04
	Construction	6.12E+04	6.12E+04	1.4E+05	5.35E+04	8.3E+04	5.85E+04
	Operation	1.46E+05	7.04E+04	1.62E+04	9.6E+03	2.9E+02	2.0E+04
	Closure	N/A	N/A	N/A	N/A	N/A	N/A
Stainless Steel (mt)	Construction	1.26E+04	1.26E+04	2.1E+04	9.5E+03	1.5E+04	1.15E+04
Hastelloy/Inconel (mt)	Construction	1.51E+03	1.51E+03	1.80E+03	1.15E+03	2.6E+03	1.15E+04
Glass Formers (mt)	Operation	2.5E+05	N/A	3.55E+05	1.47E+05	1.3E+05	2.8E+05
Process Chemicals (mt)	Operation	1.95E+05	3.06E+05	8.86E+05	9.55E+04	5.8E+04	1.5E+05
Bulk sulfur cement	Operation						
sulfur (mt)		N/A	N/A	1.7E+05	6.5E+04	5.2E+04	1.2E+05
dicyclopentadine (mt)		N/A	N/A	4.46E+03	2.65E+03	7.4E+02	3.4E+03
oligomer (mt)		N/A	N/A	4.46E+03	1.70E+03	6.8E+02	2.4E+03
Ion exchange media (cubic meters)	Operation	N/A	N/A	4.9E+03	1.1E+02	1.4E+01	1.4E+02
Borrow Site Silt (cubic meters)	Closure	3.77E+05	3.77E+05	~~5.35~~E+05 6.45	~~4.36~~E+05 5.11	0	~~5.26~~E+05 6.45
Borrow Site Sand and Gravel (cubic meters)	Total	1.29E+06	1.29E+06	1.73E+06	1.34E+06	1.2E+04	1.5E+06
	Construction	1.23E+05	1.23E+05	3.72E+05	4.1E+05	1.2E+04	1.71E+05
	Operation	N/A	N/A	N/A	(see construction)	N/A	N/A
	Closure	1.17E+06	1.17E+06	~~1.36~~ 1.5E+06	9.4E+05	N/A	~~1.36~~ 1.5E+06
Borrow Site Basalt (cubic meters) [1]	Closure	6.38E+05	6.38E+05	~~8.05~~E+05 9.31	~~7.0~~E+05 7.85	N/A	~~8.05~~E+05 9.31

Page A-12
Rev 2-15-96

Page A-13
RDW 2-15-96

TWRS EIS
CALCULATION COVER SHEET

DISCIPLINE & TITLE Engineering / Number of Canisters, Trips, and Curie Concentrations in the HLW for radtran input. Perform for all Ex Situ alternatives.

ORIGINATOR Colin Henderson DATE 1/27/96

REVISION NO. 0

OBJECTIVE Using New baseline Assumption for waste loading and Canister size and Blending factor Calculate the Number of Canisters, trips and Isotopic Concentration in the HLW product

METHODOLOGY Use WHC Rev 0 data packages to determine Curies/m³ in the old Case waste and Ratio By the change in Volume to determine Conc for new base Case. Combination alt. calculated based on % recovered on an isotope by isotope basis.

ASSUMPTIONS Noted.

(Continue on another sheet if necessary)

J C Henderson
SIGNATURE

CALCULATION & RESULTS ATTACHED

JACOBS\FORMS\CALCVR.SHT

Page A-14
RDW 2-15-96

Assumptions

1. HLW glass for any of the ex situ alternatives involving separations is calculated at 20 wt % waste oxides. The waste oxides exclude silica and sodium.
2. The HLW for the No Separations case is calculated at 20 wt % sodium oxide.
Note: EA glass limits are 17% Na2O and 4.3% Li2O and each Li2O is equivalent to 2 Na2O so the EA glass is equivalent to 25% Na2O without any Li2O. The privatization RFP states that the HLW glass will be 25 wt % waste oxides not counting the Na2O or SiO2.
3. The LAW glass composition is calculated at 15 wt % Na2O.
4. The canister size for all HLW is set at 0.62 m^3 (1X canister)
5. The material balances contained in the WHC data packages were used to calculate the waste oxides for the HLW and LAW streams.
6. Sensitivity analysis will be done for the Intermediate Separations alternative at 15 wt %, and 40 wt % waste oxide loading.
7. The material balance for the Intermediate Separations case was used for the Phased Implementation alternative and was modified to account for additional radionuclide separations.
8. For purposes of interim onsite storage and transportation to the repository 4 of the 1x cans are assumed to be placed into an HMPC or similar packaging and would be repackaged at the repository.

Pg 2/10

No Separations WHC data package values					
			Vitrification		
Radionuclide Inventory			No Separations		
			HLW Glass (WHC data pkg)		
			Total Curies		
Am-241			1.04E+05		
Am-243			3.32E+01		
Cm-244			1.18E+02		
Cs-137			3.49E+07		
Ni-63			2.69E+05		
Np-237			6.97E+01		
Pu-238			1.08E+03		
Pu-239			2.64E+04		
Pu-240			6.70E+03		
Pu-241			7.49E+04		
Ru-106			3.79E-02		
Sm-151			6.30E+05		
Sn-126			6.27E+02		
Sr-90			4.36E+07		
Tc-99			3.21E+04		
U-233			1.21E-02		
U-234			2.12E-01		
U-235			2.06E+01		
U-238			4.81E+02		
Zr-93			3.94E+03		
Total (m3)			1.36E+05		
Note: Curies from decay daughter products not included					

No Separations Alternative New Base Case (1/26/96)					
20 wt% sodium oxide loading, 1.5 blending factor					
			Vitrification		Calcination
			Radionuclide		Radionuclide
			Concentration		Concentration
			Curies /m^3		Curies /m^3
Am-241			2.86E-01		1.55E+00
Am-243		3.32E1 ÷ 36HE5 =	9.12E-05	OK	4.94E-04
Cm-244			3.24E-04		1.76E-03
Cs-137			9.58E+01		5.19E+02
Ni-63			7.39E-01		4.00E+00
Np-237			1.91E-04		1.04E-03
Pu-238			2.97E-03		1.61E-02
Pu-239			7.25E-02		3.93E-01
Pu-240			1.84E-02		9.97E-02
Pu-241			2.06E-01		1.11E+00
Ru-106			1.04E-07		5.64E-07
Sm-151			1.73E+00		9.38E+00
Sn-126			1.72E-03		9.33E-03
Sr-90			1.20E+02		6.49E+02
Tc-99			8.81E-02		4.78E-01
U-233			3.32E-08		1.80E-07
U-234			5.82E-07		3.15E-06
U-235			5.66E-05		3.07E-04
U-238			1.32E-03		7.16E-03
Zr-93			1.08E-02		5.86E-02
Total (m3)			3.64E+05		6.72E+04
Number of 0.62 m^3 canisters			5.87E+05		166,000 ~~108388~~
Number of 0.62 m^3 canisters per HMPC			4		4
Number of trips to the repository			14686	14679	4150 ~~2710~~
Based on 10 HMPCs per train					
Note: Curies from decay daughter products not included					
					108388
					587000
				b =	474612
				0.815	81.5%

Page A-17
Fdn 2-15-96

Intermediate Separations WHC data package values

Radionuclide Inventory	Low-Level Waste Glass Ci/m3	High-Level Waste Glass Ci/m3
Am-241	3.90E-02	1.00E+01
Am-243	1.30E-05	3.20E-03
C-14		
Cm-244	4.70E-06	5.90E-03
Cs-135	4.80E-06	1.50E-02
Cs-137	1.20E+00	3.70E+03
I-129		
Ni-63	2.60E-02	2.80E+01
Np-237	3.20E-05	6.60E-03
Pu-238	3.10E-04	1.10E-01
Pu-239	7.60E-03	2.60E+00
Pu-240	1.90E-03	6.70E-01
Pu-241	6.70E-03	7.80E+00
Ra-226		
Ru-106	8.50E-09	3.80E-06
Sm-151	3.10E-02	6.60E+01
Sn-126	7.20E-04	5.00E-02
Sr-90	4.30E+00	5.60E+03
Tc-99	1.20E-01	6.30E-01
Th-230	2.30E-12	4.10E-09
U-233	2.80E-09	1.20E-06
U-234	4.90E-08	2.10E-05
U-235	4.80E-06	2.10E-03
U-238	1.10E-04	4.80E-02
Zr-93	1.60E-05	4.10E-01
Total (m3)3	2.20E+05	9.40E+03

Note: Curies from decay daughter products not included

Page A-18
RGW 2-15-96

Intermediate Separations New Base Case (1/26/96)			
20 wt% waste oxide loading, 1.5 blending factor			
		Sensitivity @	Sensitivity@
	Base Case	15 wt% loading	40 wt% loading
Radionuclide Inventory	HLW	HLW	HLW
	glass	glass	glass
	Ci/m^3	Ci/m^3	Ci/m^3
Am-241	4.54E+00	3.41E+00	9.08E+00
Am-243	1.45E-03	1.09E-03	2.91E-03
C-14	0.00E+00	0.00E+00	0.00E+00
Cm-244	2.68E-03	2.01E-03	5.36E-03
Cs-135	6.81E-03	5.11E-03	1.36E-02
Cs-137	1.68E+03	1.26E+03	3.36E+03
I-129	0.00E+00	0.00E+00	0.00E+00
Ni-63	1.27E+01	9.54E+00	2.54E+01
Np-237	3.00E-03	2.25E-03	5.99E-03
Pu-238	5.00E-02	3.75E-02	9.99E-02
Pu-239	1.18E+00	8.86E-01	2.36E+00
Pu-240	3.04E-01	2.28E-01	6.09E-01
Pu-241	3.54E+00	2.66E+00	7.08E+00
Ra-226	0.00E+00	0.00E+00	0.00E+00
Ru-106	1.73E-06	1.29E-06	3.45E-06
Sm-151	3.00E+01	2.25E+01	5.99E+01
Sn-126	2.27E-02	1.70E-02	4.54E-02
Sr-90	2.54E+03	1.91E+03	5.09E+03
Tc-99	2.86E-01	2.15E-01	5.72E-01
Th-230	1.86E-09	1.40E-09	3.72E-09
U-233	5.45E-07	4.09E-07	1.09E-06
U-234	9.54E-06	7.15E-06	1.91E-05
U-235	9.54E-04	7.15E-04	1.91E-03
U-238	2.18E-02	1.63E-02	4.36E-02
Zr-93	1.86E-01	1.40E-01	3.72E-01
Total (m3)3	2.07E+04	2.76E+04	1.03E+04
Number of 0.62 m^3 canisters	3.34E+04	4.45E+04	1.67E+04
Number of 0.62 m^3 can/HMPC	4	4	4
Number of HMPCs	8347	11129	4173
Number of trips to the repository at 10 HMPCs per trip	835	1113	418
Note: Curies from decay daughter products not included			

B 6/10

Page A-17
RDW 2-15-96

Extensive Separations Data Package values			
Note: data package values modified by ECN to Rev 0 data package			
Radionuclide Inventory		HLW Glass	LLW Glass
		Base Case (A-1)	Base Case (A-1A)
		Ci/m3	Ci/m3
Am-241		2.09E+02	7.34E-04
Am-243		6.69E-02	2.35E-07
C-14		0.00E+00	0.00E+00
Cm-244		2.30E-01	4.56E-06
Cs-135		2.91E-01	9.16E-07
Cs-137		7.02E+04	2.21E-01
I-129		0.00E+00	0.00E+00
Ni-63		8.47E+00	1.83E+00
Np-237		1.40E-01	1.87E-05
Pu-238		2.15E+00	7.80E-05
Pu-239		5.25E+01	1.90E-03
Pu-240		1.33E+01	4.84E-04
Pu-241		1.49E+02	5.41E-03
Ra-226		5.40E-10	7.20E-16
Ru-106		7.58E-05	1.01E-10
Sm-151			1.68E-03
Sn-126		1.25	1.67E-06
Sr-90		1.07E+05	3.72E-02
Tc-99		6.43E+01	1.06E-03
Th-230		7.80E-08	1.04E-13
U-233		3.68E-08	5.19E-11
U-234		6.76E-07	9.10E-10
U-235		6.57E-05	8.84E-08
U-238		1.53E-03	2.06E-06
Zr-93		9.59E-02	2.68E-02
total m3		496	1.47E+05
			solid
Note: Curies from decay daughter products not included			

Extensive Separations alternative New Base Case (1/26/96)

20 wt% waste oxide loading, 1.5 blending factor

Extensive Separations Data Package values

Radionuclide Inventory	HLW Glass Base Case (A-1) Ci/m3
Am-241	1.06E+02
Am-243	3.41E-02
C-14	0.00E+00
Cm-244	1.17E-01
Cs-135	1.48E-01
Cs-137	3.58E+04
I-129	0.00E+00
Ni-63	4.31E+00
Np-237	7.13E-02
Pu-238	1.09E+00
Pu-239	2.67E+01
Pu-240	6.77E+00
Pu-241	7.59E+01
Ra-226	2.75E-10
Ru-106	3.86E-05
Sm-151	0.00E+00
Sn-126	6.37E-01
Sr-90	5.45E+04
Tc-99	3.27E+01
Th-230	3.97E-08
U-233	1.87E-08
U-234	3.44E-07
U-235	3.35E-05
U-238	7.79E-04
Zr-93	4.88E-02
total m3	9.74E+02

Number of 0.62 m^3 canisters	1571
Number of 0.62 m^3 can/HMPC	4
Number of HMPCs	393
Number of trips to the repository @ 10 HMPCs/trip	40

Note: Curies from decay daughter products not included

Phased Implementation alternative New Base Case (1/26/96)		
20 wt % waste oxide loading, 1.5 blending factor		
		Base Case
Radionuclide Inventory		HLW
		glass
		Ci/m^3
Am-241		5.01E+00
Am-243		1.60E-03
C-14		0.00E+00
Cm-244		2.68E-03
Cs-135		6.81E-03
Cs-137		1.68E+03
I-129		0.00E+00
Ni-63		1.27E+01
Np-237		3.00E-03
Pu-238		5.15E-02
Pu-239		1.26E+00
Pu-240		3.19E-01
Pu-241		3.57E+00
Ra-226		0.00E+00
Ru-106		1.73E-06
Sm-151		3.00E+01
Sn-126		2.27E-02
Sr-90		2.56E+03
Tc-99		1.54E+00
Th-230		1.86E-09
U-233		5.45E-07
U-234		9.54E-06
U-235		9.54E-04
U-238		2.18E-02
Zr-93		1.86E-01
Total (m3)		2.07E+04
Number of 0.62 m^3 canisters		33386.30179
Number of 0.62 m^3 canisters		33387
Number of 0.62 m^3 can/HMPC		4
Number of HMPCs		8347
Number of trips to the repository @ 10 HMPC/trip		835
Note: Curies from decay daughter products not included		

Ex Situ / In Situ Combination Alternative New Base Case (1/26/96)		
20 wt% waste oxide loading, 1.5 blending factor		
Radionuclide Inventory	HLW glass	Sel Ret. Recovery fraction
	Ci/m^3	
Am-241	6.97E+00	7.67E-01
Am-243	2.67E-03	9.20E-01
C-14	0.00E+00	9.00E-01
Cm-244	5.04E-03	9.40E-01
Cs-135	1.16E-02	8.50E-01
Cs-137	2.96E+03	8.80E-01
I-129	0.00E+00	9.00E-01
Ni-63	2.03E+01	8.00E-01
Np-237	5.58E-03	9.32E-01
Pu-238	3.97E-02	3.97E-01
Pu-239	1.48E+00	6.27E-01
Pu-240	3.69E-01	6.07E-01
Pu-241	4.01E+00	5.65E-01
Ra-226	0.00E+00	8.30E-01
Ru-106	1.28E-06	3.70E-01
Sm-151	4.32E+01	7.20E-01
Sn-126	3.32E-02	7.30E-01
Sr-90	3.56E+03	7.00E-01
Tc-99	5.15E-01	9.00E-01
Th-230	3.05E-09	8.20E-01
U-233	8.72E-07	8.00E-01
U-234	1.54E-05	8.10E-01
U-235	1.74E-03	9.10E-01
U-238	3.92E-02	9.00E-01
Zr-93	2.49E-01	6.70E-01
Total (m3)	1.03E+04	
Number of 0.62 m^3 canisters	16694 16613	
Number of 0.62 m^3 can/HMPC	4	
Number of HMPCs	4174 4154	
Number of trips to the repository	4 to HMPC per trip 418 416	
Note the combination alt. retrieval fraction is calculated from the % of SST and DST inventory		
recovered as follows: recovery fraction = (curies recovered from SSTs ÷ Curies from DSTs)		
divided by (total curies in the SSTs+total curies in DSTs)		
The combination alternative volume of HLW glass is 1/2 of the Intermediate Separations		
Note: Curies from decay daughter products not included		

Page A-23
RJW 2-15-96

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			LAW			HLW			HLW fraction
	STREAM 1			407	437		314	344		
	solids	liquids		FRIT	GLASS		FRIT	GLASS		
Volume kilo-liters										
Specific Gravity										
Cs and Ba, (MCi)	5.28E+00	6.28E+01			4.93E-01			6.74E+01		0.990011751
Sr and Y, (MCi)	1.05E+02	2.10E+00			1.90E+00			1.05E+02		0.980392157
Tc, (MCi)	5.89E-03	2.61E-02			2.59E-02			5.91E-03		0.184745233
Am, (MCi)	9.51E-02	8.61E-03			8.60E-03			9.52E-02		0.917944268
Np, (MCi)	9.29E-05	1.03E-05			1.03E-05			9.29E-05		0.900193798
Pu-239, (MCi)	2.47E-02	1.67E-03			1.67E-03			2.47E-02		0.936670459
Pu-240, (MCi)	6.28E-03	4.14E-04			4.14E-04			6.28E-03		0.93815357
Pu-241,(MCi)	7.34E-02	1.49E-03			1.48E-03			7.34E-02		0.980104153
Total TRU, (MCi)	2.00E-01	1.22E-02			1.22E-02			2.00E-01		0.942507069
Total MCi	1.11E+02	6.49E+01			2.43E+00			1.73E+02		0.98351336
Total Mass Flow (MT)	1.94E+04	7.10E+05		2.81E+05	3.87E+05		1.36E+04	2.51E+04		
Total Cr, (MT)	1.32E+02	5.15E+01			1.44E+02			3.96E+01		
Total Na, (MT)	1.24E+03	6.51E+04			7.18E+04			2.33E+03		
Total Si, (MT)	5.24E+02	5.65E+00		1.07E+05	1.07E+05		5.29E+03	5.83E+03		
Total P, (MT)	7.80E+02	8.42E+02			1.35E+03			2.72E+02		
Total NO2-, (MT)	7.38E+01	9.54E+03								
Total NO3-, (MT)	1.03E+03	1.06E+05								
AG+	1.38E+00	3.28E-01								
AG2O					3.52E-01			1.48E+00		
AL+3	2.37E+03									
AL2O3				1.32E+04	1.94E+04			1.73E+03		
AL(OH)4-		4.83E+03								
AM+3	2.77E-02	2.51E-03								
AM2O3					2.76E-03			3.05E-02		
AS+5	4.98E-01	7.70E-01								
AS2O5					1.18E+00			7.66E-01		
B+3	9.94E-01	5.19E-01								
B2O3					1.67E+00		1.75E+03	1.76E+03		
BA+2	3.09E+00	7.91E-01								
BAO					8.81E-01			3.45E+00		
BE+2	7.61E-03	8.19E-02								
BEO					2.27E-01			2.16E-02		
BI+3	1.96E+02	6.76E+01								
BI2O3					7.52E+01			2.19E+02		
C14	4.53E-04	7.43E-04								
CA+2	1.33E+02	1.67E+01								
CANCRINITE	2.70E+03									
CAO				3.87E+04	3.87E+04			1.89E+02		
CD+2	7.93E+00	2.09E+00								
CDO					2.38E+00			9.06E+00		
CE+3	2.35E+02	2.37E+00								
CE2O3					2.79E+00			2.76E+02		
CL-	3.49E+00	3.11E+02								
CL2										
CO										
CO2										
CO3-2	2.25E+02	3.37E+03								
CR+3	1.32E+02									
CR2O3					2.11E+02			5.79E+01		
CR(OH)4-		1.19E+02								
CS+	9.25E-02	8.19E-01								
CS2O					6.83E-03			9.58E-01		
CU+2	7.46E-01	1.77E-01								
CUO					2.21E-01			9.34E-01		

Page A-24
Revised 8-15-95

CUSO4										
F-	5.97E+01	1.12E+03								
F2										
FE+3	7.63E+02	1.44E+01								
FE2O3					2.06E+01			1.21E+03		
H2										
H2O		5.07E+05								
H2S										
HG										
HG+2	9.00E-03	9.49E-01								
I-	2.02E+01	5.46E+02								
I2										
K+	2.10E+01	2.19E-01								
K2O					2.65E-01			2.53E+01		
KEROSENE										
LA+3	2.10E+01	2.19E-01								
LA2O3					2.58E-01			2.46E+01		
LI+	2.46E-02	5.77E-03								
LI2O					1.24E-02		5.00E+02	5.03E+02		
MG+2	1.10E+01	9.65E-01								
MGO					1.60E+00			1.88E+01		
MNO2	2.09E+02	2.17E+01			2.16E+01			2.09E+02		
MO+6	8.01E-01	4.87E+00								
MOO3					7.29E+00			1.22E+00		
N2										
NA+	7.77E+02	6.51E+04								
NA2O					9.68E+04			3.14E+03		
NH3										
NI+3	6.57E+00	4.07E+00								
NI2FECN6	5.00E+02									
NI2O3					5.72E+00			9.27E+00		
NIO					1.50E-02			2.27E+02		
NO										
NO2										
NO2-	7.38E+01	9.54E+03								
NO3-	1.03E+03	1.06E+05								
NP+4	1.32E-01	1.46E-02								
NPO2					1.66E-02			1.50E-01		
O2										
OH-	5.00E+03	6.44E+03								
PB+4	3.28E+00	1.96E+00								
PBO2					2.26E+00			3.79E+00		
PO4-3	2.39E+03	2.58E+03								
P2O5					3.09E+03			6.22E+02		
P2O5:24W	5.21E-01									
PU+4	4.27E-01	2.88E-02								
PUO2					3.26E-02			4.84E-01		
S										
SI+4	7.90E+01	5.65E+00								
SIO2				2.29E+05	2.29E+05		1.13E+04	1.25E+04		
SO2										
SO4-2	3.97E+01	2.01E+03								
SR+2	3.64E+01	3.75E-01								
SRO					4.00E-01			4.29E+01		
TCO2										
TCO4-	5.68E-01	2.52E+00								
TC2O7					2.39E+00			5.45E-01		
TOC	1.16E+02	1.42E+03								
UO2+2	1.58E+03	8.52E+01								
UO3					9.02E+01			1.67E+03		
V+5	1.88E-01	6.20E-02								
V2O5					1.11E-01			3.35E-01		
W+6		7.47E-01								
WO2					2.91E-05			4.41E-01		
WO3					9.40E-01			2.06E-03		
ZN+2	9.45E-01	3.59E+00								
ZNO					4.46E+00			1.19E+00		

