0043218

TWRS EIS
CALCULATION COVER SHEET

MAR 1996
RECEIVED
EDMC

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 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.O.P. Nguyen 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	13615.1	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.

7 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 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 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 2063. 2) Assume the ongoing negotiations result 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. 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 UCL 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.

9 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. 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 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)	1665.985	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 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

JACOBS\USER\CROW\RK-CALCV.WPD

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*	

Due to Transportation Risk

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*		
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

+ Due to Transportation Risk

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	3.13E-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 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)

SIGNATURE

CALCULATION & RESULTS ATTACHED

JACOBS\FORMS\CALCVR.SHT

JACOBS ENGINEERING GROUP INC.

DATE 12/7/95 SUBJECT SHEET NO. 1-15

BY DLS CHKD. JOB NO. 01K47101

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.

FORM 01-005-1 (4/61)

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 F-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 91-005-1 (4/81)

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

* The pretreatment plant will be assumed to be roughly 1/3 between Intermediate Sep. (TPA) 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

JACOBS ENGINEERING GROUP INC.

DATE 12/7 SUBJECT SHEET NO. 4-15

BY DLS CHKD. JOB NO.

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 from 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

FORM 61-005-1 (4/81)

JACOBS ENGINEERING GROUP INC.

DATE 12/7 SUBJECT SHEET NO. 5-15

BY DL CHKD. JOB NO.

AT 1/3 between Inter. Sep + ERT. 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

FORM S1-005-1 (4/81)

JACOBS ENGINEERING GROUP INC.

DATE 12/7 SUBJECT SHEET NO. 6-15

BY DLS CHKD. 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

FORM 81-0061 (4/83)

JACOBS ENGINEERING GROUP INC.

DATE 12/7 SUBJECT SHEET NO. 7-15

BY DLS CHKD. 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 91-005-1 (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	total
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 about labor

Total op cost = $1501 million

FORM 81-005-1 (4/87)

JACOBS ENGINEERING GROUP INC.

DATE 2/26/94 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 81-005-1 (4/61)

JACOBS ENGINEERING GROUP INC.

DATE 2/26/96 SUBJECT SHEET NO. 11-15

BY [illegible] CHKD. 12 MT/D HLW, 185 MT/D LAW JOB NO.

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.

or 1/3 x $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 20 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 x (100 − 20)% = $3058 million

FORM 91-005-1 (4/81)

JACOBS ENGINEERING GROUP INC.

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

BY DRS 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 comprize 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 staff yrs

This is 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 = $1133 million

(as per TPA)

FORM 91-005-1 (4/81)

JACOBS ENGINEERING GROUP INC.

DATE 2/26/96 SUBJECT SHEET NO. 13-15

BY DLS CHKD. JOB NO.

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

FORM 91-005-1 (4/87)

JACOBS ENGINEERING GROUP INC.

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

BY DLS CHKD. JOB NO.

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
Repository Fee	—	6500	6500
Total	7866 million	25342 million	$33208 million

FORM 91-006-1 (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.

15-15

JACOBS ENGINEERING GROUP INC.

251 SOUTH LAKE AVENUE, PASADENA, CALIFORNIA 91101-3063
TELEPHONE (818) 568-7000 FAX (818) 568-7129

FAX TRANSMITTAL

PASADENA OPERATIONS
FAX # (818) 568-7129

DATE: 2/27/96

TO: Colin Henderson FAX #: (509) 736-7504

FIRM: JEG - Kennewick

FROM: D. Stein EXT: (818) 568-7132

PROJECT: 01K47101 WBS:
(For charging actual Fax) (For charging time for faxing)

COMMENTS AND MESSAGES:

Following is Phased Impl Summary + cost uncertainity info. Target Value is now slightly higher at $33,208 vs. last estimate of $32,953. Phase 1 + Phase 2 estimates are more consistent now than before. Engr. calc sheets to follow later this afternoon.

Should you not receive 1 pages (including this transmittal sheet) please contact the sender.