R 2-15-96

ZR+4	2.77E+02	4.48E-01								
ZRO2					6.49E-01			6.90E+02		
ZRO2:2H2	4.09E+02	2.15E+01								
WHC Data Package Basis:										
Mass LAW waste oxides					106544.7302					
LAW waste loading (waste oxide)					28%					
LAW waste loading (sodium oxide)					25%					
Mass HLW waste oxides								7.26E+03		
HLW waste loading (waste oxides)								29%		
HLW										
20 wt. % waste oxide loading										
Blending factor				1	1.25	1.5	2	3.5		
Mass of glass required to achieve 25% wo loading, MT				36293.1358	45366.41975	54439.7037	72586.2716	127025.9753		
additional frit required (equals increased glass) MT				1.12E+04	2.03E+04	2.93E+04	4.75E+04	1.02E+05		
total frit required, MT				2.48E+04	3.39E+04	4.29E+04	6.11E+04	1.16E+05		
glass density (MT/m^3)*	2.63									
cullet packing fraction	0.7	(LAW only)								
Waste volume (m^3)				1.38E+04	1.72E+04	2.07E+04	2.76E+04	4.83E+04		
Canister Volume (m^3)	0.62									
Number of Canisters (1x)				2.23E+04	2.78E+04	3.34E+04	4.45E+04	7.79E+04		
Nu. of Canisters /HMPC	4									
Number of HMPCs				5.56E+03	6.96E+03	8.35E+03	1.11E+04	1.95E+04		
Number of trips @ 10 HMPCs /trip				556	696	835	1113	1948		
Glass formulation:										
(ref Ext. Sep Data Pkg.)	acceptable range			1	1.25	1.5	2	3.5		
SiO2	42 to 57 wt %			60.07%	64.68%	67.75%	71.59%	76.52%		
B2O3	5 to 20 wt %			8.82%	9.63%	10.17%	10.84%	11.71%		
Na2O	5 to 20 wt %			8.65%	6.92%	5.77%	4.33%	2.47%		
Li2O	1 to 7 wt %			2.52%	2.75%	2.91%	3.10%	3.35%		
Fe2O3	2 to 15 wt %			3.33%	0.00%	0.00%	0.00%	0.00%		
CaO	< or= 10 wt %			0.52%	0.42%	0.35%	0.26%	0.15%		
MgO	< or = 8 wt %			0.05%	0.04%	0.03%	0.03%	0.01%		
Al2O3	< or = 15 wt %			4.77%	3.81%	3.18%	2.38%	1.36%		
ZrO2	< or = 13 wt %			1.90%	1.52%	1.27%	0.95%	0.54%		
Cr2O3	< or = 0.5 wt %			0.16%	0.13%	0.11%	0.08%	0.05%		
P2O5	< or = 3 wt %			1.71%	1.37%	1.14%	0.86%	0.49%		
SO3	< or = 0.5 wt %									
HLW Facility Sizing										
Schedule	14 yrs									
Capacity MT/day	20									
Overall efficiency, %				36%	44%	53%	71%	124%		
Required capacity MT/day (assuming 14 yrs ops, 60% OE)				11.84	14.80	17.76	23.67	41.43		
Required operating duration yrs (assuming 20 MT/day, 60% OE)					10.36	12.43	16.57	29.00		
15 wt % waste oxide loading										
Mass of glass required to achieve 15% wo loading MT				4.84E+04	6.05E+04	7.26E+04	9.68E+04	1.69E+05		
Volume (m^3)				1.84E+04	2.30E+04	2.76E+04	3.68E+04	6.44E+04		
Number of Canisters (1x)				2.97E+04	3.71E+04	4.45E+04	5.94E+04	1.04E+05		
40 wt % waste oxide loading										
Mass of glass required to achieve 40% wo loading MT				1.81E+04	2.27E+04	2.72E+04	3.63E+04	6.35E+04		
Volume (m^3)				6.90E+03	8.62E+03	1.03E+04	1.38E+04	2.41E+04		
Number of Canisters (1x)				1.11E+04	1.39E+04	1.67E+04	2.23E+04	3.90E+04		
LAW										

Page A-24
RDW 8-15-96

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				6.45E+05	8.07E+05	9.68E+05	1.29E+06	2.26E+06		
additional frit required (equals increased glass) MT				3.64E+05	5.26E+05	6.87E+05	1.01E+06	1.98E+06		
total frit required, MT				6.45E+05	8.07E+05	9.68E+05	1.29E+06	2.26E+06		
glass density (MT/m^3)	2.63									
cullet packing fraction	0.7									
Waste volume (m^3)				3.51E+05	4.38E+05	5.26E+05	7.01E+05	1.23E+06		
Number of 5300 m^3 vaults				66	83	99	132	231		
LAW facility sizing										
Schedule, years	14									
Capacity MT/day	200									
Overall efficiency, %				63%	79%	95%	126%	221%		
Required capacity MT/day (assuming 14 yrs ops, 60% OE)				210.48	263.10	315.72	420.96	736.68		
Required operating duration yrs (assuming 200 MT/day, 60% OE)				14.73	18.42	22.10	29.47	51.57		
10 wt. % sodium oxide loading										
Blending factor				1			2	3.5		
Mass of glass required to achieve 10 wt% Na2O				968000			1936000	3388000		
Waste volume, m^3				525801.195			1051602.39	1840304.183		
Number of 5,300 m^3 vaults				99			198	347		
25 wt. % sodium oxide loading										
Blending factor				1			2	3.5		
Mass of glass required to achive 25 wt % Na2O				387200			774400	1355200		
Waste Volume				210320.478			420640.956	736121.673		
Number of 5,300 m^3 vaults				40			79	139		

use 10% LAW
+15% HLW
as a case
+ Calculate
Column as for
table B10.0.3

and calculate
to give trips required -
additional.

Page A-27
AJW - 2-15-96

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				6.45E+05	8.07E+05	9.68E+05	1.29E+06	2.26E+06		
additional frit required (equals increased glass) MT				3.64E+05	5.26E+05	6.87E+05	1.01E+06	1.98E+06		
total frit required, MT				6.45E+05	8.07E+05	9.68E+05	1.29E+06	2.26E+06		
glass density (MT/m^3)	2.63									
cullet packing fraction	0.7									
Waste volume (m^3)				3.51E+05	4.38E+05	5.26E+05	7.01E+05	1.23E+06		
Number of 5300 m^3 vaults				66	83	99	132	231		
LAW facility sizing										
Schedule, years	14									
Capacity MT/day	200									
Overall efficiency, %				63%	79%	95%	126%	221%		
Required capacity MT/day (assuming 14 yrs ops, 60% OE)				210.48	263.10	315.72	420.96	736.68		
Required operating duration yrs (assuming 200 MT/day, 60% OE)				14.73	18.42	22.10	29.47	51.57		
10 wt. % sodium oxide loading										
Blending factor				1	1.25		2	3.5		
Mass of glass required to achieve 10				968000	1210000		1936000	3388000		
Waste volume, m^3				525801.195	657251.4938		1051602.39	1840304.183		
Number of 5,300 m^3 vaults				99	124		198	347		
25 wt. % sodium oxide loading										
Blending factor				1	1.25		2	3.5		
Mass of glass required to achive 25 wt % Na2O				387200	484000		774400	1355200		
Waste Volume				210320.478	262900.5975		420640.956	736121.673		
Number of 5,300 m^3 vaults				40	50		79	139		

Assumptions:							
1. HLW glass waste oxide loading basis to be 20 wt% sodium oxides							
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 % sodium oxide loading							
	Input		Frit	Output			
	Stream1		stream407	stream437			
	liquids	solids					
Volume kilo-liters	5.85E+05						
Specific Gravity	1.21E+00						
Cs and Ba, (MCi)	6.28E+01	5.28E+00		6.79E+01			
Sr and Y, (MCi)	2.10E+00	1.05E+02		1.07E+02			
Tc, (MCi)	2.61E-02	5.89E-03		3.18E-02			
Am, (MCi)	8.61E-03	9.51E-02		1.04E-01			
Np, (MCi)	1.03E-05	9.29E-05		1.03E-04			
Pu-239, (MCi)	1.67E-03	2.47E-02		2.64E-02			
Pu-240, (MCi)	4.14E-04	6.28E-03		6.70E-03			
Pu-241,(MCi)	1.49E-03	7.34E-02		7.48E-02			
Total TRU, (MCi)	1.22E-02	2.00E-01		2.12E-01			
Total MCi	6.49E+01	1.11E+02		1.76E+02			
Total Mass Flow (MT)	7.10E+05	1.94E+04	2.50E+05	3.57E+05			
Total Cr, (MT)	5.15E+01	1.32E+02		1.84E+02			
Total Na, (MT)	6.51E+04	1.24E+03		6.63E+04			
Total Si, (MT)	5.65E+00	5.24E+02	9.56E+04	9.61E+04			
Total P, (MT)	8.42E+02	7.80E+02		1.62E+03			
Total NO2-, (MT)	9.54E+03	7.38E+01					
Total NO3-, (MT)	1.06E+05	1.03E+03					
AG+	3.28E-01	1.38E+00					
AG2O				1.83E+00			
AL+3		2.37E+03					
AL2O3			1.00E+04	1.79E+04			
AL(OH)4-	4.83E+03						
AM+3	2.51E-03	2.77E-02					
AM2O3				3.32E-02			
AS+5	7.70E-01	4.98E-01					
AS2O5				1.95E+00			
B+3	5.19E-01	9.94E-01					
B2O3				4.87E+00			
BA+2	7.91E-01	3.09E+00					
BAO				4.33E+00			
BE+2	8.19E-02	7.61E-03					
BEO				2.48E-01			
BI+3	6.76E+01	1.96E+02					
BI2O3				2.94E+02			
C14	7.43E-04	4.53E-04					
CA+2	1.67E+01	1.33E+02					

Page A-29
RDW 2-15-96

CANCRINITE		2.70E+03					
CAO			3.55E+04	3.58E+04	*		
CD+2	2.09E+00	7.93E+00					
CDO				1.14E+01			
CE+3	2.37E+00	2.35E+02					
CE2O3				2.78E+02			
CL-	3.11E+02	3.49E+00					
CL2							
CO							
CO2							
CO3-2	3.37E+03	2.25E+02					
CR+3		1.32E+02					
CR2O3				2.68E+02			
CR(OH)4-	1.19E+02						
CS+	8.19E-01	9.25E-02					
CS2O				9.65E-01			
CU+2	1.77E-01	7.46E-01					
CUO				1.16E+00			
CUSO4							
F-	1.12E+03	5.97E+01					
F2							
FE+3	1.44E+01	7.63E+02					
FE2O3				1.23E+03			
H2							
H2O	5.07E+05						
H2S							
HG							
HG+2	9.49E-01	9.00E-03					
I-	5.46E+02	2.02E+01					
I2							
K+	2.19E-01	2.10E+01					
K2O				2.56E+01			
KEROSENE							
LA+3	2.19E-01	2.10E+01					
LA2O3				2.49E+01			
LI+	5.77E-03	2.46E-02					
LI2O				6.53E-02			
MG+2	9.65E-01	1.10E+01					
MGO				1.98E+01	*		
MNO2	2.17E+01	2.09E+02		2.31E+02			
MO+6	4.87E+00	8.01E-01					
MOO3				8.51E+00			
N2							
NA+	6.51E+04	7.77E+02					
NA2O				8.94E+04			
NH3							
NI+3	4.07E+00	6.57E+00					
NI2FECN6		5.00E+02					
NI2O3				1.50E+01			

Page A-30
RDW 2-15-96

NIO				2.27E+02			
NO							
NO2							
NO2-	9.54E+03	7.38E+01					
NO3-	1.06E+05	1.03E+03					
NP+4	1.46E-02	1.32E-01					
NPO2				1.66E-01			
O2							
OH-	6.44E+03	5.00E+03					
PB+4	1.96E+00	3.28E+00					
PBO2				6.05E+00			
PO4-3	2.58E+03	2.39E+03					
P2O5				3.71E+03			
P2O5:24W		5.21E-01					
PU+4	• 2.88E-02	4.27E-01					
PUO2				5.16E-01			
S							
SI+4	5.65E+00	7.90E+01					
SIO2			2.04E+05	2.06E+05	*		
SO2							
SO4-2	2.01E+03	3.97E+01					
SR+2	3.75E-01	3.64E+01					
SRO				4.33E+01			
TCO2							
TCO4-	2.52E+00	5.68E-01					
TC2O7				2.94E+00			
TOC	1.42E+03	1.16E+02					
UO2+2	8.52E+01	1.58E+03					
UO3				1.76E+03			
V+5	6.20E-02	1.88E-01					
V2O5				4.46E-01			
W+6	7.47E-01						
WO2				4.41E-01			
WO3				9.42E-01			
ZN+2	3.59E+00	9.45E-01					
ZNO				5.65E+00			
ZR+4	4.48E-01	2.77E+02					
ZRO2				7.07E+02			
ZRO2:2H2	2.15E+01	4.09E+02					
WHC data package basis:							
mass waste oxides				1.08E+05	1.168E5		
waste loading (wt%)				30%			
sodium oxide loading				25%			
20 wt. % sodium oxide loading							
Blending factor			1	1.25	1.5	2	3.5
Mass of glass required to achieve 20% sodium loading, M			4.47E+05	5.59E+05	6.71E+05	8.94E+05	1564500
additional frit required (equals increased glass) MT			9.00E+04	2.02E+05	3.14E+05	5.37E+05	1.21E+06

PMF-31
RBW 2-15-96

total frit required, MT			3.40E+05	4.52E+05	5.64E+05	7.87E+05	1.46E+06
glass density (MT/m^3)	2.63						
cullet packing fraction	0.7						
Waste volume (m^3)			2.43E+05	3.04E+05	3.64E+05	4.86E+05	8.50E+05
Canister Volume (m^3)	0.62						
Number of Canisters (1x)			3.92E+05	4.90E+05	5.87E+05	7.83E+05	1.37E+06
Number of Canisters per HMPC		4					
Number of HMPCs			9.79E+04	1.22E+05	1.47E+05	1.96E+05	3.43E+05
Number of trips @ 10 HMPCs /trip			9.79E+03	1.22E+04	1.47E+04	1.96E+04	3.43E+04
Glass formulation:							
(ref Ext. Sep Data Pkg.	acceptable range	Calculated value					
	•						
SiO2	42 to 57 wt %		62.51%	66.33%	68.88%	72.06%	76.15%
B2O3	5 to 20 wt %		0.00%	0.00%	0.00%	0.00%	0.00%
Na20	5 to 20 wt %		20.00%	16.00%	13.33%	10.00%	5.71%
Li2O	1 to 7 wt %		0.00%	0.00%	0.00%	0.00%	0.00%
Fe2O3	2 to 15 wt %		0.28%	0.22%	0.18%	0.14%	0.08%
CaO	< or= 10 wt %		10.87%	11.53%	11.98%	12.53%	13.25%
MgO	< or = 8 wt %		0.00%	0.00%	0.00%	0.00%	0.00%
Al2O3	< or = 15 wt %		4.81%	4.65%	4.54%	4.40%	4.23%
ZrO2	< or = 13 wt %		0.16%	0.13%	0.11%	0.08%	0.05%
Cr2O3	< or = 0.5 wt %		0.06%	0.05%	0.04%	0.03%	0.02%
P2O5	< or = 3 wt %		0.83%	0.66%	0.55%	0.41%	0.24%
SO3	< or = 0.5 wt %						
Facility Sizing							
Schedule	14 yrs						
Capacity MT/day	200						
Overall efficiency, %			44%	55%	66%	87%	153%
Required capacity MT/day (assuming 14 yrs ops, 60% OE)				182	219	292	510
Required operating duration yrs (assuming 200 MT/day, 60% OE)				13	15	20	36
15 wt % sodium oxide loading							
Mass of glass required to achieve 15% wo loading MT			5.96E+05			Na2O loadin	15%
Volume (m^3) as cullet			3.24E+05				
Number of Canisters (1x)			5.22E+05				
40 wt % sodium oxide loading							
Mass of glass required to achieve 40% wo loading MT			2.24E+05			Na2O loadin	40%
Volume (m^3) as cullet			1.21E+05				
Number of Canisters (1x)			1.96E+05				

Page A-32
HRW 2-15-96

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								
not counting the SiO2 or the Na2O								
	Input Stream			LAW			HLW	
	STREAM 1			407	437		1314	1344
	solids	liquids		FRIT	GLASS		FRIT	GLASS
Volume kilo-liters		5.84E+05						
Specific Gravity		1.21E+00						
Cs and Ba, (MCi)	7.60E+00	6.72E+01			6.86E-02			7.46E+01
Sr and Y, (MCi)	1.37E+02	1.41E+00			1.40E-02			1.37E+02
Tc, (MCi)	5.89E-03	2.61E-02			1.53E-04			3.17E-02
Am, (MCi)								
Np, (MCi)								
Pu-239, (MCi)								
Pu-240, (MCi)								
Pu-241,(MCi)								
Total TRU, (MCi)	1.92E-01	1.52E-02			1.20E-03			2.06E-01
Total MCi	1.45E+02	6.87E+01			8.39E-02			2.12E+02
Total Mass Flow (MT)	2.37E+04	7.06E+05		2.65E+05	3.86E+05		8.73E+02	1.32E+03
Total Cr, (MT)								
Total Na, (MT)								
Total Si, (MT)								
Total P, (MT)								
Total NO2-, (MT)								
Total NO3-, (MT)								
AG+	1.38E+00	3.28E-01						
AG2O					4.07E-01			1.43E+00
AL+3	2.37E+03							
AL2O3				1.16E+04	1.93E+04			1.94E+02
AL(OH)4-		4.83E+03						
AM+3	2.77E-02	2.51E-03						
AM2O3					3.41E-05			3.32E-02
APM-								3.44E-03
AS+5	4.98E-01	7.70E-01						
AS2O5					4.33E-01			1.51E+00
B+3	9.94E-01	5.19E-01						
B2O3					4.82E+00		1.22E+02	1.22E+02
BA+2	3.09E+00	7.91E-01						
BAO					8.76E-01			3.46E+00
BE+2	7.61E-03	8.19E-02						
BEO					5.53E-02			1.93E-01
BI+3	1.96E+02	6.76E+01						
BI2O3					2.90E+02			3.45E+00
C14	4.53E-04	7.43E-04						

CA+2	1.33E+02	1.67E+01						
CANCRINITE	2.70E+03							
CAO				3.84E+04	3.86E+04			2.34E+00
CD+2	7.93E+00	2.09E+00						
CDO					1.13E+01			1.26E-01
CE+3	2.35E+02	2.37E+00						
CE2O3					2.75E+02			3.40E+00
CL-	3.49E+00	3.11E+02						
CL2								
CO								
CO2								
CO3-2	2.25E+02	3.37E+03						
CR+3	1.32E+02							
CR2O3					2.67E+02			1.38E+00
CR(OH)4-		1.19E+02						
CS+	9.25E-02	8.19E-01						
CS2O					8.85E-04			9.64E-01
CU+2	7.46E-01	1.77E-01						
CUO					2.57E-01			8.99E-01
CUSO4								
F-	5.97E+01	1.12E+03						
F2								
FE+3	7.63E+02	1.44E+01						
FE2O3					3.74E+03			4.24E+01
H2								
H2O		5.07E+05			2.11E-04			1.10E+00
H2S								
HG								
HG+2	9.00E-03	9.49E-01						
HGO					2.07E+00			
I-	2.02E+01	5.46E+02						
I2								
K+	2.10E+01	2.19E-01						
K2O					2.55E+01			2.34E-02
KEROSENE								
LA+3	2.10E+01	2.19E-01						
LA2O3					2.46E+01			3.04E-01
LI+	2.46E-02	5.77E-03						
LI2O					6.53E-02		1.32E+01	1.32E+01
MG+2	1.10E+01	9.65E-01						
MGO					1.96E+01			2.20E-01
MNO2	2.09E+02	2.17E+01			2.31E+02			1.08E-01
MO+6	8.01E-01	4.87E+00						
MOO3					1.03E+01			9.24E-02
N2								
NA+	3.21E+03	6.26E+04						
NA2O					9.65E+04		2.40E+01	6.59E+01
NH3								
NI+3	6.57E+00	4.07E+00						

Page A-341
KJW 2-15-96

NI2FECN6	5.00E+02							
NI2O3					2.62E+02			2.82E+00
NIO					1.06E-03			1.20E+00
NO								
NO2								
NO2-	7.38E+01	9.54E+03						
NO3-	1.03E+03	1.06E+05						
NP+4	1.32E-01	1.46E-02						
NPO2					6.52E-03			1.66E-01
O2								
OH-	6.80E+03	4.64E+03						
PB+4	3.28E+00	1.96E+00						
PBO2					1.35E+00			4.71E+00
PO4-3	2.39E+03	2.58E+03						
P2O5					3.68E+03			3.96E+01
P2O5:24W	5.21E-01							
PU+4	4.27E-01	2.88E-02						
PUO2					5.42E-03			5.11E-01
S								
SI+4	7.90E+01	5.65E+00						
SIO2				2.15E+05	2.16E+05		7.13E+02	7.52E+02
SO2								
SO3					6.22E+03			1.92E-03
SO4-2	3.97E+01	2.01E+03						
SR+2	3.64E+01	3.75E-01						
SRO					4.41E-03			4.33E+01
TCO2								
TCO4-	5.68E-01	2.52E+00						
TC2O7					1.41E-02			2.92E+00
TIO2					3.16E-02			3.51E-04
TOC	1.16E+02	1.42E+03						
UO2+2	1.58E+03	8.52E+01						
UO3								2.77E+00
U3O8					1.08E+00			1.15E-02
V+5	1.88E-01	6.20E-02						
V2O5					9.92E-02			3.47E-01
W+6		7.47E-01						
WO2					1.09E-06			2.26E-04
WO3					2.10E-01			7.33E-01
ZN+2	9.45E-01	3.59E+00						
ZNO					3.17E+01			4.31E-01
ZR+4	2.77E+02	4.48E-01						
ZRO2					6.99E+02			8.55E+00
ZRO2:2H2	4.09E+02	2.15E+01						

page A-35
RDW 2-15-96

Mass LAW waste oxides					121198.787			
LAW waste loading (waste oxides)					31%			
LAW waste loading (sodium oxide)					25%			
Mass HLW waste oxides								3.42E+02
HLW waste loading								26%
HLW								
20 wt. % waste oxide loading								
Blending factor				1	1.25	1.5	2	3.5
Mass of glass required to achieve 20% wo loading, MT				1707.54219	2134.42773	2561.313278	3415.08437	5976.397648
additional frit required (equals increased glass) MT				3.88E+02	8.14E+02	1.24E+03	2.10E+03	4.66E+03
total frit required, MT				1.26E+03	1.69E+03	2.11E+03	2.97E+03	5.53E+03
glass density (MT/m^3)	2.63							
cullet packing fraction	0.7	(LAW only)						
Waste volume (m^3)				6.49E+02	8.12E+02	9.74E+02	1.30E+03	2.27E+03
Canister Volume (m^3)	0.62							
Number of Canisters (1x)				1.05E+03	1.31E+03	1.57E+03	2.09E+03	3.67E+03
Nu. of Canisters /HMPC	4							
Number of HMPCs				2.62E+02	3.27E+02	3.93E+02	5.24E+02	9.16E+02
Number of trips @ 10 HMPCs /trip				26	33	39	52	92
Glass formulation:								
(ref Ext. Sep Data Pkg.)	acceptable range			1	1.25	1.5	2	3.5
SiO2	42 to 57 wt %			62.58%	66.39%	68.94%	72.12%	76.21%
B2O3	5 to 20 wt %			10.32%	11.06%	11.55%	12.16%	12.95%
Na20	5 to 20 wt %			4.48%	4.14%	3.91%	3.62%	3.25%
Li2O	1 to 7 wt %			1.11%	1.19%	1.24%	1.31%	1.39%
Fe2O3	2 to 15 wt %			2.48%	0.00%	0.00%	0.00%	0.00%
CaO	< or= 10 wt %			0.14%	0.11%	0.09%	0.07%	0.04%
MgO	< or = 8 wt %			0.01%	0.01%	0.01%	0.01%	0.00%
Al2O3	< or = 15 wt %			11.36%	9.09%	7.57%	5.68%	3.25%
ZrO2	< or = 13 wt %			0.50%	0.40%	0.33%	0.25%	0.14%
Cr2O3	< or = 0.5 wt %			0.08%	0.06%	0.05%	0.04%	0.02%
P2O5	< or = 3 wt %			2.32%	1.86%	1.55%	1.16%	0.66%
SO3	< or = 0.5 wt %			0.00%	0.00%	0.00%	0.00%	0.00%
HLW Facility Sizing								
Schedule	14 yrs							
Capacity MT/day	1							
Overall efficiency, %				33%	42%	50%	67%	117%
Required capacity MT/day (assuming 14 yrs ops, 60% OE)				0.56	0.70	0.84	1.11	1.95
Required operating duration yrs (assuming 1 MT/day, 60% OE)					9.75	11.70	15.59	27.29

15 wt % waste oxide loading								
Mass of glass required to achieve 15% wo loading MT				2.28E+03	2.85E+03	3.42E+03	4.55E+03	7.97E+03
Volume (m^3)				8.66E+02	1.08E+03	1.30E+03	1.73E+03	3.03E+03
Number of Canisters (1x)				1.40E+03	1.75E+03	2.09E+03	2.79E+03	4.89E+03
40 wt % waste oxide loading								
Mass of glass required to achieve 40% wo loading MT				8.54E+02	1.07E+03	1.28E+03	1.71E+03	2.99E+03
Volume (m^3)				3.25E+02	4.06E+02	4.87E+02	6.49E+02	1.14E+03
Number of Canisters (1x)				5.24E+02	6.54E+02	7.85E+02	1.05E+03	1.83E+03

Page A-37
RDW 2-15-96

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				6.43E+05	8.04E+05	9.65E+05	1.29E+06	2.25E+06
additional frit required (equals increased glass) MT				2.57E+05	4.18E+05	5.79E+05	9.01E+05	1.87E+06
total frit required, MT				5.22E+05	6.83E+05	8.44E+05	1.17E+06	2.13E+06
glass density (MT/m^3)	2.63							
cullet packing fraction	0.7							
Waste volume (m^3)				3.49E+05	4.37E+05	5.24E+05	6.99E+05	1.22E+06
Number of 5300 m^3 vaults				66	82	99	132	231
LAW facility sizing								
Schedule, years	19							
Capacity MT/day	200							
Overall efficiency, %				46%	58%	70%	93%	162%
Required capacity MT/day (assuming 19 yrs ops, 60% OE)				154.61	193.26	231.92	309.22	541.14
Required operating duration yrs (assuming 200 MT/day, 60%				14.69	18.36	22.03	29.38	51.41
10 wt. % sodium oxide loading								
Blending factor				1	1.25	1.5	2	3.5
Mass of glass required to achieve 10				9.65E+05	1.21E+06	1.45E+06	1.93E+06	3.38E+06
Waste volume, m^3				5.24E+05	6.55E+05	7.86E+05	1.05E+06	1.83E+06
Number of 5,300 m^3 vaults				99	124	148	198	346
25 wt. % sodium oxide loading								
Blending factor				1	1.25	1.5	2	3.5
Mass of glass required to achive 25 wt % Na2O				3.86E+05	4.83E+05	5.79E+05	7.72E+05	1.35E+06
Waste Volume				2.10E+05	2.62E+05	3.15E+05	4.19E+05	7.34E+05
Number of 5,300 m^3 vaults				40	49	59	79	138

Ex Situ alternative comparison

	Waste Loading weight %	Blending Factor	Canister Count (HLW) or, Number of LAW Vaults	Canister Size Vault Size (m^3)	Overall Processing Plant Efficiency	Duration of Operations (years)	Trips to Repository 10 rail cars/train 2 can/HMPC	Trips to Repository 10 rail cars/train 4 can/HMPC
No Separations								
WHC Data Pkg.	30%	1	21400	10	36%	14	2140	
Proposed DEIS	20%	1.5	587426	0.62	60%	15	29371	14686
Intermediate Separations								
HLW								
WHC Data Pkg.	45%	1	6800	1.26	25%	14	340	170
Proposed DEIS	20%	1.5	33386	0.62	60%	12	1669	835
LAW								
WHC Data Pkg	25%	1	40	5300	36%	14		
Proposed DEIS	15%	1.25	83	5300	60%	19		
Extensive Separations								
HLW								
WHC Data Pkg.	34%	1	502	0.62	26%	14	25	13
Proposed DEIS	20%	1.5	1571	0.62	50%	14	79	39
LAW								
WHC Data Pkg.	25%	1	40	5300	36%	19		
Proposed DEIS	15%	1.25	83	5300	60%	19		

Phased 26

Page A-38
RDW 2-15-96

not sys 15 2 it col.

others at 19

SELECTIVE RETRIEVAL INVENTORY RECOVERED					
DECAYED TO 12/31/95					% OF TOTAL
Radionuclides	3WDS	3EDS	5EDS	TOTAL	DST INVENTORY
14C	0.00E+00	2.30E+03	1.49E+00	2.30E+03	99%
90Sr	3.52E+04	9.64E+06	3.82E+03	9.68E+06	87%
90Y	3.52E+04	9.64E+06	3.82E+03	9.68E+06	87%
99Tc	3.62E+03	1.51E+04	6.08E+02	1.93E+04	92%
137Cs	3.57E+06	2.08E+07	1.89E+06	2.63E+07	89%
137Ba	3.39E+06	1.98E+07	1.79E+06	2.50E+07	85%
154Eu	0.00E+00	7.43E+04	0.00E+00	7.43E+04	100%
237Np	0.00E+00	4.46E+01	0.00E+00	4.46E+01	98%
238Pu	0.00E+00	1.69E+02	0.00E+00	1.69E+02	12%
239Pu	5.79E+01	2.25E+03	5.39E+01	2.36E+03	28%
240Pu	1.45E+01	5.98E+02	1.35E+01	6.26E+02	26%
241Pu	3.18E+01	1.14E+04	2.96E+01	1.15E+04	29%
241Am	5.07E+02	4.96E+04	1.36E+02	5.03E+04	71%
Total Curies	7.03E+06	6.00E+07	3.69E+06	7.08E+07	87%

Page A-35
ABW 2-15-96

Page A-40
RDW 2-15-96

Table A.7
SST Radionuclide Inventory by Tank Group

Ra-225	1.13E-06	1.30E-06	5.22E-06	1.65E-06	2.73E-06	1.20E-05	77%
Ra-226	5.37E-08	3.24E-08	4.78E-08	2.64E-08	1.33E-08	1.74E-07	83%
Ra-228	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	
Rh-106	5.40E-05	1.10E-02	7.58E-02	8.60E-02	3.35E-01	5.08E-01	86%
Rn-219	4.57E-03	2.75E-03	8.13E-03	1.37E-03	2.34E-04	1.71E-02	85%
Rn-220	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	
Rn-222	5.37E-08	3.24E-08	4.78E-08	2.64E-08	1.33E-08	1.74E-07	83%
Ru-106	5.85E-05	7.82E-03	7.93E-02	9.63E-02	3.43E-02	2.18E-01	37%
Sb-126	7.62E+00	1.21E+01	6.24E+00	1.33E+01	2.45E+01	6.38E+01	73%
Sb-126m	5.44E+01	8.62E+01	4.46E+01	9.51E+01	1.75E+02	4.55E+02	73%
Se-79	8.02E+01	2.31E+02	4.90E+02	3.05E+01	6.15E+00	8.38E+02	92%
Sm-151	5.88E+04	9.46E+04	5.01E+04	9.46E+04	1.71E+05	4.69E+05	72%
Sn-126	5.44E+01	8.62E+01	4.46E+01	9.51E+01	1.75E+02	4.55E+02	73%
Sr-90	1.29E+06	6.84E+06	7.57E+06	4.65E+06	1.12E+07	3.16E+07	66%
Tc-99	9.67E+02	2.78E+03	5.91E+03	3.72E+02	7.43E+01	1.01E+04	92%
Th-227	4.47E-03	3.79E-03	7.88E-03	1.40E-03	1.85E-04	1.77E-02	89%
Th-228	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	
Th-229	1.13E-06	1.30E-06	5.22E-06	1.65E-06	2.73E-06	1.20E-05	77%
Th-230	7.89E-06	4.87E-06	6.85E-06	3.85E-06	2.73E-06	2.62E-05	82%
Th-231	6.93E+00	2.28E+00	6.48E+00	2.48E+00	5.72E-01	1.87E+01	91%
Th-232	1.77E-14	2.78E-14	2.93E-14	4.92E-14	4.32E-14	1.67E-13	86%
Th-234	1.65E+02	5.10E+01	1.53E+02	5.66E+01	1.37E+01	4.39E+02	91%
Tl-207	4.52E-03	3.83E-03	7.97E-03	1.42E-03	1.87E-04	1.79E-02	89%
Tl-208	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	
Tl-209	3.26E-08	5.60E-08	1.18E-07	4.44E-08	4.15E-08	2.92E-07	86%
U-233	8.15E-04	8.91E-04	5.29E-03	5.72E-04	1.08E-03	8.65E-03	80%
U-234	4.28E-02	2.82E-02	3.90E-02	2.72E-02	1.90E-02	1.56E-01	81%
U-235	6.93E+00	2.28E+00	6.48E+00	2.48E+00	5.72E-01	1.87E+01	91%
U-236	2.08E-04	3.25E-04	3.43E-04	5.76E-04	5.06E-04	1.96E-03	86%
U-237	9.22E-02	1.21E-01	1.94E-01	2.85E-01	2.23E-01	9.15E-01	87%
U-238	1.65E+02	5.10E+01	1.53E+02	5.66E+01	1.37E+01	4.39E+02	91%
Y-90	1.31E+06	6.92E+06	7.65E+06	4.69E+06	1.13E+07	3.19E+07	66%
Zr-93	3.41E+01	3.78E+02	2.23E+02	5.35E+02	1.46E+03	2.63E+03	67%
TOTAL						7.95E+07	69%

Page A-41
RDW 2-15-96

Table A.7
SST Radionuclide Inventory by Tank Group

Radionuclide	12/31/95	CURIES	SELECTIVE RETRIEVAL INVENTORY RECOVERED				% OF TOTAL
SST group	1WSS	2WSS	1ESS	2ESS	4ESS	Total	SST RAD
Number of Tanks	40	43	40	16	10	149	INVENTORY
Ac-225	1.13E-06	1.30E-06	5.22E-06	1.65E-06	2.73E-06	1.20E-05	77%
Ac-227	4.53E-03	3.84E-03	7.99E-03	1.42E-03	1.88E-04	1.80E-02	89%
Am-241	1.52E+03	7.08E+03	7.21E+03	9.51E+03	4.07E+03	2.94E+04	89%
Am-242	2.45E+00	1.52E+01	1.82E+01	1.97E+01	7.59E+00	6.31E+01	91%
Am-242m	2.46E+00	1.52E+01	1.83E+01	1.98E+01	7.62E+00	6.34E+01	91%
Am-243	8.95E-01	6.53E+00	9.23E+00	1.15E+01	2.50E+00	3.07E+01	92%
At-217	1.13E-06	1.30E-06	5.22E-06	1.65E-06	2.73E-06	1.20E-05	77%
Ba-137m	7.12E+05	3.35E+06	3.22E+06	7.44E+04	8.29E+04	7.44E+06	88%
Bi-210	1.33E-08	7.53E-09	1.23E-08	5.85E-09	1.69E-09	4.07E-08	82%
Bi-211	4.53E-03	3.84E-03	7.99E-03	1.42E-03	1.88E-04	1.80E-02	89%
Bi-212	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	
Bi-213	1.13E-06	1.30E-06	5.22E-06	1.65E-06	2.73E-06	1.20E-05	77%
Bi-214	5.37E-08	3.25E-08	4.78E-08	2.63E-08	1.33E-08	1.74E-07	83%
C-14	2.48E+02	4.49E+02	1.73E+03	2.07E+02	1.62E+02	2.80E+03	93%
Cm-242	2.03E+00	1.26E+01	1.51E+01	1.63E+01	6.29E+00	5.24E+01	91%
Cm-244	2.58E+00	2.28E+01	4.73E+01	5.29E+01	3.94E+00	1.29E+02	94%
Cm-245	1.64E-04	1.66E-03	3.61E-03	4.05E-03	3.02E-04	9.79E-03	94%
Cs-135	1.62E+01	5.73E+01	4.72E+01	8.91E-01	1.47E+00	1.23E+02	85%
Cs-137	7.52E+05	3.54E+06	3.40E+06	7.86E+04	8.76E+04	7.87E+06	88%
Fr-221	1.13E-06	1.30E-06	5.22E-06	1.65E-06	2.73E-06	1.20E-05	77%
Fr-223	6.25E-05	5.30E-05	1.10E-04	1.96E-05	2.59E-06	2.48E-04	89%
I-129	1.40E+00	4.03E+00	8.59E+00	5.66E-01	1.10E-01	1.47E+01	92%
Nb-93m	7.44E+01	4.03E+02	3.52E+02	3.79E+02	1.11E+03	2.32E+03	76%
Ni-59	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0%
Ni-63	4.79E+03	2.21E+04	4.81E+04	5.47E+04	9.07E+04	2.20E+05	80%
Np-237	6.93E+00	9.19E+00	4.61E+01	7.24E-02	3.46E-01	6.26E+01	90%
Np-238	1.13E-02	7.73E-02	8.68E-02	9.44E-02	3.31E-02	3.03E-01	91%
Np-239	8.95E-01	6.53E+00	9.23E+00	1.15E+01	2.49E+00	3.07E+01	92%
Pa-231	8.61E-03	6.58E-03	1.40E-02	3.13E-03	4.49E-04	3.27E-02	90%
Pa-233	6.93E+00	9.20E+00	4.61E+01	7.17E-02	3.46E-01	6.26E+01	90%
Pa-234	2.64E-01	8.16E-02	2.44E-01	9.06E-02	2.20E-02	7.03E-01	91%
Pa-234m	1.65E+02	5.10E+01	1.53E+02	5.66E+01	1.37E+01	4.39E+02	91%
Pb-209	1.13E-06	1.30E-06	5.22E-06	1.65E-06	2.73E-06	1.20E-05	77%
Pb-210	1.33E-08	7.53E-09	1.23E-08	5.84E-09	1.69E-09	4.07E-08	82%
Pb-211	4.53E-03	3.84E-03	7.99E-03	1.42E-03	1.88E-04	1.80E-02	89%
Pb-212	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	
Pb-214	5.37E-08	3.24E-08	4.78E-08	2.63E-08	1.33E-08	1.74E-07	83%
Pd-107	7.49E+00	2.15E+01	4.67E+01	3.50E+00	6.21E-01	7.98E+01	92%
Po-210	1.33E-08	7.54E-09	1.23E-08	5.80E-09	1.64E-09	4.06E-08	82%
Po-211	1.26E-05	7.55E-06	2.22E-05	3.49E-06	4.42E-07	4.63E-05	84%
Po-212	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	
Po-213	1.11E-06	1.28E-06	5.11E-06	1.61E-06	2.67E-06	1.18E-05	77%
Po-214	5.37E-08	3.24E-08	4.78E-08	2.63E-08	1.33E-08	1.74E-07	83%
Po-215	4.53E-03	3.84E-03	7.99E-03	1.42E-03	1.88E-04	1.80E-02	89%
Po-216	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	
Po-218	5.37E-08	3.24E-08	4.78E-08	2.63E-08	1.33E-08	1.74E-07	83%
Pu-238	1.69E+02	1.71E+02	1.62E+02	1.77E+02	1.50E+02	8.30E+02	75%
Pu-239	1.48E+03	2.17E+03	2.47E+03	4.40E+03	3.68E+03	1.42E+04	79%
Pu-240	3.09E+02	4.80E+02	6.09E+02	1.13E+03	9.18E+02	3.45E+03	80%
Pu-241	3.44E+03	3.98E+03	7.65E+03	1.23E+04	7.74E+03	3.52E+04	82%
Pu-242	9.46E-06	5.80E-05	7.93E-05	8.99E-05	3.44E-05	2.71E-04	79%
Ra-223	4.53E-03	3.84E-03	7.99E-03	1.42E-03	1.88E-04	1.80E-02	89%
Ra-224	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	

Page A-42
ADW 2-15-96

Assumptions:										
1. Phased Implementation Separations and Treatment is similar to Intermediate Separations										
except the separations for Sr, Tc, and TRU elements are taken from Extensive Separations										
2. HLW glass waste oxide loading basis to be 20 wt% waste oxides										
not counting the Na2O or SiO2 in the waste feed streatm										
3. 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										
4. LAW glass sodium oxide loading basis is to be 15 wt%										
	Input Stream			LAW			HLW			
	STREAM 1			407	437		314	344		
	solids	liquids		FRIT	GLASS		FRIT	GLASS		HLW
Volume kilo-liters										fraction
Specific Gravity										
Cs and Ba, (MCi)	5.28E+00	6.28E+01			6.81E-01			6.74E+01		0.99
Sr and Y, (MCi)	1.05E+02	2.10E+00			1.07E+00			1.06E+02		0.99
Tc, (MCi)	5.89E-03	2.61E-02			3.20E-04			3.17E-02		0.99
Am, (MCi)	9.51E-02	8.61E-03			1.04E-03			1.03E-01		0.99
Np, (MCi)	9.29E-05	1.03E-05			1.03E-06			1.02E-04		0.99
Pu-239, (MCi)	2.47E-02	1.67E-03			2.64E-04			2.61E-02		0.99
Pu-240, (MCi)	6.28E-03	4.14E-04			6.69E-05			6.63E-03		0.99
Pu-241,(MCi)	7.34E-02	1.49E-03			7.49E-04			7.41E-02		0.99
Total TRU, (MCi)	2.00E-01	1.22E-02			2.12E-03			2.10E-01		0.99
Total MCi	1.11E+02	6.49E+01			1.76E+00			1.74E+02		0.99
Total Mass Flow (MT)	1.94E+04	7.10E+05		2.81E+05	3.87E+05		1.36E+04	2.51E+04		
Total Cr, (MT)	1.32E+02	5.15E+01			1.44E+02			3.96E+01		
Total Na, (MT)	1.24E+03	6.51E+04			7.18E+04			2.33E+03		
Total Si, (MT)	5.24E+02	5.65E+00		1.07E+05	1.07E+05		5.29E+03	5.83E+03		
Total P, (MT)	7.80E+02	8.42E+02			1.35E+03			2.72E+02		
Total NO2-, (MT)	7.38E+01	9.54E+03								
Total NO3-, (MT)	1.03E+03	1.06E+05								
AG+	1.38E+00	3.28E-01								
AG2O					3.52E-01			1.48E+00		
AL+3	2.37E+03									
AL2O3				1.32E+04	1.94E+04			1.73E+03		
AL(OH)4-		4.83E+03								
AM+3	2.77E-02	2.51E-03								
AM2O3					2.76E-03			3.05E-02		
AS+5	4.98E-01	7.70E-01								
AS2O5					1.18E+00			7.66E-01		
B+3	9.94E-01	5.19E-01								
B2O3					1.67E+00		1.75E+03	1.76E+03		
BA+2	3.09E+00	7.91E-01								
BAO					8.81E-01			3.45E+00		
BE+2	7.61E-03	8.19E-02								
BEO					2.27E-01			2.16E-02		
BI+3	1.96E+02	6.76E+01								
BI2O3					7.52E+01			2.19E+02		
C14	4.53E-04	7.43E-04								
CA+2	1.33E+02	1.67E+01								
CANCRINITE	2.70E+03									
CAO				3.87E+04	3.87E+04			1.89E+02		
CD+2	7.93E+00	2.09E+00								
CDO					2.38E+00			9.06E+00		
CE+3	2.35E+02	2.37E+00								
CE2O3					2.79E+00			2.76E+02		
CL-	3.49E+00	3.11E+02								
CL2										
CO										
CO2										
CO3-2	2.25E+02	3.37E+03								
CR+3	1.32E+02									
CR2O3					2.11E+02			5.79E+01		
CR(OH)4-		1.19E+02								
CS+	9.25E-02	8.19E-01								

Proj A-43
ADW 2-15-96

CS2O					6.83E-03			9.58E-01		
CU+2	7.46E-01	1.77E-01								
CUO					2.21E-01			9.34E-01		
CUSO4										
F-	5.97E+01	1.12E+03								
F2										
FE+3	7.63E+02	1.44E+01								
FE2O3					2.06E+01			1.21E+03		
H2										
H20		5.07E+05								
H2S										
HG										
HG+2	9.00E-03	9.49E-01								
I-	2.02E+01	5.46E+02								
I2										
K+	2.10E+01	2.19E-01								
K2O					2.65E-01			2.53E+01		
KEROSENE										
LA+3	2.10E+01	2.19E-01								
LA2O3					2.58E-01			2.46E+01		
LI+	2.46E-02	5.77E-03								
LI2O					1.24E-02		5.00E+02	5.03E+02		
MG+2	1.10E+01	9.65E-01								
MGO					1.60E+00			1.88E+01		
MNO2	2.09E+02	2.17E+01			2.16E+01			2.09E+02		
MO+6	8.01E-01	4.87E+00								
MOO3					7.29E+00			1.22E+00		
N2										
NA+	7.77E+02	6.51E+04								
NA2O					9.68E+04			3.14E+03		
NH3										
NI+3	6.57E+00	4.07E+00								
NI2FECN6	5.00E+02									
NI2O3					5.72E+00			9.27E+00		
NIO					1.50E-02			2.27E+02		
NO										
NO2										
NO2-	7.38E+01	9.54E+03								
NO3-	1.03E+03	1.06E+05								
NP+4	1.32E-01	1.46E-02								
NPO2					1.66E-02			1.50E-01		
O2										
OH-	5.00E+03	6.44E+03								
PB+4	3.28E+00	1.96E+00								
PBO2					2.26E+00			3.79E+00		
PO4-3	2.39E+03	2.58E+03								
P2O5					3.09E+03			6.22E+02		
P2O5:24W	5.21E-01									
PU+4	4.27E-01	2.88E-02								
PUO2					3.26E-02			4.84E-01		
S										
SI+4	7.90E+01	5.65E+00								
SIO2				2.29E+05	2.29E+05		1.13E+04	1.25E+04		
SO2										
SO4-2	3.97E+01	2.01E+03								
SR+2	3.64E+01	3.75E-01								
SRO					4.00E-01			4.29E+01		
TCO2										
TCO4-	5.68E-01	2.52E+00								
TC2O7					2.94E-02			2.91E+00		
TOC	1.16E+02	1.42E+03								
UO2+2	1.58E+03	8.52E+01								
UO3					9.02E+01			1.67E+03		
V+5	1.88E-01	6.20E-02								
V2O5					1.11E-01			3.35E-01		
W+6		7.47E-01								
WO2					2.91E-05			4.41E-01		