DATE/TIME Submitted: _____

MUST BE SENT by: _____
(date) (time)

Date Sent: _____

Time Sent: _____

Operator's Initials: _____

MISC34-008W (8/94)

JACOBS ENGINEERING GROUP INC.

DATE 2/26/96 SUBJECT

BY DLS CHKD.

SHEET NO. 14-15

JOB NO.

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
Repository Fee	—	6500	6500
Total	7866 million	25342 million	$33208 million

FORM 61-006-1 (4/61)

JACOBS ENGINEERING GROUP INC.

DATE 2/27/96 SUBJECT SHEET NO.

BY D Stein CHKD. JOB NO.

Phased Implementation (2/27/96 update)

Target Value $33,208

95% Confidence Range $30,306 – $36,542

FORM 91-005-1 (4/81)

REP/PC (Ver 4.0) - MGMT REPORT 1 RANGE ESTIMATE : 02-27-96

DATA : Phased Implementation case 10B
MODEL : BASIC MODEL (SUMMATION)

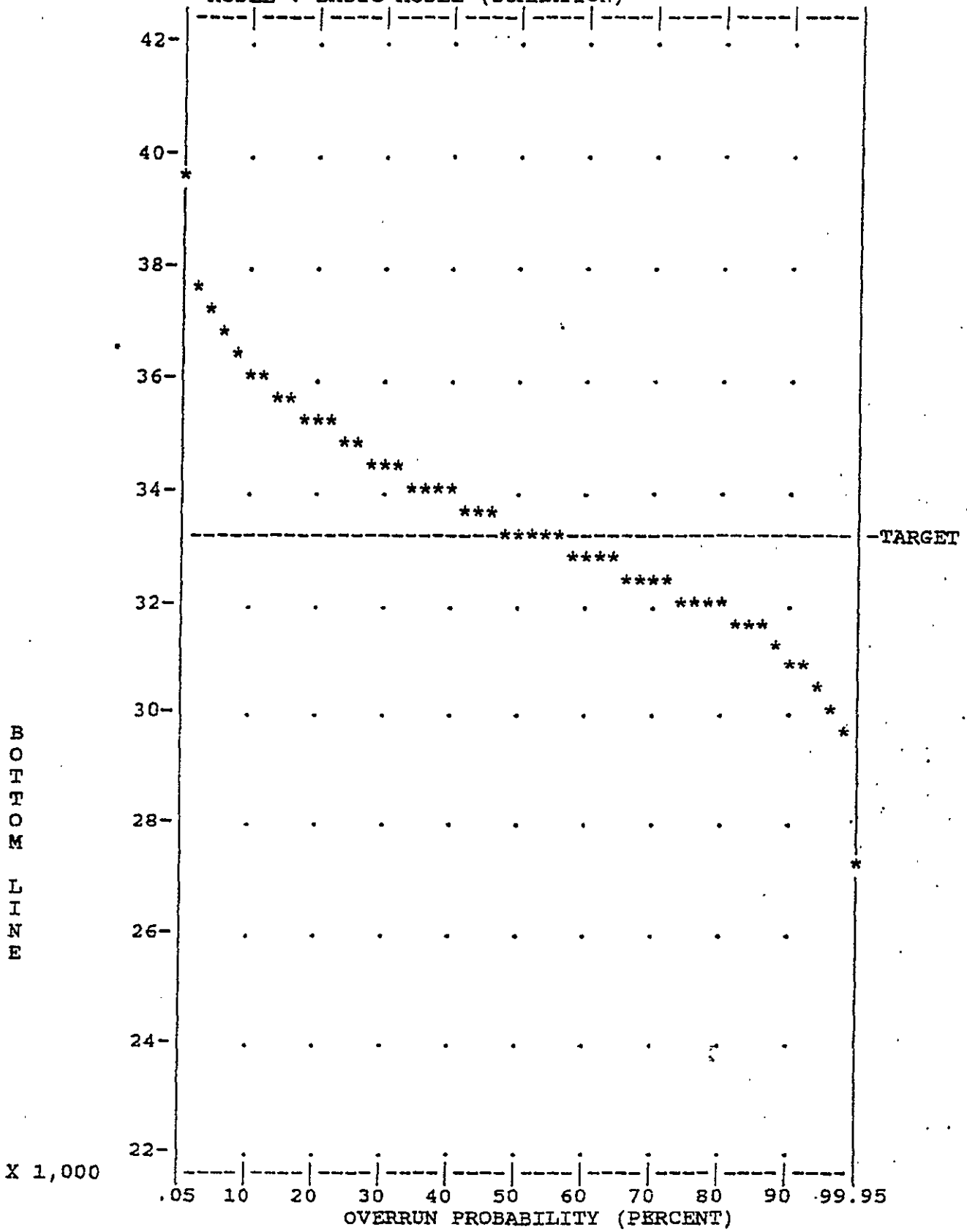
NUM	ELEMENT	UNIT	TARGET	PROB+	LOW	HIGH
1	Current Operations		8600	50	6880	10320
2	R&D Waste Ret. & Transfer		190.00		190.00	190.00
3	R&D Treatment		0		0	0
4	Capital Waste Ret. & Transfer		2280	50	1824	3876
5	Capital Treament		4483	40	3586	8966
6	Capital Closure		211.00		211.00	211.00
7	Operations Waste Ret. & Transfer		3990	50	3192	6783
8	Operations Treatment		6954	50	5215	6955
9	M & M		0		0	0
10	Repository Fee		6500	95	3900	6501
	TOTAL EXPENSE (INPUT TO REP/PC)		33208		24998 (THEORETICALS)	43802