Page A-44
RDW 2-15-96

WO3					9.40E-01			2.06E-03		
ZN+2	9.45E-01	3.59E+00								
ZNO					4.46E+00			1.19E+00		
ZR+4	2.77E+02	4.48E-01								
ZRO2					6.49E-01			6.90E+02		
ZRO2:2H2	4.09E+02	2.15E+01								
WHC Data Package Basis:										
Mass LAW waste oxides					106542.3696					
LAW waste loading (waste oxide)					28%					
LAW waste loading (sodium oxide)					25%					
Mass HLW waste oxides								7.26E+03		
HLW waste loading (waste oxides)								29%		
HLW										
20 wt. % waste oxide loading										
Blending factor				1	1.25	1.5	2	3.5		
Mass of glass required to achieve 20% wo loading, MT				36304.93905	45381.17381	54457.40858	72609.8781	127067.2867		
additional frit required (equals increased glass) MT				1.12E+04	2.03E+04	2.94E+04	4.75E+04	1.02E+05		
total frit required, MT				2.48E+04	3.39E+04	4.30E+04	6.11E+04	1.16E+05		
glass density (MT/m^3)	2.63									
cullet packing fraction	0.7	(LAW only)								
Waste volume (m^3)				1.38E+04	1.73E+04	2.07E+04	2.76E+04	4.83E+04		
Canister Volume (m^3)	0.62									
Number of Canisters (1x)				2.23E+04	2.78E+04	3.34E+04	4.45E+04	7.79E+04		
Nu. of Canisters /HMPC	4									
Number of HMPCs				5.57E+03	6.96E+03	8.35E+03	1.11E+04	1.95E+04		
Number of trips @ 10 HMPCs /trip				557	696	835	1113	1948		
Glass formulation:										
(ref Ext. Sep Data Pkg.)	acceptable range			1	1.25	1.5	2	3.5		
SiO2	42 to 57 wt %			60.08%	64.68%	67.75%	71.59%	76.52%		
B2O3	5 to 20 wt %			8.82%	9.63%	10.17%	10.84%	11.71%		
Na20	5 to 20 wt %			8.65%	6.92%	5.77%	4.32%	2.47%		
Li2O	1 to 7 wt %			2.52%	2.75%	2.91%	3.10%	3.35%		
Fe2O3	2 to 15 wt %			3.33%	0.00%	0.00%	0.00%	0.00%		
CaO	< or= 10 wt %			0.52%	0.42%	0.35%	0.26%	0.15%		
MgO	< or = 8 wt %			0.05%	0.04%	0.03%	0.03%	0.01%		
Al2O3	< or = 15 wt %			4.77%	3.81%	3.18%	2.38%	1.36%		
ZrO2	< or = 13 wt %			1.90%	1.52%	1.27%	0.95%	0.54%		
Cr2O3	< or = 0.5 wt %			0.16%	0.13%	0.11%	0.08%	0.05%		
P2O5	< or = 3 wt %			1.71%	1.37%	1.14%	0.86%	0.49%		
SO3	< or = 0.5 wt %									
HLW Facility Sizing										
Schedule	~~14 yrs~~									
Capacity MT/day	~~20~~			not valid for Phased Implementation taken from Ind Sep						
Overall efficiency, %				~~36%~~	~~44%~~	~~53%~~	~~71%~~	~~124%~~		
Required capacity MT/day (assuming 14 yrs ops, 60% OE)				11.84	14.80	~~17.76~~	~~23.68~~	41.44		
Required operating duration yrs (assuming 20 MT/day, 60% OE)					10.36	12.43	16.58	~~29.01~~		
15 wt % waste oxide loading										
Mass of glass required to achieve 15% wo loading MT				4.84E+04	6.05E+04	7.26E+04	9.68E+04	1.69E+05		
Volume (m^3)				1.84E+04	2.30E+04	2.76E+04	3.68E+04	6.44E+04		
Number of Canisters (1x)				2.97E+04	3.71E+04	4.45E+04	5.94E+04	1.04E+05		
40 wt % waste oxide loading										
Mass of glass required to achieve 40% wo loading MT				1.82E+04	2.27E+04	2.72E+04	3.63E+04	6.35E+04		
Volume (m^3) as cullet				6.90E+03	8.63E+03	1.04E+04	1.38E+04	2.42E+04		
Number of Canisters (1x)				1.11E+04	1.39E+04	1.67E+04	2.23E+04	3.90E+04		

P-45
RAW 2-15-96

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				6.45E+05	8.07E+05	9.68E+05	1.29E+06	2.26E+06		
additional frit required (equals increased glass) MT				3.64E+05	5.26E+05	6.87E+05	1.01E+06	1.98E+06		
total frit required, MT				6.45E+05	8.07E+05	9.68E+05	1.29E+06	2.26E+06		
glass density (MT/m^3)	2.63									
cullet packing fraction	0.7									
Waste volume (m^3)				3.51E+05	4.38E+05	5.26E+05	7.01E+05	1.23E+06		
Number of 5300 m^3 vaults				66	83	99	132	231		
LAW facility sizing										
Schedule, years	14									
Capacity MT/day	200									
Overall efficiency, %				63%	79%	95%	126%	221%		
Required capacity MT/day (assuming 14 yrs ops, 60% OE)				210.48	263.10	315.72	420.96	736.68		
Required operating duration yrs (assuming 200 MT/day, 60% OE)				14.73	18.42	22.10	29.47	51.57		
10 wt. % sodium oxide loading										
Blending factor				1			2	3.5		
Mass of glass required to achieve 10				968000			1936000	3388000		
Waste volume, m^3				525801.195			1051602.39	1840304.183		
Number of 5,300 m^3 vaults				99			198	347		
25 wt. % sodium oxide loading										
Blending factor				1			2	3.5		
Mass of glass required to achive 25 wt % Na2O				387200			774400	1355200		
Waste Volume				210320.478			420640.956	736121.673		
Number of 5,300 m^3 vaults				40			79	139		

Page A-46
RDWPg 1/3 2-15-96

Phased IMPLEMENTATION

TPA LIMITS:

Complete HLW Vit. 12/31/2028
Complete LAW Vit 12/31/2024

Phase 1: LAW Processing Begins 2002 Ends 2012
HLW Processing Begins 2002 - 2008

Phase 2 LAW 2011 - 2024 END DATES ARE
HLW 2011 - 2028 NEW TPA MILESTONES.

ASSUMPTIONS: 1) The Phased Implementation Alt waste loading is the same as Intermediate Separations. Therefore the mass of HLW & LAW Produced would be the SAME over the total Phased Implementation alternative.

2. Phase 1 Consists of 2 Plants making 20 mt/day LAW and 1 plant at 1 mt/day HLW

3. The Operating efficiency during phase 1 is 60%.

4. Following Phase 1 the LAW demonstration plants would be upgraded during a 1 year period to double the through put from 20 mt/day/plant to 40 mt/day/plant.

5. The Operating Efficiency for Phase 2 operations will be 85%.

6. The Phase 1 HLW Plant would not operate during Phase 2.

Page A-47
RDW 2-15-96
Pg 2/3

FROM the Intermediate Separations Alternative

Mass of LAW = 8.07E+05 mt

Mass of HLW = 54400 mt

Phase 1 Waste Processed

LAW = 2 x 20 mt/day x 365 day/yr x 0.6(OE) x 10 yr

= 87600 mt

HLW = 1 x 1 mt/day x 365 day/yr x 0.6(OE) x 10 yr

= 2190 1314

Therefore during Phase 2 must process a total of

LAW = 8.07E5 - 87600 = 719400 mt LAW

HLW = 54400 - 2190 = 52,210 mt HLW.

≈ 53080

Table 5.1.1 Key Geology and Soil Impact Parameters

Alternatives		Mineral Resources m³ (yd³)			Soil Disturbance [1] ha (ac)	
Tank Waste		Sand and Gravel	Silt	Rip rap	Temporary	Permanent
No Action	Remediation	None Required	None Required	None Required	0	0
	Total Project [2]	None Required	None Required	None Required	0	17 (42)
Long-Term Management	Remediation	None Required	None Required	None Required	50 (120)	8 (20)
	Total Project	None Required	None Required	None Required	50 (120)	25 (62)
In Situ Fill and Cap	Remediation	690,000 (912,000)	None Required	None Required	26 (64)	17 (42)
	Total Project	1.10E+06 (1.5E+06)	380,000 (500,000)	640,000 (840,000)	97 (240)	25 (62)
In Situ Vitrification	Remediation	540,000 (714,000)	None Required	None Required	110 (270)	17 (42)
	Total Project	955,000 (1.3E+06)	380,000 (500,000)	630,000 (840,000)	180 (440)	25 (62)
Ex Situ Intermediate Separations	Remediation	317,000 (419,000)	None Required	None Required	96 (240)	30 (74)
	Total Project	1.7E+06 (2.2E+06)	530,000 (700,000)	800,000 (1.01E+06)	210 (520)	40 (100)
Ex Situ No Separations	Remediation	123,000 (163,000)	None Required	None Required	68 (170)	19 (47)
	Total Project	1.3E+06 (1.7E+06)	380,000 (500,000)	640,000 (840,000)	160 (400)	27 (67)
Ex Situ Extensive Separations	Remediation	372,000 (492,000)	None Required	None Required	97 (240)	30 (74)
	Total Project	1.7E+06 (2.3E+06)	540,000 (710,000)	810,000 (1.1E+06)	220 (540)	40 (100)
Ex Situ/In Situ Combination	Remediation	410,000 (542,000)	None Required	None Required	90 (220)	29 (72)
	Total Project	1.3E+06 (1.8E+06)	440,000 (580,000)	700,000 (930,000)	180 (440)	37 (91)
Phased Implementation (Phase 1)	Remediation	12,000 (16,900)	None Required	None Required	33 (82)	0
	Total Project	1.2E+04 (1.6E+04)	None Required	None Required	33 (82)	0
Phased Implementation (Total Alternative)	Remediation	159,000 (210,000)	None Required	None Required	120 (300)	33 (82)
	Total Project	1.5E+06 (2.0E+06)	526,000 (695,000)	805,000 (1.06E+06)	240 (590)	43 (110)

Page A-48
Rev 2-15-96

Table 5.1.1 Key Geology and Soil Impact Parameters (cont'd)

Alternatives	Mineral Resources m^3 (yd^3)			Soil Disturbance [1] ha (ac)	
Cesium and Strontium Capsules	Sand and Gravel	Silt	Rip rap	Temporary	Permanent
No Action	None Required	None Required	None Required	0	0.6 (1.5)
Onsite Disposal	None Required	None Required	None Required	4 (10)	1.8 (4.5)
Overpack and Ship	None Required	None Required	None Required	2 (5)	0
Vitrify with Tank Waste	None Required	None Required	None Required	1 (2)	0

Notes:
[1] These estimates are based on closure of the tank farms by filling tanks and covering them with a Hanford Barrier. Numbers have been rounded to two significant digits.
[2] Total project estimates include remediation and closure as landfill.

Page A-50
RDW 2-15-96

TWRS EIS
CALCULATION COVER SHEET

DISCIPLINE & TITLE ENGINEERING - Calculation of DATA Revisions for DRAFT TWR-EIS

ORIGINATOR Ronald D. WEED DATE 2-15-96

REVISION NO. 0

OBJECTIVE Calculate DATA FOR TRANSPORTATION Evaluations BASED ON REVISED FROM table B.10.0.3.

METHODOLOGY applied INPUT data to obtain the new values FOR inclusion IN THE TRANSPORTATION tables and Accident ANALYSIS WORK within OTHERS SECTIONS of THE TWRS-EIS.

ASSUMPTIONS See Calculation. sheet 1 of contains a listing of the tables and calculations covered within this Calculation.

(Continue on another sheet if necessary)

Ronald D. Weed
SIGNATURE

CHECKED CH 1/22/96.

CALCULATION & RESULTS ATTACHED

cover sheet - 1
pages - 37
appended material pages - B-1 through B-50

JACOBS\FORMS\CALCVR.SHT

JACOBS ENGINEERING GROUP INC.

DATE 2-15-96 SUBJECT SHEET NO. 1 of 37

BY RDW CHKD. JOB NO. 01K 47/01

Items and areas covered within this calculation

1. Input for Calculation of number trips by Truck or number of Cars by train required. 03

A Table I 03

1. Ex Situ Intermediate Separations
2. Ex Situ no separations - vitrification
3. Ex Situ no separations - Calcination
4 Ex Situ Extensive Separations
5 Ex Situ Insitu Combination
6 Phased Implementation - phase 2

B Table II - Number trips or Cars from A above 05

2. Calculate trip combinations for Mike Harkin's tables.

A. Ex Situ Intermediate Separations alternative 07
B. Ex Situ no Separations alternative - Vitrification 08
C. Ex Situ no Separations alternative - Calcination 10
D. Ex Situ Extensive Separations alternative 11
E. Ex Situ / Insitu Combination alternative 12
F. Phased Implementation - phase I 14
G. Phased Implementation - Phase II 14

3. Sensitivity Evaluation - Intermediate Separations 16

A table III Input for Calcution of table IV 17
B table IV 19

1. HLW - 40wt% and 1.5; LAW - 25wt% and 1.25
2. HLW - 20wt% and 1.5; LAW = 15wt% and 1.25
3. HLW - 15wt% and 1.5; LAW - 10wt% and 1.25

4. Calculate Table entrys for the trip evaluation tables 20

A Case 1 - HLW at 40% and LAW at 25% 20
B. Case 2 - HLW at 20% and LAW at 15% 22
C Case 3 - HLW at 15% and LAW at 10% 23

5. Calculate Transportation Summary input for table B.10.0.7 25

A. Ex Situ Intermediate Separations 25
B. Ex Situ No Separations - vitrification 26
C. Ex Situ No Separations - Calcination 27

FORM 91-005-1 (4/81)

JE JACOBS ENGINEERING GROUP INC.

DATE 2-15-96 SUBJECT SHEET NO. 2 of 37

BY RDW CHKD. JOB NO. 01K47101

D. Ex Situ Extensive separations alternative 28
E. Ex situ/In Situ Combination alternative 29
F. Phased Implementation alternative - Phase II 31
G. Compare values of Table B.10.0.7 with data in traffic analysis input tables 32

6. Develop basis for understanding of train trips shown in Table 5.10.2 34

JACOBS ENGINEERING GROUP INC.

DATE 2-15-96 SUBJECT SHEET NO. 3 of 37

BY RDW CHKD. JOB NO. 01K 47101

The object of this calculation is to prepare the data from Table B.10.0.3 recalculation and to obtain the number of trips to be made in order to provide the new increased quantities of material for the various alternatives so that an accident analysis can be performed.

table I

		1	2	3	4	5	6
1.	Gasoline (m^3)	54.6	NA	NA	54.6	20	75.5
	(gal)	14414.4	NA	NA	14414.4	5280	19932
2.	Diesel (m^3)	3.51E+03	1.4E+04	6.044E+04	2.3E+04	5.05E+03	4.78E+03
	(gal)	9.27E+05	3.7E+06	1.6E+07	6.07E+06	1.333E+06	1.262E+06
3.	Kerosene (m^3)	4.06E+04	1.06E+05	NA	1.404E+05	2.03E+04	2.1E+04
	(gal)	1.072E+07	2.80E+07	NA	3.71E+07	5.36E+06	5.544E+06
4.	Concrete (m^3)	2.67E+05	1.66E+05	2.23E+04	2.58E+05	9.9E+04	1.98E+05
	(yds^3)	3.5E+05	2.18E+05	2.92E+04	3.38E+05	1.297E+05	2.59E+05
	(Tons)	4.7E+05	2.92E+05	3.93E+04	4.54E+05	1.74E+05	3.49E+05
4a	Cement (Tons)	4.7E+05	2.92E+05	3.93E+04	4.54E+05	1.74E+05	3.49E+05
4b	Sand (yds^3)	3.5E+04	2.18E+05	2.92E+04	3.38E+05	1.297E+05	2.59E+05
4c	Gravel (yds^3)	3.5E+05	2.18E+05	2.92E+04	3.38E+05	1.297E+05	2.59E+05
5*	Concrete (m^3)	3.77E+05	7.13E+06	9.52E+05	8.11E+03	1.88E+05	3.77E+05
	Prefab Shapes (Tons)	6.64E+05	1.255E+07	1.68E+06	1.43E+04	3.31E+05	6.64E+05
	(Number of units)	6645	125600	16797	143	3222	6645
6.	Carbon Steel (m^3)	4.951E+04	5.97E+03	7.56E+02	3.0E+04	1.1E+04	2.24E+04
	Rebar (Tons)	5.45E+04	6.57E+03	1.652E+03	3.3E+04	1.21E+04	2.464E+04
7	Carbon Steel (m^3)	1.26E+05	NA	NA	1.26E+05	5.35E+04	1.06E+05
	Prefab Shapes (Tons)	1.4E+05	NA	NA	1.39E+05	5.89E+04	1.17E+05
8	Stainless Steel (m^3)	4.41E+04	4.4E+05	8.13E+04	1.2E+03	1.25E+04	2.51E+04
	Prefab Shapes (Tons)	4.85E+04	4.84E+05	8.94E+04	1.32E+03	1.375E+04	2.76E+04
9	Glass Formers (m^3)	2.1E+05	2.18E+05	NA	5.33E+05	1.03E+05	1.96E+05
	(Tons)	2.31E+05	2.4E+05	NA	5.9E+05	1.133E+05	2.2E+05
	(yds)	2.75E+05	2.86E+05	NA	7.0E+05	1.35E+05	2.57E+05
9a	(yds) Sand (0.816) (0.1837)	2.244E+05	2.334E+05	NA	5.712E+05	1.102E+05	2.1E+05
9b	(yds) other material	42435	44088	NA	108383	20814	40414
5*	Concrete (yds^3)	4.94E+05	9.58E+06	1.21E+06	1.06E+04	2.46E+05	4.94E+05
5a*	Cement (Tons)	6.64E+05	1.255E+07	1.68E+06	1.43E+04	3.64E+05	6.64E+05
5b	Sand (yds^3)	4.94E+05	9.58E+06	1.21E+06	1.06E+04	2.46E+05	4.94E+05
5c	Gravel (yds^3)	4.94E+05	9.58E+06	1.21E+06	1.06E+04	2.46E+05	4.94E+05

FORM 91-005-1 (4/81)

JACOBS ENGINEERING GROUP INC.

DATE 2-15-96 SUBJECT SHEET NO. 4 of 37

BY RDW CHKD. JOB NO. 01427101

Continuation from page 3

	1	2	3	4	5	6
10 Process (mT)	5.15E+05	3.56E+05	3.06E+05	1.32E+06	2.59E+05	4.75E+05
chemicals (tons)	5.67E+05	3.92E+05	3.37E+05	1.45E+06	2.85E+05	5.23E+05
a oxygen (mT)	3.25E+05	3.46E+05	2.65E+05	4.63E+05	1.63E+05	3.25E+05
(tons)	3.58E+05	3.81E+05	2.92E+05	5.1E+05	1.79E+05	3.58E+05
11 Sulfur cement						
a Sulfur (mT)	9.1E+04	NA	NA	2.55E+05	4.6E+04	8.4E+04
tons	1.001E+05	NA	NA	2.81E+05	5.1E+04	9.24E+04
b Dicyclopentadiene						
(DCPD) (mT)	2.38E+03	NA	NA	6.74E+03	1.19E+03	2.38E+03
(tons)	2.62E+03	NA	NA	7.414E+03	1.31E+03	2.62E+03
c Dijoxane, (DCP) (mT)	2.38E+03	NA	NA	6.74E+03	1.19E+03	2.38E+03
(tons)	2.62E+03	NA	NA	7.414E+03	1.31E+03	2.62E+03

alternative columns

1. Exsitu Intermediate Separations
2. Exsitu no Separations - Vitrification
3. Exsitu no Separations - Calcination
4. Exsitu Extensive Separations
5. Exsitu/Insitu combination
6. Phased Implementation - Phase 2.

Conversion factors used

gallons = (m^3) (264)
Cubic yds = (m^3) (1.31)
Tons = (m Tons) 1.1)
tons = (m^3) (1.76)

With the information in Table I above the information for Table II is generated using certain assumptions with respect to shipment origin and mode of transportation which is either by rail car or by truck and with respect to trucks can vary by cubic yards, gallons and/or tonnage. This is identified for each material in determining the number of trips to the 200E/200W area of the Hanford Nuclear site.

FORM 91-005-1 (4/81)

JACOBS ENGINEERING GROUP INC.

DATE 2-15-96 SUBJECT SHEET NO. 5 of 37

BY RDW CHKD. JOB NO. 01K47101

Table II Number of trips required (Continued on sheet 6 for Columns 5 & 6

	Material item	Size & Mode of Transport	Point of Origin	1	2	3	4
1	Gasoline	5000 gallons tank truck	Tri cities	3	NA	NA	3
2	Diesel fuel	5000 gallon tank truck	Tri cities	186	740	3200	1214
3	Kerosene	5000 gallon tank truck	Tri cities	2144	5600	NA	7420
4	Concrete	6 cubic yard Cement truck	Site Concrete Plant	58,334	36,334	4867	56334
	a Cement	25 tons/load TRUCK	SEATTLE PORTLAND	18800	11680	1572	18160
	b Sand	6 cu yd. dump TRUCK	PIT-30	58334	36334	4867	56334
	c Gravel	6 cu yd. dump TRUCK	PIT-30	58334	36334	4867	56334
5	Concrete Prefab Shapes	Special multi axel truck & Lowboy.	100 tons each unit. Tri cities	6645	125,600	16797	143
	Concrete shapes	Cast on site with	Concrete Plant source				
	a Concrete	6 cu yd Cement truck	Site Concrete Plant.	82334	1596667	201667	1767
	b Cement	25 TONS/Load TRUCK	SEATTLE PORTLAND	26560	502000	67200	572
	c Sand	6 cu yd dump truck	Pit-30	82334	1596667	201667	1767
	d Gravel	6 cu yd dump Truck	Pit-30	82334	1596667	201667	1767
6.	Carbon steel rebar	20 ton TRUCK	SEATTLE PORTLAND	2725	329	53	1650
7.	Carbon steel Prefab shapes 4.2 m³ [illegible]	20 ton TRUCK	Seattle Portland	7000	NA	NA	6950
8.	Stainless steel prefab 0.62 m³ cylinder	20 ton truck	Seattle Portland	2425	24200	4470	66
9.	Glass formers	20 ton TRUCK	—	11550	12000	NA	29500
	a Sand (0.816)	16 cu yd dump truck	Tri cities	1403	14588	NA	35700
	b Other material (0.1837)	20 ton TRUCK	Seattle Portland	2122	2205	NA	5420
10	Process chemicals	20 ton TRUCK	Seattle Portland	28350	19600	16850	72500
	a Oxygen	25 ton tank TRUCK.	Seattle Portland	14320	15240	11680	20400
11.	Sulfur Cement						
	a Sulfur	45,000 lb/Load tank TRUCK	SEATTLE PORTLAND	4449	NA	NA	12489
	b Dicyclopentadiene	45 ton Rail Tank Car	SEATTLE PORTLAND	59	NA	NA	165
	c. Oligomer	20 ton TRUCK	SEATTLE PORTLAND	131	NA	NA	371

FORM 91-005-1 (4/81)

JACOBS ENGINEERING GROUP INC.

DATE 2-15-96 SUBJECT SHEET NO. 6 of 37

BY RDW CHKD. JOB NO. 01R47101

	5	6
1	2	4
2	267	253
3	1072	1109
4	21617	43167
a	6960	13960
b	21617	43167
c	21617	43167
5.		
	3222	6645
a	41000	82334
b	14560	26560
c	41000	82334
d	41000	82334
6.	605	1232
7	2945	5850
8	688	1380
9.	5665	11000
a	6888	13125
b	1041	2021
10	14250	26150
a	7160	14320
11		
a	2267	4107
b	30	59
c	66	131

alternative columns

1. Ex Situ Intermediate Separations
2. Ex Situ no Separations - Vitrification
3. Ex Situ no Separations - Calcination
4. Ex Situ Extensive Separations
5. Ex Situ / In Situ Combination
6. Phased Implementation - Phase 2

FORM 91-005-1 (4/81)

JACOBS ENGINEERING GROUP INC.

DATE 2-15-96 SUBJECT SHEET NO. 7 of 37

BY P.D.W. CHKD. JOB NO. 01K47101

Calculate the number of various trip combinations for the different alternatives to fill in the changed values for the accident analyses tables for Mr. Mike Harker.

A. Ex Situ Intermediate separations alternative

1. On Site Borrow Trips

From table II above item 4

sand = 58 334 trips

gravel = 58 334 trips

total = 116 668 = 1.17 E+5

Σ for table entry = (1.17 E+05) + (5.20 E+04)

= 1.69 E+05 trips

2. offsite Concrete truck

Portland cement = 18,800 trips

Concrete pref fab shapes = 6 645 trips

Σ = 25 445

Σ for table entry = (2.54 E+04) + (2.90 E+04)

= 5.44 E+04

3. offsite truck steel

Carbon Steel Rebar = 2725

Carbon Steel shapes = 7000

Stainless Steel shapes = 2 425

Σ = 1.2150 E+04

Σ for table entry = (1.22 E+04) + (9.50 E+03)

= 2.17 E+04

4. offsite Miscellaneous Trucked materials in trips/year

Sosolin = 3

Diesel fuel = 186

Kerosene = 2144

Σ = 2333 Trips/yr = 2333/19 = 123

Σ for table entry = 5200 + 123

= 5.3 E+03 trips/yr

FORM 91-005-1 (4/81)

5 processing offsite Truck trips/yr. period = 19 years.

Glassforming chemicals = 2122

Sulfur = 4449

oxygen = 14,320

oligomer = 131

Σ = 21022 trips/yr = 1107

Σ for Table entry = (1107) + (23) = 1130

= 1.13 E+03

6. processing offsite truck trips per year

sand miscellaneous = 1403

trips/yr = 74

Σ for Table entry = (74) + (5.200)

= 5.3 E+03

7. offsite rail glassforming chemicals

DCPD = 59

trips/yr = 59/19 = 4

Σ for Table entry = (260) + (4) = 264

= 2.64 E+02

8. trips to Yucca mountain = 9.35 E+02

B. C. Site Mo Separations alternative - vitrification

1. on site Borrow Pits

Sand = 36334

gravel = 36334

total = 72668

Σ for Table entry = (7.27 E+04) + (8.02 E+04)

= 9.29 E+04

JACOBS ENGINEERING GROUP INC.

DATE 2-15-96 SUBJECT SHEET NO. 9 of 37

BY RDW CHKD. JOB NO. 01K 47101

2 offsite truck tricities

Concrete prefab shapes = 125,600

Diesel fuel = 740

Kerosene 5600

total = 13 1940

= 1.32 E+05

Σ for table entry = (1.32 E+05) + (1.3 E+04)

= 1.45 E+05 ←

3 offsite truck portland Seattle

Cement = 11680

Steel rebar = 329

Stainless steel shapes = 24,200

Σ = 36209 = 3.6 E+04

Σ for table entry = (3.6 E+04) + (5.00 E+03)

= 4.1 E+04 ←

4. processing offsite truck portland Seattle

other material = 2205

oxygen = 15,240 trips/yr period = 15

total = 17445

trips/yr = 1163

Σ for table entry = (1163) + (50)

= 1.21 E+03 ←

5. processing miscellaneous trips/year

Sand = 14588

Σ = 14588 trips/yr = 973

Σ for table entry = (973) + (5200)

= 6173 = 6.2 E+03 ←

6. offsite Rail = no change

7. trips to yucca mountain = 1.47 E+04

FORM 91-005-1 (4/81)

JACOBS ENGINEERING GROUP INC.

DATE 2-15-96 SUBJECT SHEET NO. 10 of 37

BY RDW CHKD. JOB NO. 01K47101

C. In situ no separations alternative - Calculation

1. onsite truck Borrow site Trips

Sand = 4867
Gravel = 4867
total = 9734

Σ for Table entry = (9734) + (20200)
= 29934
= 3.0 E+04

2. offsite truck tri cities

Concrete prefab shapes = 16797
Diesel fuel = 3200
total = 19997 = 2.0 E+04

Σ for Table entry = (2.0E+04) + (1.30E+04)
= 3.3E+04

3. offsite truck portland/Seattle

Cement = 1572
Steel rebar = 53
Stainless steel shapes = 4470
total = 6095

Σ for table Entry = (6.1E+03) + (5.00E+03)
= 1.11E+04

4. Processing offsite truck trips/year

portland/Seattle period = 15 yrs.
oxygen = 11680
trips/yr = 779

Σ for Table entry = (779) + (50)
= 8.29 E+02

5. offsite rail - no change.

6. offsite rail - Yucca mountain = 2.71E+03

FORM 91-005-1 (4/81)

JACOBS ENGINEERING GROUP INC.

DATE 2-15-96 SUBJECT SHEET NO. 11 of 38

BY RDW CHKD. JOB NO. 01K 47101

D. Ex Situ Extensive separations alternative

1. onsite truck Borrow site Trips

Sand = 56334
Gravel = 56334
total = 112,668

Σ for Table entry = (1.13 E+05) + (6.10 E+04)
= 1.74 E+05

2. offsite truck tricities trips

Gasoline = 3
diesel fuel = 1214
Concrete prefab shape = 143
Kerosene = 7420
total = 8780

Σ for Table entry = (8780) + (27000)
= 35780
= 3.58 E+04

3 offsite truck portland/Sealble trips

cement = 18160
Carbon Steel rebar = 1650
Carbon Steel shapes = 6950
Stainless steel Shapes = 66
total = 26826

Σ for Table entry = (26826) + (11000)
= 37826
= 3.78 E+04

4. Processing offsite truck glassformers/chemicals

oxygen = 20400
other materials = 5420 Trips/year period = 19
sulfur = 12489
DCP = 371
total = 38680 Trips/yr = 2036

FORM 91-005-1 (4/81)

E for Table entry = (2036) + (513)
= 2.55E+03

5. processing miscellaneous
Sand = 35700
Trips/yr = 1879

E for Table entry = (1879) + (5200)
= 7.1E+03

6. offsite Rail
Dcpd = 165
Trips/yr = 165/19 = 9

E for table entry = (9) + (637)
= 6.46 E+02

7. offsite Rail - yucca mountain = 3.9 E+01

E. Ex Situ / Insitu Combination Alternative

1. onsite truck Borrow site Trips
Sand = 21617
Gravel = 21617
Total = 43234

E for Table entry = (4.32E+04) + (2.60E+04)
= 6.92 E+04

2. offsite Concrete Truck
Portland cement = 6960
Concrete Prf Shapes = 3222
total = 10182

E for Table entry = (10182) + (14500)
= 2.47E+04

3. offsite steel Truck

Carbon Steel Rebar = 605
Carbon Steel Shapes = 2945
Stainless Steel Shapes = 688
Total = 4238

Σ for table Entry = (4238) + (4750)
= 8988 = 9.0 E+03

4. offsite truck miscellaneous trips/yr

Gasoline = 2 period = 19
Diesel Fuel = 267
Kerosene = 1072
total = 1341 trips/yr = 71

Σ for table entry = (71) + (2600)
= 2.7 E+03

5. processing offsite trucks trips/yr.
ylare former / Chemicals

oxygen = 7160 period = 19
other materials = 1041
Sulfur = 2267
oligomers = 66
Total = 10534 trips/yr = 555

Σ for Table entry = (555) + (11.5)
= 5.67 E+02

6. processing offsite truck miscellaneous trips/yr.

Sand = 6888
trips/yr = 363

Σ for Table entry = (363) + (2600)
= 2.96 E+03

7 offsite Rail glassforms Chunks

D=OD = 30 trips/yr = 2

Σ for table entry = (2) + (130)

= 1.32 E+02

8. offsite rail trips to Yucca mountain = 418

F. Phased Implementation phase 1 - no change

G. phased Implementation - phase II

1. on Site Truck Borrow Site Trips

Sand = 43167

Gravel = 43167

total = 86334

Σ for Table entry = (86334) + (28000)

= 114334 = 1.14 E+05

2. offsite Concrete truck

Concrete prefab Shapes = 6645

Portland Cement = 13960

total = 20605

Σ for table entry = (20605) + (15700)

= 36305 = 3.63 E+04

3. offsite truck steel

Carbon Steel rebar = 1232

Carbon Steel Shapes = 5850

Stainless steel Shapes = 1380

total = 8462

Σ for Table entry = (8462) + (1210)

= 9672 = 9.67 E+03

JACOBS ENGINEERING GROUP INC.

DATE 2-15-96 SUBJECT SHEET NO. 15 of 37

BY RDW CHKD. JOB NO. 01K47101

4. Offsite Truck Miscellaneous

Gasoline = 4
Diesel Fuel = 253
Kerosene = 1109
total = 1366

Σ for table entry = (1366) + (29200)
= 30566 = 3.06 E+04

5. Processing offsite Truck Glass former Chemicals

oxygen = 14320
other materials = 2021
Sulfur = 4107
oligomer = 131
total = 20579

Σ for table entry = (20579) + (3720)
= 24299 = 2.43 E+04

6. processing offsite Truck process material

Sand = 11000

Σ for table ENTRY = (11000) + (3570)
= 14570 = 1.46 E+04

7. offsite rail glass former chemicals.

DCPD = Dicyclopentadiene
= 59

Σ for Table ENTRY = (59) + (2750)
= 2.81 E+03.

8. offsite Rail - Yucca mountain = 8.35 E+02

FORM 91-005-1 (4/81)

To provide information on the sensitivity of the process to changes in the sodium or waste oxide loading of the glass and the use of the 1.5 and 1.25 blending factors respectively for HLW and LAW the following calculations have been assembled and performed for comparative purposes. The Intermediate Separations alternative has been selected for this evaluation.

1. This case is defined as LAW - 25 wt % Na_2O loading of the glass waste with a blending factor of 1.25 applied; and HLW - 40 wt % waste oxides loading in the waste glass with a blending factor of 1.5 applied.

2. This case is defined as LAW - 15 wt % Na_2O loading of the glass waste with a blending factor of 1.25 applied; and HLW - 20 wt % waste oxides loading of the waste glass with a blending factor of 1.5 applied.

3. This case is defined as LAW - 10 wt % Na_2O loading of the glass waste with a blending factor of 1.25 applied; and HLW - 15 wt % waste oxides loading of the waste glass with a blending factor of 1.5 applied.

The items listed in Table I on page 2 and 3 above have been computed and are tabulated in the following Table, Table III for the sensitivity evaluation using the three cases mentioned and defined above on page 16.

JACOBS ENGINEERING GROUP INC.

DATE 2-15-96 SUBJECT SHEET NO. 17 of 37

BY PDel CHKD. JOB NO. 01K4710/

Table III

Item	units	Case 1	Case 2	Case 3
1 Gasoline	m^3	9.1	54.6	77.3
	gal	2402	14414	20407
2 Diesel Fuel	m^3	2.23E+03	7.53E+03	1.39E+04
	gal	588720	1987920	3669600
3 Kerosene	m^3	7.2E+04	9.86E+04	1.08E+05
	gal	19008000	26030400	28512000
4 Concrete	m^3	4.63E+04	1.98E+05	3.79E+05
	yds^3	6.07E+04	2.594E+05	4.97E+05
	Tons	8.15E+04	3.49E+05	6.67E+05
a Cement	Tons	81500	349000	667000
b sand	yds^3	60700	259000	497000
c gravel	yds^3	60700	259000	497000
5 Concrete prefab. Shapes	m^3	1.4E+05	3.77E+05	5.34E+05
	Tons	2.464E+05	6.64E+05	9.4E+05
	Number of units	2470	6645	9420
	yds^3	1.834E+05	4.94E+05	7.0E+05
a Cement	Tons	246400	664000	940000
b Sand	yds^3	183400	494000	700000
c gravel	yds^3	183400	494000	700000
6 Carbon Steel rebar	mTons	5.03E+03	2.24E+04	4.31E+04
	Tons	5533E+03	2.464E+04	4.741E+04
7 Carbon Steel shapes	mTons	6.37E+04	1.25E+05	1.58E+05
	Tons	7.01E+04	1.375E+05	1.738E+05
8 Stainless steel shapes	mTons	1.3E+04	2.51E+04	3.34E+04
	Tons	14300	27610	36740
9 Glass forms	mTons	3.65E+05	5.0E+05	6.26E+05
	Tons	401500	550000	688600
	yds^3	478150	655000	820060
a Sand (0.816)	yds^3	390170	534480	669169
b. other materials (0.183)	Tons	73756	101035	126496
10 Process chemicals	MT	4.27E+05	5.15E+05	5.97E+05
	Tons	469700	566500	656700
a oxygen	MT	2.37E+05	3.05E+05	4.07E+05
	Tons	260700	357500	447700

FORM 91-005-1 (4/81)

JACOBS ENGINEERING GROUP INC.

DATE 2-15-96 SUBJECT SHEET NO. 18 of 37

BY RDW CHKD. JOB NO. 01K 47101

Table III Continued.

Item	units	Case 1	Case 2	Case 3
11 Sulfur cement				
a Sulfur	MT	1.61E+05	2.21E+05	2.77E+05
	TONS	177100	243100	304700
b Dicyclopentadiene, DCPD	MT	4.22E+03	5.78E+03	7.24E+03
	TONS	4642	6358	7964
c Oligomer	MT	4.22E+03	5.78E+03	7.24E+03
	TONS	4642	6358	7964

Table IV will contain the listing of the number trips required for each of the intermediate separations case evaluated in this sensitivity study. The number of trips calculated and tabulated in this table will be used to establish the values for the accident evaluation on road mileage traveled.

FORM 91-005-1 (4/81)

JACOBS ENGINEERING GROUP INC.

DATE 2-15-96 SUBJECT SHEET NO. 19 of 37

BY RAW CHKD. JOB NO. 01K47101

Table II Number of Trips

Material Item	Size + mode of transport	Point of origin	Case 1	Case 2	Case 3
1 Gasoline	5000 gal Tank + truck	Tri Cities	1	3	5
2 Diesel Fuel	5000 gal + tank + truck	Tri Cities	118	398	734
3 Kerosene	5000 gallon tank + truck	Tri Cities	3802	5607	5702
4 Concrete	6 cu yd cement + truck	Site concrete plant	10117	43167	82834
a Cement	25 tons/Load + truck	Seattle Portland	3260	13960	26680
b Sand	6 cu yd dump truck	Pit 30	10117	43167	82834
c Gravel	6 cu yd dump truck	Pit 30	10117	43167	82834
5 Concrete prefab shapes	Special walls with trailer + truck	Tri Cities	2470	6645	9420
a Concrete	6 cu yd Cement truck	Site Concrete Plant	30567	82334	116667
b Cement	25 tons/Load + truck	Seattle Portland	9856	26560	37600
c Sand	6 cu yd dump truck	Pit 30	30567	82334	116667
d Gravel	6 cu yd dump truck	Pit 30	30567	82334	116667
6 Carbon Steel rebar	20 ton TRUCK	Seattle Portland	277	1232	2371
7 Carbon Steel shapes	20 ton + truck	Seattle Portland	3505	6875	8690
8 Stainless Steel Shapes	20 ton truck	Seattle Portland	715	1381	1837
9. Block formers	20 ton truck	—	20095	27500	34430
a Sand (0.816)	16 cu yd dump truck	Tri Cities	24386	33405	41824
b other material (0.1837)	20 ton/load + truck	Seattle Portland	3688	5032	6325
10. Process chemicals	20 ton/Load + truck	Seattle Portland	23485	28325	32835
a Oxygen (liquid	25 ton tank truck	Seattle Portland	10428	14300	17908
11 Sulfur Cement					
a Sulfur	45,000 lb/load tank truck	Seattle Portland	7872	10805	13543
b Dicyclopentadiene (DCPD)	45 ton rail tank car	Seattle Portland	104	142	177
c Oligomer (DCP)	20 ton/Load truck	Seattle Portland	233	318	399
HLW waste shipments.					
Rail car Trips to Yucca Mountain			418	835	1113

FORM 91-005-1 (4/81)

Calculate the Table entry values for the various trip combinations for the three (3) cases used to present the sensitivity evaluation. These tabulated values will be used to perform a road haul mileage accident analysis for each of the three cases.

A. Case 1 evaluation numbers.

1 on site Borrow trips

Sand = 10117
Gravel = 10117
total = 20234

E for Table entry = (20234) + (52000)
= 72234 = 7.22 E+04

2. offsite Concrete truck

Portland cement = 3260
Concrete prefab shapes = 2470
Total = 5730

E for table entry = (5730) + (29000)
= 34730
= 3.47 E+04

3. offsite truck steel

Carbon steel rebar = 277
Carbon steel shape = 3505
Stainless steel shapes = 715
total = 4497

E for Table entry = (4497) + (9500)
= 13997
= 1.4 E+04

4. offsite miscellaneous trucked materials

Lubricant = 1
Diesel fuel = 118
Kerosene = 3802

total = 3921 trips/yr = 3921/19 period = 19

Trips/yr = 207 = 207

Σ for table entry = (207) + (5200)

= 5407 = 5.41E+03

5. Processing offsite truck trips/year period = 19 years.

glassforming chemicals

other materials = 3688

oxygen = 10428

sulfur = 7872

Oligomer = 233

total = 22221 trips/yr = 1170

Σ for table entry = (1170) + (23) = 1193

= 1.19E+03

6. Processing offsite truck trips/year, miscellaneous

total = 24386

= 1284 trips/year

Σ for table entry = (1284) + (5200)

= 6484 = 6.5E+03

7 offsite rail glassforming chemicals trips/year

Dicyclopentadiene = 104

= 6 trips/yr

Σ for table entry = (6) + (260)

= 266 = 2.7E+02

8. offsite rail trips to yucca mountain

HLW = 418

JACOBS ENGINEERING GROUP INC.

DATE 2-15-96 SUBJECT SHEET NO. 22 of 37

BY [illegible] CHKD. JOB NO. 01K 4701

B. Case 2 evaluation numbers.

1. On Site Borrow Trips

Sand = 43167

gravel = 43167

Total = 86334

Σ for table entry = (86334) + (52000)

= 138334 = 1.38E+05

2. Offsite Concrete Truck

Portland Cement = 13960

Concrete Prefab Shapes = 6645

total = 20605

Σ for Table entry = (20605) + (29000)

= 49605 = 5.0E+04

3. Offsite Truck Steel

Carbon steel rebar = 1232

Carbon Steel Shapes = 6875

Stainless Steel Shapes = 1381

total = 9488

Σ for Table entry = (9488) + (9500)

= 18988 = 1.9E+04

4. Offsite miscellaneous materials trips/year period = 19

Gasoline = 3

Diesel Fuel = 398

Kerosene = 5207

total = 5608 trips/yr = 296

Σ for Table entry = (296) + (5200)

= 5496 = 5.5E+03

FORM 91-005-1 (4/81)

5. processing offsite truck glassformer chemicals per year

other materials = 5052
oxygen = 14300
sulfur = 10805
oligomer = 318
total = 30475 trips/yr = 1604

Σ for Table entry = (1604) + (23)
= 1627 = 1.63 E+03

6 processing offsite truck miscellaneous trips/yr.

Sand = 33405
total = 33405 trips/yr = 1759

Σ for table entry = (1759) + (5200)
= 6959 = 7.0E+03

7 offsite rail glassformer chemicals trips/yr

Dicyclopentadiene = 142
total = 142 trips/yr = 8

Σ for Table entry = (8) + (260)
= 268 = 2.7 E+02

8. offsite rail trips to yucca mountain.

HLW = 835

C. Case 3 evaluation numbers.

1. On Site Borrow Trips

Sand = 82834
gravel = 82834
total = 165668

Σ for Table entry = (165668) + (52000)
= 217668 = 2.18E+05

JACOBS ENGINEERING GROUP INC.

DATE 2-15-96 SUBJECT SHEET NO. 24 of 37

BY RDW CHKD. JOB NO. OIK 4701

2. Offsite Truck concrete trips:

portland cement = 26680

Concrete prefab shapes = 9420

Total = 36100

Σ for Table entry = (36100) + (29000)

= 65100 = 6.51E+04

3. Offsite Truck Steel

Carbon Steel rebar = 2371

Carbon Steel shapes = 8690

Stainless Steel Shapes = 1837

Total = 12898

Σ for table Entry = (12898) + (9500)

= 22398 = 2.24E+04

4. Offsite Truck miscellaneous trips/yr - period = 19

Gasoline = 5

Diesel fuel = 734

Kerosene = 5702

total = 6441 trips/yr = 339

Σ for Table entry = (339) + (5200)

= 5539 = 5.54E+03

5. Processing offsite truck & laboratory chemicals trips/yr.

Other materials = 6325

oxygen = 12908

Sulfur = 13543

oligomer = 399

Total = 38175 trips/yr = 2010

Σ for Table entry = (2010) + (23)

= 2033 = 2.03E+03

FORM 91-005-1 (4/81)

JACOBS ENGINEERING GROUP INC.

DATE 2-15-96 SUBJECT SHEET NO. 25 of 37

BY RPW CHKD. JOB NO. 01K 47101

6. Processing offsite Truck miscellaneous Trips/yr.

Sand = 41824

Total = 41824 Trips/yr = 2202

Σ for Table entry = (2202) + (5200)

= 7402 = 7.4E+03

7. offsite rail glass formers Trips/year

Dicyclopentadiene = 177

total = 177 Trips/yr = 10

Σ for table entry = (10) + (260)

= 270 = 2.7E+02

8. offsite rail Trips to yucca mountain

HLW = 1113

Calculate the input for table B.10.0.7 Transportation summary for rail transport and truck transport.

a. Ex Situ Intermediate Separations alternative

1. Rail transport, distance Km

a. Seattle portland = (59)(8.0E+02) Km S/P = 8.00E+02 Km

= 47200 TC = 1.40E+01 Km

b. Yucca Mountain (835) − (170)(2.93E+03) YM = 2.93E+03 Km

= (665)(2.93E+03) = 1948450 pit 30 = 10 Km

= 1948450

Σ for table entry = (4.71E+06) + (1.95E+06) + 4.72E+04

= 6.72E+06 Km

2. Truck transport distance Km

a onsite

		Cost on site	Cost off site
Sand	= (58334) (10)	= 583340	583340
gravel	= (58334) (10)	= 583340	583340
Sand	= (82334) (10)	= 823340	
gravel	= (82334) (10)	= 823340	
Borrow Silt	= (30567) (10)	= 305670	305670
Closure Sand and Gravel	= (26000) (10)	= 260000	260000
Borrow Site Basalt	= (27510) (10)	= 275100	275100

FORM 91-005-1 (4/81)

JACOBS ENGINEERING GROUP INC.

DATE 2-15-96 SUBJECT SHEET NO. 26 of 37

BY RDW CHKD. JOB NO. 01K 47101

Closure Sand and gravel = (1.5 - 1.36) E+06 m^3
= 0.14 E+06 m^3
= (1.4 E+05)(1.31) = 1.834 E+05 yds^3

6 Cu yd Dump Truck = 30567 Trips

Borrow Site Silt = (6.45 - 5.29) E+05) = 1.19 E+05 m^3
= (1.19 E+05)(1.31) = 1.56 yds^3 E+05
= 156000
= 26000 trips

Borrow Site Basalt = (9.31 E+05) - (8.05 E+05) = 1.26 E+05 m^3
= (1.26 E+05)(1.31) = 165060 yds^3
= 27510 Trips

Σ from page 24 = 3654130 = 3.65 E+06 Km Cost on Site
Σ for Table entry = (- - - - -) · (7.79 E+06) Km
Cost on site = 1.144 E+07 Km ; Cost off Site = 1.50 E+07 Km
Cost off site = 723438 = 7234380 = 7.24 E+06 Km
b. off site
Tri cities = (10381)(140) = 1.45 E+06 Cost off Site | (3736)(140) Con Site = 5.23 E+05
Portland Seattle = (78532)(800) = 6.28 E+07 Cost on Site | C off Site = 4.16 E+07 (51972)(800)
Cost on site Σ = 6.33 E+07 ; Cost off site = 4.31 E+07
Σ for Table entry = (5.52 E+07) + (- - - - -)
Cost on site = 1.19 E+08 Km ; cost off site = 9.83 E+07

B. Ex situ no separations alternative - Vitrification
1. Rail transport distance Km
a. Seattle portland = NA
b. Yucca Mountain = 14700 - 2140 = 12560
= (2930)(12560) = 36800800
= 3.7 E+07 Kms.