+ PROBABILITY THAT ACTUAL VALUE WILL BE EQUAL TO OR LESS THAN TARGET

REP/PC (Ver 4.0) - MGMT REPORT 2 GRAPHICAL OVERRUN PROFILE : 02-27-96

DATA : Phased Implementation case 10B

MODEL : BASIC MODEL (SUMMATION)



REP/PC (Ver 4.0) - MGMT REPORT 3 GRAPHICAL PRIORITY PROFILE : 02-27-96

DATA : Phased Implementation case 10B
MODEL : BASIC MODEL (SUMMATION)

TOTAL EXPENSE	PROB OF OVERRUN	NET EFFECT OF FROZEN ELEMENTS
33208	52 PCT	0 = .0 PCT

NUM	ELEMENT	UNIT	CORRECT	PROTECT
5	Capital Treament		----------	++
10	Repository Fee			+++++++++++
7	Operations Waste Ret. & Transfer		-------	++
1	Current Operations		----	++++
4	Capital Waste Ret. & Transfer		----	+
8	Operations Treatment			++++
	NET EFFECT OF FROZEN ELEMENTS			

REP/PC (Ver 4.0) - MGMT REPORT 4 CONTINGENCY PROFILE : 02-27-96

DATA : Phased Implementation case 10B
MODEL : BASIC MODEL (SUMMATION)

TO BE THIS CONFIDENT OF NOT HAVING COST OVERRUN		ADD THIS CONTINGENCY ABSOLUTE	RELATIVE	
100	PCT	10594	31.9	PCT
99.95	"	6308	19.0	"
95	"	3734	11.2	"
90	"	2865	8.6	"
85	"	2383	7.2	"
80	"	1958	5.9	"
75	"	1567	4.7	"
70	"	1254	3.8	"
65	"	921	2.8	"
60	"	646	2.0	"
55	"	360	1.1	"
50	"	77	.2	"
45	"	-132	-.4	"
40	"	-369	-1.1	"
35	"	-622	-1.9	"
30	"	-886	-2.7	"
25	"	-1101	-3.3	"
20	"	-1384	-4.2	"
15	"	-1745	-5.2	"
10	"	-2210	-6.7	"
5	"	-2902	-8.7	"
0.05	"	-5850	-17.6	"
0	"	-8210	-24.7	"

(ABOVE RESULTS DERIVED FROM 1000 SIMULATIONS)

TWRS EIS
CALCULATION COVER SHEET

DISCIPLINE & TITLE Safety: LCFs from radiological Accidents

ORIGINATOR Michael Harker DATE 02/12/95

REVISION NO. _____

OBJECTIVE Show LCFs from Radiological accidents.