Σ for table entry = (3.7 E+07) + (7.58 E+06) = 4.458 E+07 Km
= 4.5 E+07 Km

2. Truck Transport distance Km
a. onsite

FORM 91-005-1 (4/81)

Sand = (36334)(10) Cost off Site = 72668
gravel = (36334)(10) = 726680 Km
Sand = (1596667)(10) = 7.27E+05 Km
gravel = (1596667)(10)
Σ = (3 266002)(10)
= 3.27E+07 Km cost on Site

Σ for table entry = (3.27+E07) + (5.93E+06) Km
Cost on Site = 3.86E+07 Km
Cost off Site = 6.66E+06 Km.

b. Offsite
Seattle/Portland = 555654 Trips Cost on Site cost off site = 53654
Tri cities = 146528 Trips Cost off site Cost on site = 20925
Cost on Site SP Km = (555654)(800) = 4.45E+08 Cost on Site
Cost off Site + C Km = (146528)(140) = 2.0513920E+07 Cost off site
Cost off site SP = (53654)(800) = 4.29E+07 Km cost off site
Cost on Site + C = (20925)(140) = 2.93E+06 Km Cost on Site
Σ for table entry = (— — —) + (4.23E+07)
Cost on Site 4.90E+08 Km ; Cost off site 1.06E+08 Km

C Ex Situ no Separations alternative - Calcination
1. Rail Transport Distance Km
a. yucca mountain = (2710 - 1030) = 1680
= (1680)(2930)
= 4.92E+06 Km

Σ for table entry = (4.92E+06) + (4.33E+06)
= 9.25E+06 Km

2. Truck transport distance, Km
a. onsite
Sand = 4867
gravel = 4867
Sand = 201667
gravel = 201667 Cost off site = (9734)(10) = 97340 Km
= (413068)(10) = 4130680 Km
Covers Cost on Site = 4.13E+06 Km Covers Cost off Site = 9.73E+04 Km

Σ for Table entry = (- - - - -)(5.93E+06)
Cost on Site = 1.01E+07 Km
Cost off Site = 6.03E+06 Km

b. Offsite
Tri-Cities = 19997 Cost off site Cost on site = 3200
Seattle Portland = 84975 Cost on site Cost off site = 17775

Cum Cost on site – Seattle Portland = (84975)(800) = 6.8E+07 Km
Cum Cost off Site – = (17775)(800) = 1.42E+07 Km
Cost off site – Tri-Cities = (19997)(140) = 2.8E+06 Km
Cost on Site – = (3200)(140) = 4.5E+05 Km

Σ for table entry = (- - - -) + (4.23E+07) Km
Cost on site Σ = 1.13E+07 Km ; Cost off site = 5.93E+07 Km

D. Cellular Extension Separations alternative
1. Rail Transport Distance, Km
a. Offsite
Seattle Portland = 165
Yucca Mountain = 39 – 10 = 29

Seattle Portland = (165)(800) = 132000 Km
Yucca Mountain = (29)(2930) = 84970 Km
Σ = 216970 = 2.17E+05 Km

Σ for table entry = (2.17E+05) + (8.34E+06) Km
= 8.56E+06 Km

2. Truck Transport Distance, Km
a. Onsite
Sand = 56334 Cost off site
Gravel = 56334 Cost off Site
Sand = 1767 add for Cost on Site
Gravel = 1767 add for Cost on Site
Σ = (116202)(10) = 1162020 Km Cost on Site
(112668)(10) = 1126680 Km Cost off Site

JACOBS ENGINEERING GROUP INC.

DATE 2-15-96 SUBJECT SHEET NO. 29 of 37

BY RDW CHKD. JOB NO. 01K47101

Borrow Site Silt = (6.45 − 5.35) = 1.10 E+05 m^3
= 1.44 E+05 yds^3
6 yd Truck = 24000 + trips

Closure Sand and gravel = 1.5 − 1.36 = 1.4 E+05 m^3
= 1.834 E+05 yd^3
6 yd Truck = 30567 trips

Borrow Site Basalt = (9.31 − 8.05) = 1.26 E+05 m^3
= 1.6506 yd^3 E+05
6 yd Truck = 27510 trips

Σ = (24000) + (30567) + (27510)
= 82077
= (82077)(10) = 820770 Km

Σ = (1162020) + (820770) = 1982790 Km = 1.98 E+06 Cost on Site
= (1126680) + 820770) = 1947450 Km = 1.95 E+06 Cost off Site

Σ for table entry = (- - - - -) + (7.88 E+06)
Cost on Site = 9.86 E+06 Cost off Site = 9.83 E+06

b. off Site Truck
Tricities = 44480 Cost off Site Cost on Site = 44337 Trips
Seattle/Portland = 66078 Cost on Site Cost off Site = 65506 trips

Cost off site − Tricities = (44480 (140) = 6227200 = 6.23 E+06 Km
Cost on Site − = (44337) (140) = 6207180 = 6.21 E+06 Km
cost on Site − Seattle/Portland = (66078)(800) = 52862400 Km = 5.29 E+07 Km
Cost off Site − = (65506)(800) = 52404800 Km = 5.24 E+07 Km
Cost on Site = 5.91 E+07 Km Cost off Site = 5.86 E+07 Km

Σ for Table entry = (- - - - -) + (5.91 E+07)
Cost on Site = 1.182 E+08 Km Cost off Site = 1.18 E+08 Km

E. Exclusive/on Site combination alternative
1. Rail transport distance, Km
a. Seattle Portland = 30
b. Yucca mountain = 418 − 85 = 333

Seattle Portland = 30)(800) = 24000 Km

Yucca mountain = (333)(2930) = 975690 Km

Σ = 999690 = 1.0 E+06 Km

Σ for Table Entry = (1.0E+06) + (2.36E+06)

= 3.36 E+06 Km

2. Truck distance Km.

a. On Site

Sand = 21617 Trips

gravel = 21617 Trips

Sand = 41000 Trips — for Casting Cover on site

gravel = 41000 Trips

Basalt Borrow pit = 7.85 - 7.0 = 8.5 E+04 m^3

= 1.1135 E+05 yds^3

6 cy/truck = 18559 Trips

Borrow site silt = 5.11 - 4.36 = 7.5 E+04 m^3

= 9.825 E+04 yds^3

6 cy/truck = 16375 Trips

Σ of trips = 160168 Trips (= 78168)

at 10 Km/Trip = 1601680 Km (= 781680) Km

= 1.60 E+06 Km Cover Cast on site (= 7.82 E+05 Km) Cover Cast off site

Σ for Table entry = (1.60E+06) + (6.55 E+06)

= 8.15 E+06 Km Casting Cover on site

= 7.33 E+06 Km (Cover Cast off site)

b. off site

Tricities = 8229 Cast off site Cast on site = 5007 Trips

Seattle Portland = 36292 Cast on site Cast off site = 21732 Trips

Tricities = (8229)(140) = 1152060 Km Cast off site

Seattle Portland = (36292)(800) = 29033600 Km Cast on site

Tricities (5007)(140) = 700980 Km Cast on site

Seattle Portland (21732)(800) = 17385600 Km Cast off site

Cast on site = 3.0E+07 Cast off site = 1.74E+07

Σ for Table entry = (2.77E+07) + (----)
Cost on Site = 5.77E+07 Km ; Cost off Site = 4.51E+07 Km

3. Phased Implementation alternative – Phase II
1. Offsite Rail Transport Distance, Km.
Seattle/Portland = 59
Yucca Mountain = 835 - 170 = 665

Seattle/Portland = (59)(800) = 47200 Km

Yucca mountain = (665)(2930) = 1948450 Km

Σ = 1995650 Km = 2.0E+06 Km

Σ for Table Entry = (2.0E+06) + (2.74E+06)
= 4.74E+06 Km

2. Truck Transport, Distance Km
a. onsite Traffic

Cost on Site	Cost off Site
Sand = 43167	Sand = 43167
gravel = 43167	gravel = 43167
Sand = 82374	
gravel = 82334	

Borrow site Silt = [(6.45E+05) − (5.26E+05)] = 1.19E+05 m³
= (1.19E+05)(1.31) = 1.56E+05 yd³
6 yd³ truck = 26000 = 26000

Borrow site Sand + Gravel Alone = (1.5 − 1.36)E+06 m³ = 1.4E+05 m³
= (1.4E+05)(1.31) = 1.834E+05 yd³
6 yd³ truck = 30567 = 30567

Borrow site Basalt = (9.71 − 8.05)E+05 m³ = 1.26E+05 m³
= (1.26E+05)(1.31) = 1.651E+05 yd³
6 yd³ truck = 27517 = 27517
Σ = 335086 trips = 170418 trips
at 10 Km = 3350860 Km = 1704180 Km
Σ for table entry = (6.30E+06) + (----)
= 9.65E+06 Km Cost on Site = 8.01E+06 Km Cost off Site

FORM 91-005-1 (4/81)

JACOBS ENGINEERING GROUP INC.

DATE 2-15-96 SUBJECT SHEET NO. 32 of 37

BY RDW CHKD. JOB NO. 01K47101

b. off site truck distance km

Tri cities = 21136 trips (-6645 if shaper cost on site)

Seattle Portland =

Cement = 13960 trips (+26560 if shaper cost on site)

Steel = 9462 trips

Glass other = 2021 trips

Oregon = 14320 trips

Sulfur = 4107 trips

Oligomer = 131 trips

	Cost on Site	Cost off site
Tri cities	= 14491 trips	= 21136 trips
at 140	= 2028740 Km	= 2959040 Km
Seattle Portland	= 69561	= 43001
at 800 Km	= 55648800	= 34400800
Σ	= 57677540	= 37359840
	= 3.77E+07 Km	= 3.74E+07 Km

Σ for table Entry = (2.98 E+07) + (- - - -)

= 8.75E+07 Km = 6.72E+07 Km

4. Compare these values in table B-10.0.7 to the values obtained from the transportation mileage accident analyses sheets.

1. Ex situ intermediate separations alternative.

a. offsite rail transport, Km

Table cost on site	Table cost off site	analysis sheet
6.72 E+06 Km	6.72 E+06 Km	7.73 E+06 Km

b. onsite truck transport, km

1.14 E+07 Km	1.50 E+07 Km	1.02 E+07

c. offsite truck transport, km

1.20 E+08	9.83 E+07 Km	1.05 E+08

2. Ex situ no separations alternative - vitrification

a. offsite Rail transport, Km

4.5 E+07	4.5 E+07	6.4 E+07

FORM 91-005-1 (4/81)

JACOBS ENGINEERING GROUP INC.

DATE 2-15-96 SUBJECT SHEET NO. 33 of 37

BY RAW CHKD. JOB NO. OIK 47101

b. onsite Truck Transport, Km

Table Cost on Site	Table Cost off Site	analysis Sheet
3.86 E+07	6.66 E+06	6.87 E+06

c. offsite Truck Transport, Km

4.90 E+08	1.06 E+08	8.6 E+07

3. In situ no separations alternative - Calcination

a. offsite rail transport, Km

9.25 E+06	9.25 E+06	1.28 E+07

b. onsite Truck transport, Km

1.01 E+07	6.03 E+06	6.02 E+06

c. offsite truck transport, Km

1.13 E+08	5.93 E+07	6.06 E+07

4. In situ Solvent separations alternative

a offsite rail transport, Km

8.56 E+06	8.56 E+06	1.05 E+07

b. Onsite truck transport, Km

9.86 E+06	9.83 E+06	1.06 E+07

c. offsite truck transport, Km

1.182 E+08	1.18 E+08	1.11 E+08

5. Ex situ/In situ combustion alternative

a offsite rail transport, Km

3.36 E+06	3.36 E+06	3.87 E+06

b. onsite truck transport, Km

8.15 E+06	7.33 E+06	7.89 E+06

c. offsite truck transport, Km

5.77 E+07	5.41 E+07	5.25 E+07

6. Phased Implementation alternative - Phase 2

a. offsite rail transport, Km

4.74 E+06	4.74 E+06	5.97 E+06

b. onsite truck transport, Km

9.65 E+06	8.01 E+06	9.9 E+06

c. offsite truck transport, Km

8.75 E+07	6.72 E+07	9.29 E+07

FORM 91-005-1 (4/81)

JACOBS ENGINEERING GROUP INC.

DATE 2-15-96 SUBJECT SHEET NO. 34 of 37

BY RDW CHKD. JOB NO. 01K47101

Develop verification for number of rail cars per trip etc for better defense of rail transport mileage analysis.

Glass formers	WCH data [illegible]			
B_2O_3	5.75E+04 Mg			
Fe_2O_3	1.4E+01 Mg			
Li_2O_2	2.1E+03 Mg			
SiO_2	2.87E+05 Mg	4.35E+05 MT		
MgO	4.1E+03 Mg			
CaO	4.1E+03 Mg			
	others	9.8E+04 MT		2396
Resin				
R-F for Cs Removal	9.0E+02 m^3			
CST for Sr Removal	8.0E+02 m^3			
Reillex HPQ for Tc	3.0E+03 m^3			
AMP for Cs	1.6E+02 m^3			
Reillex HPQ for AM/LAM	5.0E+01 m^3			
Nitric acid 50%	4.65E+05 Mg	*4.65E+05 MT	11367	Tank Cars
NaOH 50%	1.5E+05 Mg	*1.5E+05 MT	3667	Tank Cars
Flocculent - Polyelectrolyte	1.50E+02 Mg			
Glycolic acid, 100%	7.7E+03 Mg	*7.7E+03 MT	189	
Oxalic acid, 50%	1.2E+04 Mg	*1.2E+04 MT	294	
FEGA	4.72E+03 Mg			
Aluminum Nitrate	1.12E+02 Mg			
CMPO	5.0 Mg			
TBP	7.55E+02 Mg			
NPH	7.03E+02 Mg			
Sodium Carbonate	1.8E+02 Mg			
Crown ether	2.84E+02 Mg			
Formic acid, 96%	1.47E+03 Mg	*1.47E+03 MT	36	
HF	7.42E+02 Mg			
H_2O_2, 100%	6.4E+03 Mg	*6.4E+03 MT	157	
Sodium oxalate	2.09E+04 Mg	2.09E+04 MT		511
Sodium Bicarbonate	1.25E+04 Mg	1.25E+04 MT		306
Zinc nitrate	4.7E+01 Mg			
Na_3 DTPO	1.96E+02 Mg			
HPM	1.0E+01 Mg			

FORM 91-005-1 (4/81)

JACOBS ENGINEERING GROUP INC.

DATE 2-15-96 SUBJECT SHEET NO. 35 of 37

BY RDW CHKD. JOB NO. 01K47101

Hydroxylamine nitrate	9.5E+1 mg		
RPW glass, 2			
steel	3.36E+02 mg.		
ammonia	9.24E+03 mg	9.24E+03 mT	226
DCPD	4.46E+03 mg	*6.74E+03 mT	165 tank cars.
CPD	4.46E+03 mg		
Sulfur	1.7E+05 mg.		
Material for RPW vault			
Concrete			
Steel	1.6E+04 mg.		
	total Steel =	3.1E+05 mT	7578 rail cars
decontamination chemicals	1.4E+04 mg		or 399/yr
			or 34/month.
Kerosene	9.356E+04 m^3	1.404E+05 m^3	3.71 ÷ 07 gallons

* items by Rail Tank Car at 45 Tons/Car

** rail tank cars/yr. Period = 19 yrs.

HNO_3 50% =	559 cars/yr.	47 cars/month	24	24
NaOH, 50% =	193	16	8	8
glycolic acid, 100% =	10	1	1	
oxalic acid, 50% =	16	2	1	1
formic acid 96% =	2	1	1	
H_2O_2, 100% =	9	1	1	
DCPD =	9	1	1	
			37	33

Estimate of average Cars per Trip

1 train/month = 37 Cars
1 train/month = 33 Cars

= 24 train/year

= 456 Total (19 yrs)

FORM 91-005-1 (4/81)

JACOBS ENGINEERING GROUP INC.

DATE 2-15-96 SUBJECT SHEET NO. 36 of 37

BY RDW CHKD. JOB NO. 01K 47101

Based on calculational estimate above there are two rail trips per month for a total of 48 Trip year

add the construction number of 10 Trips per year

a total would equal 58 Trip year

If 20 Cars/train are assumed as in WHC report,

total Estimated = 15875 Cars
= 835.5 Cars/yr.
= 42 Trips/yr at 20 Cars/train

to carry total steel
by 45 Ton Capacity rail car.
7578 rail cars
= 399 cars/yr
= 34 rail cars/month

= 17 Cars each of two trains/month.

						cars/month
Σ other glass formers	=	2396	Rail Cars @ 45 Tons each.		Box car)	11
Sodium oxalate	=	511	"	"	"	3
Sodium Bicarbonate	=	306	"	"	"	2
ammonia	=	226	Rail Tank Car @ 45 Tons each.			1

Split = 1, 1, 2, 6, & 0, 1, 1, 5

= one train with 10 Cars; one train with 7 Cars

Still 2 trains per month.

1st train carries (37) + (17) + (10) = 64 Cars
2nd train Carries (33) + (17) + (7) = 57 Cars.

Total Σ = 26892 Cars. = 1416 Cars/yr.
at 20 Cars/train = 71 Trips/yr. = 6 Trips/month.

FORM 91-005-1 (4/81)

JACOBS ENGINEERING GROUP INC.

DATE 2-15-96 SUBJECT SHEET NO. 37 of 37

BY RDW CHKD. JOB NO. 01K47101

The Westinghouse document Table 9-7 for the extensive separation alternative lists 637 trains per year in support of processing. Each train consists of 20 cars.

Car per year = (20)(637) = 12740 Cars/year

Increased material = DCPD = (1.12E+04) − (4.46E+03) mtons
= 6.74 E+03 mtons = 7.41 E+03 tons
= 7414 tons
= 390 tons/yr.
at 45 tons/car = 9 Cars per year.

Σ = 12740 + 9 = 12749 Cars/yr
at 20/train = 638 Trains/yr.

FORM 91-005-1 (4/81)

Sheet B-1
RGW 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	1.67E+05	~~5.20E+04~~	1.00E+01		5.20E+05		
							Total	5.20E+05
Offsite Truck			trips	km/trip		total		
	concrete	6.45E+04	2.90E+04	1.40E+02		4.06E+06		
	steel	1.51E+04	9.50E+03	8.00E+02		7.60E+06		
			trips/yr	km/trip	yr			
	miscellaneous	~~9.54E+03~~	~~5.20E+03~~	1.40E+02	1.00E+01	7.28E+06		
			5.3E+03				Total	1.89E+07
Processing								
~~2.2E+04~~ Offsite Truck		1.13E+03	trips/yr	km/trip	yr	total		
~~4.11E+04~~	glassformer/chem		~~2.30E+01~~	8.00E+02	1.95E+01	3.59E+05		
	miscellaneous	~~3.33E+03~~	5.20E+03	1.40E+02	1.95E+01	1.42E+07		
		~~6.7E+03~~	5.3E+03				Total	1.46E+07
Offsite Rail		~~5.22E+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
			2.64E+02					
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-2
RDW 2-15-96

			EX SITU NO SEPARATIONS ALTERNATIVE - Vitrification					
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/misc W-314		1.53E+02	1.40E+02		2.14E+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	~~1.45E+05~~	~~2.02E+04~~	1.00E+01		2.02E+05	Total	2.02E+05
			9.29E+04					
Offsite Truck		1.45 E+05	trips	km/trip		total		
	Try Cities	~~4.38E+04~~	1.30E+04	1.40E+02		1.82E+06		
	Portland/Seattle		5.00E+03	8.00E+02		4.00E+06		
	4.1E+04	4.34E+4	trips/yr	km/trip	yr			
	miscellaneous		5.20E+03	1.40E+02	5.50E+00	4.00E+06	Total	9.82E+06
Processing		417 1.2E+03						
Offsite Truck		~~3.55E+03~~	trips/yr	km/trip	yr	total		
	Portand/Seattle		~~5.00E+01~~	8.00E+02	1.40E+01	5.60E+05		
	miscellaneous		~~5.20E+03~~	1.40E+02	1.40E+01	1.02E+07	Total	1.08E+07
		~~3.05E+04~~	~~6.85E+03~~					
			6.2E+03					
Offsite Rail			trips/yr	km/trip	yr	total		
	Portland/Seattle (ok.)		1.03E+02	8.00E+02	1.40E+01	1.15E+06	Total	1.15E+06
VITRIFIED HLW TRANSPORT								
Offsite Rail			trips	km/trip		total		
	Yucca Mountain		2.14E+03	2.93E+03		6.27E+06	Total	6.27E+06
			1.47E+04					
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-3
AGW 2-15-96

			EX SITU NO SEPARATIONS ALTERNATIVE -Calcination					
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/misc W-314		1.53E+02	1.40E+02		2.14E+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		3.0						
Onsite Truck		~~3.03~~ E+04	trips	km/trip		total		
	borrow	~~[illegible]~~	2.02E+04	1.00E+01		2.02E+05	Total	2.02E+05
Offsite Truck		3.3	trips	km/trip		total		
	Try Cities	3.4E+04	~~1.30E+04~~	1.40E+02		1.82E+06		
6.07E+4	Portland/Seattle	1.1E+04	~~5.00E+03~~	8.00E+02		4.00E+06		
			trips/yr	km/trip	yr			
	miscellaneous		5.20E+03	1.40E+02	5.50E+00	4.00E+06	Total	9.82E+06
Processing								
8.97 E+02	Offsite Truck	8.29E+02	trips/yr	km/trip	yr	total		
	Portand/Seattle		~~5.00E+01~~	8.00E+02	1.40E+01	5.60E+05		
	miscellaneous		5.20E+03	1.40E+02	1.40E+01	1.02E+07	Total	1.08E+07
Offsite Rail			trips/yr	km/trip	yr	total		
	Portland/Seattle	ok	1.03E+02	8.00E+02	1.40E+01	1.15E+06	Total	1.15E+06
VITRIFIED HLW TRANSPORT								
Offsite Rail			trips	km/trip		total		
	Yucca Mountain		~~2.14E+03~~	2.93E+03		6.27E+06	Total	6.27E+06
			2.710E+03					
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-4
RDW 2-15-96

		EX SITU EXTENSIVE 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/misc W-314		1.53E+02	1.40E+02		2.14E+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		1.38E+03	1.00E+01		1.38E+04	Total	1.38E+04
VITRIFICATION								
Construction								
Onsite Truck			trips	km/trip		total		
	borrow	~~2.12E+05~~	~~6.10E+04~~	1.00E+01		6.10E+05	Total	6.10E+05
			1.74E+05					
Offsite Truck		3.58E+04	trips	km/trip		total		
	Tri-Cities	~~1.07E+05~~	2.70E+04	1.40E+02		3.78E+06		
	Portland/Seattle	~~2.62~~	1.10E+04	8.00E+02		8.80E+06		
	3.78E+04	1.5E+04	trips/yr	km/trip	yr			
	miscellaneous		5.20E+03	1.40E+02	9.00E+00	6.55E+06	Total	1.91E+07
Processing								
2.17E+03 Offsite Truck		2.55E+03	trips/yr	km/trip	yr	total		
	glassformer/chem		5.13E+02	8.00E+02	1.60E+01	6.57E+06		
	miscellaneous		~~5.20E+03~~	1.40E+02	1.60E+01	1.16E+07	Total	1.82E+07
			7.1E+03					
Offsite Rail			trips/yr	km/trip	yr	total		
	glassformer/chem		~~6.37E+02~~	8.00E+02	1.60E+01	8.15E+06	Total	8.15E+06
			~~6.77E+02~~					
			6.46E+02					
VITRIFIED HLW TRANSPORT								
Offsite Rail			trips	km/trip		total		
	Yucca Mountain		~~1.00E+01~~	2.93E+03		2.93E+04	Total	2.93E+04
			3.9E+01					
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-5
RDW 2-15-96

			EX SITU COMBINATION					
RETRIEVAL								
Waste Transport						total		
Onsite Truck						0.00E+00		
Construction								
Offsite Truck			trips/yr	km/trip	yr	total		
	concrete		2.40E+02	1.40E+02	2.00E+01	6.72E+05		
	raw material		2.25E+01	8.00E+02	2.00E+01	3.60E+05		
	equipment		1.25E+01	1.00E+04	2.00E+01	2.50E+06		
	miscellaneous		2.60E+03	1.40E+02	2.00E+01	7.28E+06		
	steel W-314		5.30E+01	8.00E+02		4.24E+04		
	cement/misc W-314		1.53E+02	1.40E+02		2.14E+04	Total	1.09E+07
Offsite Rail			trips/yr	km/trip	yr	total		
	raw material		5.00E+00	8.00E+02	2.00E+01	8.00E+04	Total	8.00E+04
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	~~6.4E+04~~	2.60E+04	1.00E+01		2.60E+05	Total	2.60E+05
			6.92E+04					
Offsite Truck		2.47E+04	trips	km/trip		total		
	concrete	~~2.3E+04~~	1.45E+04	1.40E+02		2.03E+06		
	steel	9.0E+03	4.75E+03	8.00E+02		3.80E+06		
			trips/yr	km/trip	yr			
~~1.31E+04~~	miscellaneous		~~2.60~~E+03	1.40E+02	1.00E+01	3.64E+06	Total	9.47E+06
			~~3.15~~E+03					
			2.7					
Processing		5.67E+02						
~~7.30E+03~~	Offsite Truck		trips/yr	km/trip	yr	total		
	glassformer/chem		1.15E+01	8.00E+02	1.95E+01	1.79E+05		
	miscellaneous		~~2.60~~E+03	1.40E+02	1.95E+01	7.10E+06	Total	7.28E+06
			2.96E+03					
Offsite Rail			trips/yr	km/trip	yr	total		
	glassformer/chem		~~1.30E+02~~	8.00E+02	~~1.95E+01~~	2.03E+06	Total	2.03E+06
			~~1.37E+02~~					
			1.32E+02					
VITRIFIED HLW TRANSPORT								
Offsite Rail			trips	km/trip		total		
	Yucca Mountain		~~8.50E+01~~	2.93E+03		2.49E+05	Total	2.49E+05
		4.15E+02						
			415					
CLOSURE								
Onsite Truck			cu yd	trip/cu yd	km/trip	total		
	fill		9.36E+05	1.00E-01	1.00E+01	9.36E+05		

No change?