METHODOLOGY See attachments

ASSUMPTIONS See attachments

(Continue on another sheet if necessary)

3/15/96
SIGNATURE/DATE

3/15/96
CHECKED/DATE

CALCULATION & RESULTS
ATTACHED

			NO ACTION ALTERNATIVE				
	Mispositioned Jumper (spray release 207 psi)						
1.10E-02	per year x	1.00E+01	years =	1.10E-01	probability		
	dose	LCF/rem	LCF	probability	LCF risk		
receptor	personrem				point esti		
W	1.40E+03	8.00E-04	1.12E+00	1.10E-01	1.23E-01		
MEI-W	1.40E+02	8.00E-04	1.12E-01	1.10E-01	1.23E-02		
N	2.50E+03	4.00E-04	1.00E+00	1.10E-01	1.10E-01		2.67E-01
MEI-N	6.70E+01	8.00E-04	5.36E-02	1.10E-01	5.90E-03		
P	6.20E+02	5.00E-04	3.10E-01	1.10E-01	3.41E-02		
MEI-P	2.90E-01	5.00E-04	1.45E-04	1.10E-01	1.60E-05		
		total LCF	2.43E+00				
	Hydrogen burn in waste tank						
9.00E-07	per year x	1.00E+02	years x	2.50E+01	tanks =	2.25E-03	probability
	dose	LCF/rem	LCF	probability	LCF risk		
receptor	personrem				point esti		
W	2.18E+05	n/a	n/a	2.25E-03	2.25E-03		
MEI-W	2.18E+04	n/a	n/a	2.25E-03	2.25E-03		
N	2.45E+04	4.00E-04	9.80E+00	2.25E-03	2.21E-02		
MEI-N	1.74E+03	n/a	n/a	2.25E-03	2.25E-03		
P	3.70E+03	5.00E-04	1.85E+00	2.25E-03	4.16E-03		
MEI-P	4.23E+00	5.00E-04	2.12E-03	2.25E-03	4.76E-06		
		total LCF	2.17E+01				

	LONG TERM MANAGEMENT ALTERNATIVE						
	Mispositioned Jumper (spray release 207 psi)						
1.10E-02	per year x	2.00E+01	years =	2.20E-01	probability		
	dose	LCF/rem	LCF	probability	LCF risk		
receptor	personrem				point esti		
W	1.40E+03	8.00E-04	1.12E+00	2.20E-01	2.46E-01		
MEI-W	1.40E+02	8.00E-04	1.12E-01	2.20E-01	2.46E-02		
N	2.50E+03	4.00E-04	1.00E+00	2.20E-01	2.20E-01		5.35E-01
MEI-N	6.70E+01	8.00E-04	5.36E-02	2.20E-01	1.18E-02		
P	6.20E+02	5.00E-04	3.10E-01	2.20E-01	6.82E-02		
MEI-P	2.90E-01	5.00E-04	1.45E-04	2.20E-01	3.19E-05		
		total LCF	2.43E+00				
	Hydrogen burn in waste tank						
9.00E-07	per year x	1.00E+02	years x	2.50E+01	tanks =	2.25E-03	probability
	dose	LCF/rem	LCF	probability	LCF risk		
receptor	personrem				point esti		
W	2.18E+05	n/a	n/a	2.25E-03	2.25E-03		
MEI-W	2.18E+04	n/a	n/a	2.25E-03	2.25E-03		
N	2.45E+04	4.00E-04	9.80E+00	2.25E-03	2.21E-02		
MEI-N	1.74E+03	n/a	n/a	2.25E-03	2.25E-03		
P	3.70E+03	5.00E-04	1.85E+00	2.25E-03	4.16E-03		
MEI-P	4.23E+00	5.00E-04	2.12E-03	2.25E-03	4.76E-06		
		total lcf	2.17E+01				

	INSITU FILL AND CAP ALTERNATIVE						
	Mispositioned Jumper (spray release 207 psi)						
1.10E-02	per year x	1.50E+01	years =	1.65E-01	probability		
	dose	LCF/rem	LCF	probability	LCF risk		
receptor	personrem				point esti		
W	1.40E+03	8.00E-04	1.12E+00	1.65E-01	1.85E-01		
MEI-W	1.40E+02	8.00E-04	1.12E-01	1.65E-01	1.85E-02		
N	2.50E+03	4.00E-04	1.00E+00	1.65E-01	1.65E-01		4.01E-01
MEI-N	6.70E+01	8.00E-04	5.36E-02	1.65E-01	8.84E-03		
P	6.20E+02	5.00E-04	3.10E-01	1.65E-01	5.12E-02		
MEI-P	2.90E-01	5.00E-04	1.45E-04	1.65E-01	2.39E-05		
		total lcf	2.43E+00				
	Tank Dome Collapse Due To Hydrogen Deflagration						
				1.00E-04	probability		
	dose	LCF/rem	LCF	probability	LCF risk		
receptor	personrem				point esti		
W	6.20E+04	n/a	n/a	1.00E-04	1.00E-04		
MEI-W	6.20E+03	n/a	n/a	1.00E-04	1.00E-04		
N	2.30E+04	4.00E-04	9.20E+00	1.00E-04	9.20E-04		
MEI-N	1.50E+03	n/a	n/a	1.00E-04	1.00E-04		
P	3.70E+03	5.00E-04	1.85E+00	1.00E-04	1.85E-04		
MEI-P	3.90E+00	5.00E-04	1.95E-03	1.00E-04	1.95E-07		
		total lcf	2.11E+01				
	Hydrogen burn in waste tank						
9.00E-07	per year x	1.90E+01	years x	2.50E+01	tanks =	4.28E-04	probability
	dose	LCF/rem	LCF	probability	LCF risk		
receptor	personrem				point esti		
W	2.18E+05	n/a	n/a	4.28E-04	4.28E-04		
MEI-W	2.18E+04	n/a	n/a	4.28E-04	4.28E-04		
N	2.45E+04	4.00E-04	9.80E+00	4.28E-04	4.19E-03		
MEI-N	1.74E+03	n/a	n/a	4.28E-04	4.28E-04		
P	3.70E+03	5.00E-04	1.85E+00	4.28E-04	7.91E-04		
MEI-P	4.23E+00	5.00E-04	2.12E-03	4.28E-04	9.04E-07		
		total lcf	2.17E+01				

	IN SITU VITRIFICATION ALTERNATIVE						
	Mispositioned Jumper (spray release 207 psi)						
1.10E-02	per year x	1.50E+01	years =	1.65E-01	probability		
	dose	LCF/rem	LCF	probability	LCF risk		
receptor	personrem				point esti		
W	1.40E+03	8.00E-04	1.12E+00	1.65E-01	1.85E-01		
MEI-W	1.40E+02	8.00E-04	1.12E-01	1.65E-01	1.85E-02		
N	2.50E+03	4.00E-04	1.00E+00	1.65E-01	1.65E-01		4.01E-01
MEI-N	6.70E+01	8.00E-04	5.36E-02	1.65E-01	8.84E-03		
P	6.20E+02	5.00E-04	3.10E-01	1.65E-01	5.12E-02		
MEI-P	2.90E-01	5.00E-04	1.45E-04	1.65E-01	2.39E-05		
		total lcf	2.43E+00				
		Off-Gas Duct Rupture					
7.00E-04	per year x	9.00E+00	years =	6.30E-03	probability		
	dose	LCF/rem	LCF	probability	LCF risk		
receptor	personrem				point esti		
W	2.50E+04	n/a	n/a	6.30E-03	6.30E-03		
MEI-W	2.50E+03	n/a	n/a	6.30E-03	6.30E-03		2.68E-01
N	4.50E+04	8.00E-04	3.60E+01	6.30E-03	2.27E-01		
MEI-N	1.20E+03	n/a	n/a	6.30E-03	6.30E-03		
P	1.10E+04	5.00E-04	5.50E+00	6.30E-03	3.47E-02		
MEI-P	5.20E+00	5.00E-04	2.60E-03	6.30E-03	1.64E-05		
		total LCF	5.15E+01				
	Hydrogen burn in waste tank						
9.00E-07	per year x	1.90E+01	years x	2.50E+01	tanks =	4.28E-04	
	dose	LCF/rem	LCF	probability	LCF risk		
receptor	personrem				point esti		
W	2.18E+05	n/a	n/a	4.28E-04	4.28E-04		
MEI-W	2.18E+04	n/a	n/a	4.28E-04	4.28E-04		
N	2.45E+04	4.00E-04	9.80E+00	4.28E-04	4.19E-03		
MEI-N	1.74E+03	n/a	n/a	4.28E-04	4.28E-04		
P	3.70E+03	5.00E-04	1.85E+00	4.28E-04	7.91E-04		
MEI-P	4.23E+00	5.00E-04	2.12E-03	4.28E-04	9.04E-07		
		total lcf	2.17E+01				