	PHASE 1 IMPLEMENTATION SUB-ALTERNATIVE							
		no change						
RETRIEVAL								
WASTE TRANSFER SYSTEM UPGRADE (W-314)								
Onsite Truck			trips	km/trip		total		
	borrow		1.38E+03	1.00E+00		1.38E+03	Total	1.38E+03
Offsite Truck								
	steel		5.30E+01	8.00E+02		4.24E+04		
	cement		1.00E+02	1.40E+02		1.40E+04	Total	5.64E+04
VITRIFICATION								
Construction								
Onsite Truck			trips	km/trip		total		
	borrow		1.96E+03	1.00E+01		1.96E+04	Total	1.96E+04
Offsite Truck			trips	km/trip		total		
	concrete		1.20E+03	1.40E+02		1.68E+05		
	steel		7.32E+03	8.00E+02		5.86E+06		
	miscellaneous		3.18E+03	1.40E+02		4.45E+05	Total	6.47E+06
Processing								
Offsite Truck			trips	km/trip		total		
	glassformer/chem		3.50E+03	8.00E+02		2.80E+06		
	glassformer/chem		3.57E+03	1.40E+02		5.00E+05		
	miscellaneous		5.20E+04	1.40E+02		7.28E+06	Total	1.06E+07
Offsite Rail			trips	km/trip		total		
	glassformer/chem		2.18E+02	8.00E+02		1.74E+05	Total	1.74E+05
VITRIFIED HLW TRANSPORT								
SITE RESTORATION								
Onsite Truck			trips	km/trip		total		
	contaminated waste		1.50E+03	1.61E+01		2.42E+04		
	noncont. waste		6.23E+04	1.61E+01		1.00E+06	Total	1.03E+06

phased implementation I + II

Sheet B-7
RDW 2-15-96

	TOTAL 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		
	borrow (W-314)		1.38E+03	1.00E+01		1.38E+04	Total	2.16E+07
Offsite Rail			trips/yr	km/trip	yr	total		
	raw material		1.00E+01	8.00E+02	2.00E+01	1.60E+05		
	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	2.16E+05
VITRIFICATION								
Construction								
Onsite Truck		1.14	trips	km/trip		total		
	borrow	~~1.44~~ E+05	~~2.80E+04~~	1.00E+01		2.80E+05	Total	2.80E+05
Offsite Truck		3.63	trips	km/trip		total		
	concrete	~~2.61~~ E+04	1.57E+04	1.40E+02		2.20E+06		
	steel 9.67	9.7E+03	1.21E+03	8.00E+02		9.68E+05		
	miscellaneous		2.92E+04	1.40E+02		4.09E+06	Total	7.25E+06
		~~3.11E+04~~	3.06+04					
Processing								
Offsite Truck		2.43E+04	trips	km/trip		total		
~~1.65E+04~~	glassformer/chem		~~3.72E+03~~	8.00E+02		2.98E+06		
	miscellaneous		1.03E+05	1.40E+02		1.44E+07		
~~3.0E+04~~	process material		3.57E+03	1.40E+02		5.00E+05	Total	1.79E+07
1.46E+04								
Offsite Rail			trips	km/trip		total		
3.0E+03	glassformer/chem		~~2.75E+03~~	8.00E+02		2.20E+06	Total	2.20E+06
2.81E+03								
VITRIFIED HLW TRANSPORT								
Offsite Rail			trips	km/trip		total		
	Yucca Mountain		1.70E+02	2.93E+03		4.98E+05	Total	4.98E+05
			8.35E+02					
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-8
AJW 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	1.69E+05	~~5.20E+04~~	1.00E+01		5.20E+05		
							Total	5.20E+05
Offsite Truck			trips	km/trip		total		
5.45E+04	concrete	~~6.65~~	~~2.90E+04~~	1.40E+02		4.06E+06		
1.5[illegible]E+04	steel	~~[illegible]~~	~~9.50E+02~~	8.00E+02		7.60E+06		
			trips/yr	km/trip	yr			
~~[illegible]~~	miscellaneous	~~[illegible]~~	~~5.20E+03~~	1.40E+02	1.00E+01	7.28E+06		
		7.54E+03					Total	1.89E+07
Processing								
4.11E+04 Offsite Truck		~~3.15E+03~~	trips/yr	km/trip	yr	total		
~~[illegible]~~	glassformer/chem	~~[illegible]~~	2.30E+01	8.00E+02	1.95E+01	3.59E+05		
~~[illegible]~~	miscellaneous	~~[illegible]~~	~~5.20E+03~~	1.40E+02	1.95E+01	1.42E+07		
		8.1E+03					Total	1.46E+07
Offsite Rail			trips/yr	km/trip	yr	total		
5.[illegible]2	glassformer/chem	~~[illegible]~~	~~2.60E+02~~	8.00E+02	1.95E+01	4.06E+06		
							Total	4.06E+06
VITRIFIED HLW TRANSPORT								
Offsite Rail			trips	km/trip		total		
~~[illegible]~~	Yucca Mountain	835	~~1.70E+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		

1.03E+05
9.62E+04

2.244
1.853

Sheet B-9
RDW 2-15-95

	silt		6.93E+05	1.00E-01	3.00E+01	2.08E+06		
	riprap		1.05E+06	1.00E-01	3.20E+01	3.36E+06		
	ag/sand		7.93E+05	1.00E-01	1.00E+01	7.93E+05		
							Total	7.22E+06
GROUT FILL IMUST								
Onsite Truck sand/gravel			2.20E+03	1.00E+01		2.20E+04	Total	2.20E+04
Offsite Truck cement			4.63E+02	1.40E+02		6.48E+04	Total	6.48E+04
Onsite Truck (km)		7.79E+06						
Onsite Rail (km)		0.00E+00						
Offsite Truck (km)		5.52E+07						
Offsite Rail (km)		4.71E+06						
EMPLOYEE VEHICLE								
Retrieval		person-yr	trip/yr	km/trip	car pool	total		
	Const.	1.06E+04	2.60E+02	1.40E+02	7.41E-01	2.86E+08		
	Ops/D&D	3.74E+04	2.60E+02	1.40E+02	7.41E-01	1.01E+09		
Vitrification								
	Const.	1.98E+04	2.60E+02	1.40E+02	7.41E-01	5.34E+08		
	Ops/D&D	1.73E+04	2.60E+02	1.40E+02	7.41E-01	4.67E+08		
Closure		4.90E+02	2.60E+02	1.40E+02	7.41E-01	1.32E+07		
							Total	2.31E+09
Distance traveled in population zones								
Urban		Offsite km	zone fraction		Onsite	TOTALS		
	Truck	5.52E+07	5.00E-02			2.76E+06		
	Rail	4.71E+06	5.00E-02			2.36E+05		
Suburban								
	Truck	5.52E+07	5.00E-02		7.79E+06	1.05E+07		
	Rail	4.71E+06	5.00E-02			2.36E+05		
Rural								
	Truck	5.52E+07	9.00E-01			4.97E+07		
	Rail	4.71E+06	9.00E-01			4.24E+06		
Fatalities/Injuries resulting from Truck and Rail transportation accidents								
			urban km		suburban km		rural km	
			truck	rail	truck	rail	truck	rail
			2.76E+06	2.36E+05	1.05E+07	2.36E+05	4.97E+07	4.24E+06
urban truck fat/km		7.50E-09	2.07E-02					

Sheet B-10
RJW 2-15-96

urban truck inj/km		3.70E-07	1.02E+00					
urban rail fat/km		1.70E-08		4.01E-03				
urban rail inj/km		3.30E-08		7.78E-03				
sub truck fat.km		1.30E-08			1.37E-01			
sub truck inj/km		3.80E-07			4.01E+00			
sub rail fat/km		1.70E-08				4.01E-03		
sub rail inj/km		3.30E-08				7.78E-03		
rural truck fat/km		5.30E-08					2.63E+00	
rural truck inj/km		8.00E-07					3.98E+01	
rural rail fat/km		1.70E-08						7.21E-02
rural rail inj/km		3.30E-08						1.40E-01
	TOTAL FATALITIES		2.87E+00					
	TOTAL INJURIES		4.50E+01					
Fatalities/Injuries resulting from Employee vehicle accidents								
		km	rate/km	TOTAL				
	fatalities	2.31E+09	8.98E-09	2.07E+01				
	injuries	2.31E+09	7.14E-07	1.65E+03				
Cumulative fatalities/injuries from traffic impacts								
			transport	employee	TOTAL			
	FATALITIES		2.87E+00	2.07E+01	2.36E+01			
	INJURIES		4.50E+01	1.65E+03	1.69E+03			
CONSTRUCTION ACCIDENTS								
		rate	person-yr					
	TRC =	9.75E-02	3.09E+04	=	3011.775			
	LWC =	2.45E-02	3.09E+04	=	756.805			
	Fatality =	3.20E-05	3.09E+04	=	0.98848			
OPERATION ACCIDENTS								
		rate	person-yr					
	TRC =	2.20E-02	5.47E+04	=	1203.4			
	LWC =	1.10E-02	5.47E+04	=	601.7			
	Fatality =	3.20E-05	5.47E+04	=	1.7504			
TOTALS								

Sheet B-11
RDW 2-15-96

	INJUR	5.91E+03						
	FATAL	2.63E+01						

Sheet B-12
RDW-2-15-96

			EX SITU NO 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/misc W-314		1.53E+02	1.40E+02		2.14E+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	1.18E+05	~~2.02E+04~~	1.00E+01		2.02E+05	Total	2.02E+05
Offsite Truck		4.38	trips	km/trip		total		
	Try Cities	~~2.6~~	~~1.30E+04~~	1.40E+02		1.82E+06		
	Portland/Seattle	~~1.76E+04~~	~~5.00E+03~~	8.00E+02		4.00E+06		
		4.34E+04	trips/yr	km/trip	yr			
	miscellaneous	6.2	~~5.20E+03~~	1.40E+02	5.50E+00	4.00E+06	Total	9.82E+06
Processing								
Offsite Truck		5.55E+03	trips/yr	km/trip	yr	total		
	Portand/Seattle	~~10.0~~	~~5.00E+01~~	8.00E+02	1.40E+01	5.60E+05		
	miscellaneous	~~4.84~~	~~5.20E+03~~	1.40E+02	1.40E+01	1.02E+07	Total	1.08E+07
		3.0E+04						
Offsite Rail			trips/yr	km/trip	yr	total		
	Portland/Seattle	~~1.76~~	~~1.03E+02~~	8.00E+02	1.40E+01	1.15E+06	Total	1.15E+06
VITRIFIED HLW TRANSPORT								
Offsite Rail			trips	km/trip		total		
	Yucca Mountain		~~2.14E+03~~	2.93E+03		6.27E+06	Total	6.27E+06
			1.47E+04					
CLOSURE								
Onsite Truck			cu yd	trip/cu yd	km/trip	total		
	fill		9.86E+05	1.00E-01	1.00E+01	9.86E+05		

3.33E+04
Calcination
Diesel 3400 Trips
~~Concrete~~ 20 Tons
8.47E+05 trips
steel
7.3E+03
SS
5.2E+03
2710

Sheet B-13
RDW-2-15-96

	silt		4.93E+05	1.00E-01	3.00E+01	1.48E+06		
	riprap		8.35E+05	1.00E-01	3.20E+01	2.67E+06		
	ag/sand		5.43E+05	1.00E-01	1.00E+01	5.43E+05	Total	5.68E+06
GROUT FILL IMUST								
Onsite Truck sand/gravel			2.20E+03	1.00E+01		2.20E+04	Total	2.20E+04
Offsite Truick cement			4.63E+02	1.40E+02		6.48E+04	Total	6.48E+04
Onsite Truck (km)		5.93E+06						
Onsite Rail (km)		0.00E+00						
Offsite Truck (km)		4.23E+07						
Offsite Rail (km)		7.58E+06						
EMPLOYEE VEHICLE								
Retrieval		person-yr	trip/yr	km/trip	car pool	total		
	Const.	1.06E+04	2.60E+02	1.40E+02	7.41E-01	2.86E+08		
	Ops	3.15E+04	2.60E+02	1.40E+02	7.41E-01	8.50E+08		
Vitrification								
	Const.	1.48E+04	2.60E+02	1.40E+02	7.41E-01	3.99E+08		
	Ops	9.78E+03	2.60E+02	1.40E+02	7.41E-01	2.64E+08		
Closure		4.62E+02	2.60E+02	1.40E+02	7.41E-01	1.25E+07		
	total	6.71E+04					Total	1.81E+09
Distance traveled in population zones								
Urban		Offsite km	zone fraction		Onsite	TOTALS		
	Truck	4.23E+07	5.00E-02			2.12E+06		
	Rail	7.58E+06	5.00E-02			3.79E+05		
Suburban								
	Truck	4.23E+07	5.00E-02		5.93E+06	8.05E+06		
	Rail	7.58E+06	5.00E-02			3.79E+05		
Rural								
	Truck	4.23E+07	9.00E-01			3.81E+07		
	Rail	7.58E+06	9.00E-01			6.83E+06		
Fatalities/Injuries resulting from Truck and Rail transportation accidents								
			urban km		suburban km		rural km	
			truck	rail	truck	rail	truck	rail
			2.12E+06	3.79E+05	8.05E+06	3.79E+05	3.81E+07	6.83E+06
urban truck fat/km		7.50E-09	1.59E-02					
urban truck inj/km		3.70E-07	7.83E-01					
urban rail fat/km		1.70E-08		6.45E-03				
urban rail inj/km		3.30E-08		1.25E-02				

Sheet B-14
RW 2-15-96

sub truck fat.km		1.30E-08			1.05E-01			
sub truck inj/km		3.80E-07			3.06E+00			
sub rail fat/km		1.70E-08				6.45E-03		
sub rail inj/km		3.30E-08				1.25E-02		
rural truck fat/km		5.30E-08					2.02E+00	
rural truck inj/km		8.00E-07					3.05E+01	
rural rail fat/km		1.70E-08						1.16E-01
rural rail inj/km		3.30E-08						2.25E-01
	TOTAL FATALITIES		2.27E+00					
	TOTAL INJURIES		3.46E+01					
Fatalities/Injuries resulting from Employee vehicle accidents								
		km	rate/km	TOTAL				
	fatalities	1.81E+09	8.98E-09	1.63E+01				
	injuries	1.81E+09	7.14E-07	1.29E+03				
Cumulative fatalities/injuries from traffic impacts								
			transport	employee	TOTAL			
	FATALITIES		2.27E+00	1.63E+01	1.85E+01			
	INJURIES		3.46E+01	1.29E+03	1.33E+03			
CONSTRUCTION ACCIDENTS								
		rate	person-yr					
	TRC =	9.75E-02	2.59E+04	=	2521.545			
	LWC =	2.45E-02	2.59E+04	=	633.619			
	Fatality =	3.20E-05	2.59E+04	=	0.827584			
OPERATION ACCIDENTS								
		rate	person-yr					
	TRC =	2.20E-02	4.13E+04	=	908.16			
	LWC =	1.10E-02	4.13E+04	=	454.08			
	Fatality =	3.20E-05	4.13E+04	=	1.32096			
TOTALS								
	INJUR	4.76E+03						
	FATAL	2.07E+01						

Sheet B-15
~~SHW~~ 2-15-96

		EX SITU EXTENSIVE 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/misc W-314		1.53E+02	1.40E+02		2.14E+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		~~1.38E+03~~	1.00E+01		1.38E+04	Total	1.38E+04
VITRIFICATION								
Construction								
Onsite Truck			trips	km/trip		total		
	borrow	2.12E+05	~~6.10E+04~~	1.00E+01		6.10E+05	Total	6.10E+05
Offsite Truck			trips	km/trip		total		
35 640	Tri-Cities	1.07E+05	~~2.70E+04~~	1.40E+02		3.78E+06		
	Portland/Seattle 2.62		~~1.10E+04~~	8.00E+02		8.80E+06		
			trips/yr	km/trip	yr			
	miscellaneous 6.2		~~5.20E+03~~	1.40E+02	9.00E+00	6.55E+06	Total	1.91E+07
Processing								
Offsite Truck			trips/yr	km/trip	yr	total		
32E+04	glassformer/chem		~~5.13E+02~~	8.00E+02	1.60E+01	6.57E+06		
	miscellaneous 6.2		~~5.20E+03~~	1.40E+02	1.60E+01	1.16E+07	Total	1.82E+07
Offsite Rail			trips/yr	km/trip	yr	total		
1.38E+03	glassformer/chem		~~6.37E+02~~	8.00E+02	1.60E+01	8.15E+06	Total	8.15E+06
VITRIFIED HLW TRANSPORT								
Offsite Rail			trips	km/trip		total		
	Yucca Mountain 3.9		~~1.00E+01~~	2.93E+03		2.93E+04	Total	2.93E+04
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-16
RDW 2-15-96

	silt		6.93E+05	1.00E-01	3.00E+01	2.08E+06		
	riprap		1.05E+06	1.00E-01	3.20E+01	3.36E+06		
	ag/sand		7.93E+05	1.00E-01	1.00E+01	7.93E+05	Total	7.22E+06
GROUT FILL IMUST								
Onsite Truck sand/gravel			2.20E+03	1.00E+01		2.20E+04	Total	2.20E+04
Offsite Truck cement			4.63E+02	1.40E+02		6.48E+04	Total	6.48E+04
Onsite Truck (km)		7.88E+06						
Onsite Rail (km)		0						
Offsite Truck (km)		5.91E+07						
Offsite Rail (km)		8.34E+06						
EMPLOYEE VEHICLE								
Retrieval		person-yr	trip/yr	km/trip	car pool	total		
	Const.	1.06E+04	2.60E+02	1.40E+02	7.41E-01	2.86E+08		
	Ops/D&D	3.74E+04	2.60E+02	1.40E+02	7.41E-01	1.01E+09		
Vitrification								
	Const.	2.58E+04	2.60E+02	1.40E+02	7.41E-01	6.96E+08		
	Ops/D&D	6.95E+03	2.60E+02	1.40E+02	7.41E-01	1.87E+08		
Closure		4.90E+02	2.60E+02	1.40E+02	7.41E-01	1.32E+07		
	total	8.12E+04					Total	2.19E+09
Distance traveled in population zones								
Urban		Offsite km	zone fraction		Onsite	TOTALS		
	Truck	5.91E+07	5.00E-02			2.95E+06		
	Rail	8.34E+06	5.00E-02			4.17E+05		
Suburban								
	Truck	5.91E+07	5.00E-02		7.88E+06	1.08E+07		
	Rail	8.34E+06	5.00E-02			4.17E+05		
Rural								
	Truck	5.91E+07	9.00E-01			5.32E+07		
	Rail	8.34E+06	9.00E-01			7.51E+06		
Fatalities/Injuries resulting from Truck and Rail transportation accidents								
			urban km		suburban km		rural km	
			truck	rail	truck	rail	truck	rail
			2.95E+06	4.17E+05	1.08E+07	4.17E+05	5.32E+07	7.51E+06
urban truck fat/km		7.50E-09	2.22E-02					
urban truck inj/km		3.70E-07	1.09E+00					

Sheet B-17
RDW 2-15-96

urban rail fat/km		1.70E-08		7.09E-03				
urban rail inj/km		3.30E-08		1.38E-02				
sub truck fat.km		1.30E-08			1.41E-01			
sub truck inj/km		3.80E-07			4.12E+00			
sub rail fat/km		1.70E-08				7.09E-03		
sub rail inj/km		3.30E-08				1.38E-02		
rural truck fat/km		5.30E-08					2.82E+00	
rural truck inj/km		8.00E-07					4.26E+01	
rural rail fat/km		1.70E-08						1.28E-01
rural rail inj/km		3.30E-08						2.48E-01
	TOTAL FATALITIES		3.12E+00					
	TOTAL INJURIES		4.80E+01					
Fatalities/Injuries resulting from Employee vehicle accidents								
		km	rate/km	TOTAL				
	fatalities	2.19E+09	8.98E-09	1.97E+01				
	injuries	2.19E+09	7.14E-07	1.56E+03				
Cumulative fatalities/injuries from traffic impacts								
			transport	employee	TOTAL			
	FATALITIES		3.12E+00	1.97E+01	2.28E+01			
	INJURIES		4.80E+01	1.56E+03	1.61E+03			
CONSTRUCTION ACCIDENTS								
		rate	person-yr					
	TRC =	9.75E-02	3.69E+04	=	3596.775			
	LWC =	2.45E-02	3.69E+04	=	903.805			
	Fatality =	3.20E-05	3.69E+04	=	1.18048			
OPERATION ACCIDENTS								
		rate	person-yr					
	TRC =	2.20E-02	4.44E+04	=	975.7			
	LWC =	1.10E-02	4.44E+04	=	487.85			
	Fatality =	3.20E-05	4.44E+04	=	1.4192			
TOTALS								