EX SITU INTERMEDIATE SEPARATIONS ALTERNATIVE							
	Mispositioned Jumper (spray release 207 psi)						
1.10E-02	per year x	2.30E+01	years =	2.53E-01	probability		
	dose	LCF/rem	LCF	probability	LCF risk		
receptor	personrem				point esti		
W	1.40E+03	8.00E-04	1.12E+00	2.53E-01	2.83E-01		
MEI-W	1.40E+02	8.00E-04	1.12E-01	2.53E-01	2.83E-02		6.15E-01
N	2.50E+03	4.00E-04	1.00E+00	2.53E-01	2.53E-01		
MEI-N	6.70E+01	8.00E-04	5.36E-02	2.53E-01	1.36E-02		
P	6.20E+02	5.00E-04	3.10E-01	2.53E-01	7.84E-02		
MEI-P	2.90E-01	5.00E-04	1.45E-04	2.53E-01	3.67E-05		
		total lcf	2.43E+00				
	Loss of Filtration (HEPA filter blowout)						
8.80E-06	per year x	2.30E+01	years x	2.50E+01	tanks =	5.06E-03	probability
	dose •	LCF/rem	LCF	probability	LCF risk		
receptor	personrem				point esti		
W	3.70E+04	n/a	n/a	5.06E-03	5.06E-03		
MEI-W	3.70E+03	n/a	n/a	5.06E-03	5.06E-03		
N	1.04E+03	4.00E-04	4.16E-01	5.06E-03	2.10E-03		
MEI-N	2.42E+01	8.00E-04	1.94E-02	5.06E-03	9.80E-05		
P	1.56E+02	5.00E-04	7.80E-02	5.06E-03	3.95E-04		
MEI-P	1.04E-01	5.00E-04	5.20E-05	5.06E-03	2.63E-07		
		total lcf	1.05E+01				
	Seismic Induced Line Break in Vault						
6.00E-05	per year x	2.00E+01	years =	1.20E-03	probability		
	dose	LCF/rem	LCF	probability	LCF risk		
receptor	personrem				point esti		
W	3.40E+01	4.00E-04	1.36E-02	1.20E-03	1.63E-05		
MEI-W	3.40E+00	4.00E-04	1.36E-03	1.20E-03	1.63E-06		
N	7.10E+00	4.00E-04	2.84E-03	1.20E-03	3.41E-06		
MEI-N	2.90E-01	4.00E-04	1.16E-04	1.20E-03	1.39E-07		
P	2.70E+00	5.00E-04	1.35E-03	1.20E-03	1.62E-06		
MEI-P	4.50E-04	5.00E-04	2.25E-07	1.20E-03	2.70E-10		
		total lcf	1.78E-02				
		Breached Canister					
6.00E-01	per year x	2.00E+01	years =	1.20E+01	probability		
	dose	LCF/rem	LCF	probability	LCF risk		
receptor	personrem				point esti		
W	1.45E-04	4.00E-04	5.80E-08	1.00E+00	5.80E-08		
MEI-W	1.45E-05	4.00E-04	5.80E-09	1.00E+00	5.80E-09		
N	5.80E-08	4.00E-04	2.32E-11	1.00E+00	2.32E-11		
MEI-N	4.00E-09	4.00E-04	1.60E-12	1.00E+00	1.60E-12		
P	1.50E-08	5.00E-04	7.50E-12	1.00E+00	7.50E-12		
MEI-P	2.40E-12	5.00E-04	1.20E-15	1.00E+00	1.20E-15		
		total lcf	5.80E-08				
	Hydrogen burn in waste tank						
9.00E-07	per year x	2.30E+01	years =	2.07E-05	probability		
	dose	LCF/rem	LCF	probability	LCF risk		
receptor	personrem				point esti		
W	2.18E+05	n/a	n/a	2.07E-05	2.07E-05		
MEI-W	2.18E+04	n/a	n/a	2.07E-05	2.07E-05		
N	2.45E+04	4.00E-04	9.80E+00	2.07E-05	2.03E-04		
MEI-N	1.74E+03	n/a	n/a	2.07E-05	2.07E-05		
P	3.70E+03	5.00E-04	1.85E+00	2.07E-05	3.83E-05		
MEI-P	4.23E+00	5.00E-04	2.12E-03	2.07E-05	4.38E-08		
		total lcf	2.17E+01				