Sheet B-18
RDW 2-15-96

	INJUR	6.19E+03					
	FATAL	2.54E+01					

Sheet B-19
RDW 2-15-96

			EX SITU COMBINATION					
RETRIEVAL								
Waste Transport						total		
Onsite Truck						0.00E+00		
Construction								
Offsite Truck			trips/yr	km/trip	yr	total		
	concrete		2.40E+02	1.40E+02	2.00E+01	6.72E+05		
	raw material		2.25E+01	8.00E+02	2.00E+01	3.60E+05		
	equipment		1.25E+01	1.00E+04	2.00E+01	2.50E+06		
	miscellaneous		2.60E+03	1.40E+02	2.00E+01	7.28E+06		
	steel W-314		5.30E+01	8.00E+02		4.24E+04		
	cement/misc W-314		1.53E+02	1.40E+02		2.14E+04	Total	1.09E+07
Offsite Rail			trips/yr	km/trip	yr	total		
	raw material		5.00E+00	8.00E+02	2.00E+01	8.00E+04	Total	8.00E+04
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 2.30	8.4E04	~~2.60E+04~~	1.00E+01		2.60E+05	Total	2.60E+05
Offsite Truck			trips	km/trip		total		
	concrete	2.3E+04	~~1.45E+04~~	1.40E+02		2.03E+06		
	steel	9.1E+03	~~4.75E+03~~	8.00E+02		3.80E+06		
			trips/yr	km/trip	yr			
1.31E+04	miscellaneous		~~2.60E+03~~	1.40E+02	1.00E+01	3.64E+06	Total	9.47E+06
		2.45E+04						
Processing		~~[illegible]~~						
Offsite Truck			trips/yr	km/trip	yr	total		
	glassformer/chem		~~1.15E+01~~	8.00E+02	1.95E+01	1.79E+05		
	miscellaneous		2.60E+03	1.40E+02	1.95E+01	7.10E+06	Total	7.28E+06
Offsite Rail			trips/yr	km/trip	yr	total		
	glassformer/chem 1.62		~~1.30E+02~~	8.00E+02	~~4.95E+01~~	2.03E+06	Total	2.03E+06
VITRIFIED HLW TRANSPORT								
Offsite Rail			trips	km/trip		total		
4.18E+02	Yucca Mountain		~~8.50E+01~~	2.93E+03		2.49E+05	Total	2.49E+05
CLOSURE								
Onsite Truck			cu yd	trip/cu yd	km/trip	total		
	fill		9.36E+05	1.00E-01	1.00E+01	9.36E+05		

Sheet B-2D
RDW 2-15-96

	silt		5.76E+05	1.00E-01	3.00E+01	1.73E+06		
	riprap		9.21E+05	1.00E-01	3.20E+01	2.95E+06		
	ag/sand		6.43E+05	1.00E-01	1.00E+01	6.43E+05	Total	6.25E+06
GROUT FILL IMUST								
Onsite Truck sand/gravel			2.20E+03	1.00E+01		2.20E+04	Total	2.20E+04
Offsite Truck cement			4.63E+02	1.40E+02		6.48E+04	Total	6.48E+04
Onsite Truck (km)		6.55E+06						
Onsite Rail (km)		0.00E+00						
Offsite Truck (km)		2.77E+07						
Offsite Rail (km)		2.36E+06						
EMPLOYEE VEHICLE								
Retrieval		person-yr	trip/yr	km/trip	car pool	total		
	Const.	6.36E+03	2.60E+02	1.40E+02	7.41E-01	1.72E+08		
	Ops/D&D	2.24E+04	2.60E+02	1.40E+02	7.41E-01	6.04E+08		
Vitrification								
	Const.	1.19E+04	2.60E+02	1.40E+02	7.41E-01	3.21E+08		
	Ops/D&D	1.04E+04	2.60E+02	1.40E+02	7.41E-01	2.81E+08		
Fill tank								
	Const.	5.70E+01	2.60E+02	1.40E+02	7.41E-01	1.54E+06		
	Ops/D&D	1.80E+03	2.60E+02	1.40E+02	7.41E-01	4.86E+07		
Closure		5.74E+02	2.60E+02	1.40E+02	7.41E-01	1.55E+07		
							Total	1.44E+09
Distance traveled in population zones								
Urban		Offsite km	zone fraction		Onsite	TOTALS		
	Truck	2.77E+07	5.00E-02			1.38E+06		
	Rail	2.36E+06	5.00E-02			1.18E+05		
Suburban								
	Truck	2.77E+07	5.00E-02		6.55E+06	7.93E+06		
	Rail	2.36E+06	5.00E-02			1.18E+05		
Rural								
	Truck	2.77E+07	9.00E-01			2.49E+07		
	Rail	2.36E+06	9.00E-01			2.12E+06		
Fatalities/Injuries resulting from Truck and Rail transportation accidents								
			urban km		suburban km		rural km	
			truck	rail	truck	rail	truck	rail
			1.38E+06	1.18E+05	7.93E+06	1.18E+05	2.49E+07	2.12E+06
urban truck fat/km		7.50E-09	1.04E-02					

Sheet B-21
RJW 2-15-96

urban truck inj/km		3.70E-07	5.12E-01					
urban rail fat/km		1.70E-08		2.00E-03				
urban rail inj/km		3.30E-08		3.89E-03				
sub truck fat.km		1.30E-08			1.03E-01			
sub truck inj/km		3.80E-07			3.02E+00			
sub rail fat/km		1.70E-08				2.00E-03		
sub rail inj/km		3.30E-08				3.89E-03		
rural truck fat/km		5.30E-08					1.32E+00	
rural truck inj/km		8.00E-07					1.99E+01	
rural rail fat/km		1.70E-08						3.61E-02
rural rail inj/km		3.30E-08						7.00E-02
	TOTAL FATALITIES		1.47E+00					
	TOTAL INJURIES		2.35E+01					
Fatalities/Injuries resulting from Employee vehicle accidents								
		km	rate/km	TOTAL				
	fatalities	1.44E+09	8.98E-09	1.30E+01				
	injuries	1.44E+09	7.14E-07	1.03E+03				
Cumulative fatalities/injuries from traffic impacts								
			transport	employee	TOTAL			
	FATALITIES		1.47E+00	1.30E+01	1.44E+01			
	INJURIES		2.35E+01	1.03E+03	1.05E+03			
CONSTRUCTION ACCIDENTS								
		rate	person-yr					
	TRC =	9.75E-02	1.89E+04	=	1841.873			
	LWC =	2.45E-02	1.89E+04	=	462.8295			
	Fatality =	3.20E-05	1.89E+04	=	0.604512			
OPERATION ACCIDENTS								
		rate	person-yr					
	TRC =	2.20E-02	3.46E+04	=	761.2			
	LWC =	1.10E-02	3.46E+04	=	380.6			
	Fatality =	3.20E-05	3.46E+04	=	1.1072			
TOTALS								

Sheet B-22
KDW 2-15-96

	INJUR	3.66E+03					
	FATAL	1.61E+01					

No Change?

Sheet B-23
RDW 2-15-96

	PHASE 1 IMPLEMENTATION SUB-ALTERNATIVE							
RETRIEVAL								
WASTE TRANSFER SYSTEM UPGRADE (W-314)								
	Onsite Truck		trips	km/trip		total		
	borrow		1.38E+03	1.00E+00		1.38E+03	Total	1.38E+03
	Offsite Truck							
	steel		5.30E+01	8.00E+02		4.24E+04		
	cement		1.00E+02	1.40E+02		1.40E+04	Total	5.64E+04
VITRIFICATION								
	Construction							
	Onsite Truck		trips	km/trip		total		
	borrow		1.96E+03	1.00E+01		1.96E+04	Total	1.96E+04
	Offsite Truck		trips	km/trip		total		
	concrete		1.20E+03	1.40E+02		1.68E+05		
	steel		7.32E+03	8.00E+02		5.86E+06		
	miscellaneous		3.18E+03	1.40E+02		4.45E+05	Total	6.47E+06
	Processing							
	Offsite Truck		trips	km/trip		total		
	glassformer/chem		3.50E+03	8.00E+02		2.80E+06		
	glassformer/chem		3.57E+03	1.40E+02		5.00E+05		
	miscellaneous		5.20E+04	1.40E+02		7.28E+06	Total	1.06E+07
	Offsite Rail		trips	km/trip		total		
	glassformer/chem		2.18E+02	8.00E+02		1.74E+05	Total	1.74E+05
VITRIFIED HLW TRANSPORT								
SITE RESTORATION								
	Onsite Truck		trips	km/trip		total		
	contaminated waste		1.50E+03	1.61E+01		2.42E+04		
	noncont. waste		6.23E+04	1.61E+01		1.00E+06	Total	1.03E+06

Sheet B-24
RJW 2-15-96

GROUT FILL IMUST								
Onsite Truck (km)		1.05E+06						
Onsite Rail (km)		0.00E+00						
Offsite Truck (km)		1.71E+07						
Offsite Rail (km)		1.74E+05						
EMPLOYEE VEHICLE								
		person-yr	trip/yr	km/trip	car pool	total		
	Const.	1.07E+04	2.60E+02	1.40E+02	7.41E-01	2.89E+08		
	Ops/D&D	6.93E+03	2.60E+02	1.40E+02	7.41E-01	1.87E+08	Total	4.76E+08
Distance traveled in population zones								
Urban		Offsite km	zone fraction		Onsite	TOTALS		
	Truck	1.71E+07	5.00E-02			8.55E+05		
	Rail	1.74E+05	5.00E-02			8.72E+03		
Suburban								
	Truck	1.71E+07	5.00E-02		1.05E+06	1.90E+06		
	Rail	1.74E+05	5.00E-02			8.72E+03		
Rural								
	Truck	1.71E+07	9.00E-01			1.54E+07		
	Rail	1.74E+05	9.00E-01			1.57E+05		
Fatalities/Injuries resulting from Truck and Rail transportation accidents								
			urban km		suburban km		rural km	
			truck	rail	truck	rail	truck	rail
			8.55E+05	8.72E+03	1.90E+06	8.72E+03	1.54E+07	1.57E+05
urban truck fat/km		7.50E-09	6.41E-03					

Sheet B-25
RDJ 2-15-96

urban truck inj/km		3.70E-07	3.16E-01					
urban rail fat/km		1.70E-08		1.48E-04				
urban rail inj/km		3.30E-08		2.88E-04				
sub truck fat.km		1.30E-08			2.47E-02			
sub truck inj/km		3.80E-07			7.23E-01			
sub rail fat/km		1.70E-08				1.48E-04		
sub rail inj/km		3.30E-08				2.88E-04		
rural truck fat/km		5.30E-08					8.16E-01	
rural truck inj/km		8.00E-07					1.23E+01	
rural rail fat/km		1.70E-08						2.67E-03
rural rail inj/km		3.30E-08						5.18E-03
	TOTAL FATALITIES		8.50E-01					
	TOTAL INJURIES		1.34E+01					
Fatalities/Injuries resulting from Employee vehicle accidents								
		km	rate/km	TOTAL				
	fatalities	4.76E+08	8.98E-09	4.27E+00				
	injuries	4.76E+08	7.14E-07	3.40E+02				
Cumulative fatalities/injuries from traffic impacts								
			transport	employee	TOTAL			
	FATALITIES		8.50E-01	4.27E+00	5.12E+00			
	INJURIES		1.34E+01	3.40E+02	3.53E+02			
CONSTRUCTION ACCIDENTS								
		rate	person-yr					
	TRC =	9.75E-02	1.07E+04	=	1043.25			
	LWC =	2.45E-02	1.07E+04	=	262.15			
	Fatality =	3.20E-05	1.07E+04	=	0.3424			
OPERATION ACCIDENTS								
		rate	person-yr					
	TRC =	2.20E-02	6.93E+03	=	152.46			
	LWC =	1.10E-02	6.93E+03	=	76.23			
	Fatality =	3.20E-05	6.93E+03	=	0.22176			
TOTALS								

Sheet B-26
RJW 2-15-96

	INJUR	1.55E+03						
	FATAL	5.68E+00						

Sheet B-27
RDW 2-15-96

	TOTAL 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		
	borrow (W-314)		1.38E+03	1.00E+01		1.38E+04	Total	2.16E+07
Offsite Rail			trips/yr	km/trip	yr	total		
	raw material		1.00E+01	8.00E+02	2.00E+01	1.60E+05		
	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	2.16E+05
VITRIFICATION								
Construction								
Onsite Truck		1.44E+05	trips	km/trip		total		
	borrow p-30		~~2.80E+04~~	1.00E+01		2.80E+05	Total	2.80E+05
Offsite Truck			trips	km/trip		total		
	concrete	2.61E4	~~1.57~~E+04	1.40E+02		2.20E+06		
	steel	9.7E03	~~1.21E+03~~	8.00E+02		9.68E+05		
	miscellaneous	3.11E04	~~2.92E+04~~	1.40E+02		4.09E+06	Total	7.25E+06
Processing								
Offsite Truck			trips	km/trip		total		
1.65 E+04	glassformer/chem		~~3.72E+03~~	8.00E+02		2.98E+06		
	miscellaneous		1.03E+05	1.40E+02		1.44E+07		
3.0 E+04	process material		~~3.57E+03~~	1.40E+02		5.00E+05	Total	1.79E+07
Offsite Rail			trips	km/trip		total		
3.0 E+03	glassformer/chem		~~2.75E+03~~	8.00E+02		2.20E+06	Total	2.20E+06
VITRIFIED HLW TRANSPORT								
Offsite Rail			trips	km/trip		total		
	Yucca Mountain		1.70E+02	2.93E+03		4.98E+05	Total	4.98E+05
			8.35E+02					
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-28
RGN 2-15-96

	silt		6.93E+05	1.00E-01	3.00E+01	2.08E+06		
	riprap		1.05E+06	1.00E-01	3.20E+01	3.36E+06		
	ag/sand		7.93E+05	1.00E-01	1.00E+01	7.93E+05		
	grout fill sand IMUST		2.20E+03	1.00E+01		2.20E+04	Total	7.24E+06
Offsite Truck			trips	km/trip		total		
	groutfill cement IMUS		4.63E+02	1.40E+02		6.48E+04	Total	6.48E+04
Onsite Truck (km)		7.53E+06						
Onsite Rail (km)		0.00E+00						
Offsite Truck (km)		4.69E+07						
Offsite Rail (km)		2.91E+06						
EMPLOYEE VEHICLE								
Phase 1		person-yr	trip/yr	km/trip	car pool	total		
	Const.	1.16E+04	2.60E+02	1.40E+02	7.41E-01	3.13E+08		
	Ops/D&D	6.77E+03	2.60E+02	1.40E+02	7.41E-01	1.83E+08		
Phase 2								
	Const.	1.98E+04	2.60E+02	1.40E+02	7.41E-01	5.34E+08		
	Ops/D&D	4.91E+04	2.60E+02	1.40E+02	7.41E-01	1.32E+09		
							Total	2.35E+09
Distance traveled in population zones								
Urban		Offsite km	zone fraction		Onsite	TOTALS		
	Truck	4.69E+07	5.00E-02			2.34E+06		
	Rail	2.91E+06	5.00E-02			1.46E+05		
Suburban								
	Truck	4.69E+07	5.00E-02		7.53E+06	9.88E+06		
	Rail	2.91E+06	5.00E-02			1.46E+05		
Rural								
	Truck	4.69E+07	9.00E-01			4.22E+07		
	Rail	2.91E+06	9.00E-01			2.62E+06		
Fatalities/Injuries resulting from Truck and Rail transportation accidents								
			urban km		suburban km		rural km	
			truck	rail	truck	rail	truck	rail
			2.34E+06	1.46E+05	9.88E+06	1.46E+05	4.22E+07	2.62E+06
urban truck fat/km		7.50E-09	1.76E-02					

Sheet B-29
RDW 2-15-96

urban truck inj/km		3.70E-07	8.67E-01					
urban rail fat/km		1.70E-08		2.48E-03				
urban rail inj/km		3.30E-08		4.81E-03				
sub truck fat.km		1.30E-08			1.28E-01			
sub truck inj/km		3.80E-07			3.75E+00			
sub rail fat/km		1.70E-08				2.48E-03		
sub rail inj/km		3.30E-08				4.81E-03		
rural truck fat/km		5.30E-08					2.23E+00	
rural truck inj/km		8.00E-07					3.37E+01	
rural rail fat/km		1.70E-08						4.46E-02
rural rail inj/km		3.30E-08						8.66E-02
	TOTAL FATALITIES		2.43E+00					
	TOTAL INJURIES		3.84E+01					
Fatalities/Injuries resulting from Employee vehicle accidents								
		km	rate/km	TOTAL				
	fatalities	2.35E+09	8.98E-09	2.11E+01				
	injuries	2.35E+09	7.14E-07	1.68E+03				
Cumulative fatalities/injuries from traffic impacts								
			transport	employee	TOTAL			
	FATALITIES		2.43E+00	2.11E+01	2.36E+01			
	INJURIES		3.84E+01	1.68E+03	1.72E+03			
CONSTRUCTION ACCIDENTS								
		rate	person-yr					
	TRC =	9.75E-02	3.14E+04	=	3061.5			
	LWC =	2.45E-02	3.14E+04	=	769.3			
	Fatality =	3.20E-05	3.14E+04	=	1.0048			
OPERATION ACCIDENTS								
		rate	person-yr					
	TRC =	2.20E-02	5.59E+04	=	1229.14			
	LWC =	1.10E-02	5.59E+04	=	614.57			
	Fatality =	3.20E-05	5.59E+04	=	1.78784			
TOTALS								

Sheet B-30
RDW 2-15-96

	INJUR	6.01E+03						
	FATAL	2.64E+01						

	1	2	3	4	5	Rev 6
					Sheet B-31	2-15-96
Gasoline (m^3)	54.6 ~~m^3~~	NA	NA	54.6	20	75.5
(gals)	26454.6 gals			26454.6 gals	5280 gallons	19884.8 gal
Diesel (m^3)	3.51E+03 ~~m^3~~	1.4E+04	6.044E+04	2.3E+04	5.05 ~~9.20~~ E+03	4.78E+0
(gals)	9.27E+05	3.7E+06	1.6E+07	6.07E+06	1.333E+06	1.262E+06
Kerosene (m^3)	4.06E+04	1.06E+05	NA	1.404E+05	2.03E+04	2.1E+04
gals	1.072E+07	2.80E+07		3.71E+07	5.36E+06	5.544E+0
Concrete (m^3) (yds)^3	2.67E+05	1.66E+05 ~~7.13E+06~~	2.23E+04	2.58E+05	9.9E+04	1.98E+05
cement (m^3)	3.5E+05	2.18E+05	2.92E+04	3.38E+05	1.297E+05	2.59E+05
on site sand (m^3) (Ton)	4.7E+05	2.92E+05	3.93E+04	4.54E+05	1.74E+05	3.49E+05
on site pit 30 gravel (m^3)						
Concrete Prefab Shapes (m^3)	3.77E+05	7.13E+06	9.52E+05	8.11E+03	1.88E+05	3.77E+05
(tons)	(#6645) 6.64E+05	(#125,600) 1.255E+07	1.68E+06	1.43E+04	3.31E+05	6.64E+05
Carbon Steel - rebar (MT)	4.951E+04	5.97E+03	9.56E+02	3.0E+04	1.1E+04	2.24E+04
(tons)	5.45E+04	6.57E+03	1.052E+03	3.3E+04	1.21E+04	2.464E+04
Carbon Steel Prefab Shapes (MT)	2.57E+03	NA	NA	1.26E+05	5.35E+04	1.06E+05
(tons)	2.83E+03			1.39E+05	5.89E+04	1.17E+05
Stainless Steel prefab shapes (MT)	4.41E+04	4.4E+05	8.13E+04	1.2E+03	1.25E+04	2.5E+04
	4.85E+04	4.94E+05	8.94E+04	1.32E+03	1.375E+04	2.76E+04
Glass formers (MT)	2.1E+05	2.18E+05	NA	5.33E+05	1.03E+05	1.96E+05
Sand (yds^3)	2.75E+05	1.4E+05		7.0E+05	1.35E+05	2.57E+05
CaO	1+P 26050	24480		Sand+ 71400	13770	26214
mg oxide	4.24E4	4.4E4		1.08E5	2.08E4	3.96 5.94E4
Boron 0.1457						
Process oxygen (MT)	1.34 ~~3.26~~E+05	1.25 ~~3.46~~E+05	NA	2.78E+05	1.63E+05	1.4E+05
Process Chemicals						
(tons)	1.47E+05	1.38E+05		3.06E+05	1.79E5	1.54E+05
Sulfur Cement						
Sulfur (MT)	9.1E+04	NA	NA	2.55E+05	4.6E+04	8.4E+04
dicyclopentadiene (MT)	2.38E+03	NA	NA	6.74E+03	1.19E+03	2.38E+03
Oligomer (MT)	2.38E+03	NA	NA	6.74E+03	1.19E+03	2.38E+03

~~m^3~~ gallons = (m^3) ~~[illegible]~~ $\left(\frac{10^3 \text{ liters}}{m^3}\right)\left(\frac{1}{3.788}\right)\left(\frac{\text{gallons}}{\text{liter}}\right)$ = (m^3)(264) = gallons

yds^3 = (m^3)(1.31)

tons = (mtons)(1.1) Concrete = 1.6 mg/m^3 (1.1) = Tons

(1.1)(2.7)

tons = (m^3)(1.76)

Sheet B-32
RDW 2-15-96

Items for Trucking/Railcar

~~[illegible]~~

Gasoline
Diesel fuel
Kerosene
Concrete: cement (tons)
(cu yds) Sand
(cu yds) gravel
Concrete prefab materials
Carbon Steel Prefab
Stainless Steel prefab
Carbon Steel Rebar
glass formers
process chemicals:
Oxygen ? m^3

		%
Silica	1760	0.816
Boron	14	0.0065
Calcium	286	0.1327
alumina	96	0.0445
	2156	

0.1837

1327
.0445
.0065
0.1837

Sulfer
dicyclopentadine
Oligmer

$$\text{Tons} = m^3 \left(\frac{Mg}{m^3}\right)\left(\frac{mT}{Mg}\right)\left(\frac{1.1\ \text{Tons}}{mT}\right)$$

$$\text{Tons} = (m^3)(1.6)(1.1) = m^3(1.76)$$

alternatives
1. Ex Situ Intermediate seps.
2. Ex Situ no Seps vitri
3. Ex Situ no Seps Calcine
4. Ex Situ Extensive Seps.
5. Ex Situ/In Situ Combo.
6. phase 0 Implementation phase 2

ITEM	TRANSPORT	ALTERNATIVES — NUMBER OF TRIPS 1	2	3	4	5	6
	Tri Cities					Sheet B-33	RDW 2-15-96
Gasoline	TK TRUCK	6	NA	NA	6	2	4
Diesel	Tri Cities/TK Truck	186	740	3200	1214	267	253
Kerosene	Tri Cities/TK Truck	2144	5600	NA	7420	1072	1109
Concrete	25T TRUCK						
Cement	PORT/Seattle	18800	11680	1168	13520	5188	10360
Sand	PIT 30 6 yd³/L	58334	48667	6550	75667	29000	58167
Gravel	PIT 30	58334	48667	6550	75667	29000	58167
Concrete Prefab Shapes	Tri Cities / Special Truck	6645 (1 PER TRUCK)	125600	16797	143	3322	6645
Carbon Steel Rebar	Truck/20T	2725	329	53	1650	688	1232
Carbon Steel Prefab Shapes	Truck/20T	142	NA	NA	6950	2945	5850
Stainless Steel Prefab Shapes	Truck/20T	2718	24200	4470	66	688	1380
Glass formers							
Sand	8 yd³/truck	28050	24480	NA	71400	13770	26214
other material	20T truck	2122	2203	NA	5386	1040	1980
oxygen 25T/	25T/truck	5896	5500	NA	12240	7172	6160
Sulfur Cement	~~20T/truck~~						
Sulfur	20T truck	5005	NA	NA	14025	2530	4640
DCPD	20T truck	131	NA	NA	371	66	131
DCP	20T truck	131	NA	NA	371	66	131

Vit Calcium

SHW 25%, 1.25 HLW 40%, 1.5
Sheet B-34
RDJ 2-15-96

Sensitivity Case 1

	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	7.22E+04	1.00E+01		5.20E+05		
						Total	5.20E+05
Offsite Truck		trips	km/trip		total		
	concrete	3.47E+04	1.40E+02		4.06E+06		
	steel	1.4E+04	8.00E+02		7.60E+06		
		trips/yr	km/trip	yr			
	miscellaneous	5.41E+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	1.19E+03	8.00E+02	1.95E+01	3.59E+05		
	miscellaneous	6.5E+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	4.19E+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		