EX SITU NO SEPARATIONS ALTERNATIVE							
	Mispositioned Jumper (spray release 207 psi)						
1.10E-02	per year x	1.80E+01	years =	1.98E-01	probability		
	dose	LCF/rem	LCF	probability	LCF risk		
receptor	personrem				point esti		
W	1.40E+03	8.00E-04	1.12E+00	1.98E-01	2.22E-01		
MEI-W	1.40E+02	8.00E-04	1.12E-01	1.98E-01	2.22E-02		
N	2.50E+03	4.00E-04	1.00E+00	1.98E-01	1.98E-01		4.81E-01
MEI-N	6.70E+01	8.00E-04	5.36E-02	1.98E-01	1.06E-02		
P	6.20E+02	5.00E-04	3.10E-01	1.98E-01	6.14E-02		
MEI-P	2.90E-01	5.00E-04	1.45E-04	1.98E-01	2.87E-05		
		total lcf	2.43E+00				
	Loss of Filtration (HEPA filter blowout)						
8.80E-06	per year x	1.80E+01	years =	1.58E-04	probability		
	dose	LCF/rem	LCF	probability	LCF risk		
receptor	personrem				point esti		
W	3.70E+04	n/a	n/a	1.58E-04	1.58E-04		
MEI-W	3.70E+03	n/a	n/a	1.58E-04	1.58E-04		
N	1.04E+03	4.00E-04	4.16E-01	1.58E-04	6.59E-05		
MEI-N	2.42E+01	8.00E-04	1.94E-02	1.58E-04	3.07E-06		
P	1.56E+02	5.00E-04	7.80E-02	1.58E-04	1.24E-05		
MEI-P	1.04E-01	5.00E-04	5.20E-05	1.58E-04	8.24E-09		
		total lcf	1.05E+01				
		Breached Canister					
6.00E-01	per year x	1.50E+01	years =	9.00E+00	probability		
	dose	LCF/rem	LCF	probability	LCF risk		
receptor	personrem				point esti		
W	1.45E-04	4.00E-04	5.80E-08	1.00E+00	5.80E-08		
MEI-W	1.45E-05	4.00E-04	5.80E-09	1.00E+00	5.80E-09		
N	5.80E-08	4.00E-04	2.32E-11	1.00E+00	2.32E-11		
MEI-N	4.00E-09	4.00E-04	1.60E-12	1.00E+00	1.60E-12		
P	1.50E-08	5.00E-04	7.50E-12	1.00E+00	7.50E-12		
MEI-P	2.40E-12	5.00E-04	1.20E-15	1.00E+00	1.20E-15		
		total lcf	5.80E-08				
	Hydrogen burn in waste tank						
9.00E-07	per year x	1.80E+01	years x	2.50E+01	tanks =	4.05E-04	probability
	dose	LCF/rem	LCF	probability	LCF risk		
receptor	personrem				point esti		
W	2.18E+05	n/a	n/a	4.05E-04	4.05E-04		
MEI-W	2.18E+04	n/a	n/a	4.05E-04	4.05E-04		
N	2.45E+04	4.00E-04	9.80E+00	4.05E-04	3.97E-03		
MEI-N	1.74E+03	n/a	n/a	4.05E-04	4.05E-04		
P	3.70E+03	5.00E-04	1.85E+00	4.05E-04	7.49E-04		
MEI-P	4.23E+00	5.00E-04	2.12E-03	4.05E-04	8.57E-07		
		total lcf	2.17E+01				

EX SITU EXTENSIVE SEPARATIONS ALTERNATIVE							
	Mispositioned Jumper (spray release 207 psi)						
1.10E-02	per year x	2.30E+01	years =	2.53E-01	probability		
	dose	LCF/rem	LCF	probability	LCF risk		
receptor	personrem				point esti		
W	1.40E+03	8.00E-04	1.12E+00	2.53E-01	2.83E-01		
MEI-W	1.40E+02	8.00E-04	1.12E-01	2.53E-01	2.83E-02		
N	2.50E+03	4.00E-04	1.00E+00	2.53E-01	2.53E-01		6.15E-01
MEI-N	6.70E+01	8.00E-04	5.36E-02	2.53E-01	1.36E-02		
P	6.20E+02	5.00E-04	3.10E-01	2.53E-01	7.84E-02		
MEI-P	2.90E-01	5.00E-04	1.45E-04	2.53E-01	3.67E-05		
		total lcf	2.43E+00				
	Loss of Filtration (HEPA filter blowout)						
8.80E-06	per year x	2.30E+01	years =	2.02E-04	probability		
	dose •	LCF/rem	LCF	probability	LCF risk		
receptor	personrem				point esti		
W	3.70E+04	n/a	n/a	2.02E-04	2.02E-04		
MEI-W	3.70E+03	n/a	n/a	2.02E-04	2.02E-04		
N	1.04E+03	4.00E-04	4.16E-01	2.02E-04	8.42E-05		
MEI-N	2.42E+01	8.00E-04	1.94E-02	2.02E-04	3.92E-06		
P	1.56E+02	5.00E-04	7.80E-02	2.02E-04	1.58E-05		
MEI-P	1.04E-01	5.00E-04	5.20E-05	2.02E-04	1.05E-08		
		total lcf	1.05E+01				
	Seismic Induced Line Break in Vault						
6.00E-05	per year x	2.00E+01	years =	1.20E-03	probability		
	dose	LCF/rem	LCF	probability	LCF risk		
receptor	personrem				point esti		
W	3.40E+01	4.00E-04	1.36E-02	1.20E-03	1.63E-05		
MEI-W	3.40E+00	4.00E-04	1.36E-03	1.20E-03	1.63E-06		
N	7.10E+00	4.00E-04	2.84E-03	1.20E-03	3.41E-06		
MEI-N	2.90E-01	4.00E-04	1.16E-04	1.20E-03	1.39E-07		
P	2.70E+00	5.00E-04	1.35E-03	1.20E-03	1.62E-06		
MEI-P	4.50E-04	5.00E-04	2.25E-07	1.20E-03	2.70E-10		
		total lcf	1.78E-02				
		Breached Canister					
6.00E-01	per year x	2.00E+01	years =	1.20E+01	probability		
	dose	LCF/rem	LCF	probability	LCF risk		
receptor	personrem				point esti		
W	1.45E-04	4.00E-04	5.80E-08	1.00E+00	5.80E-08		
MEI-W	1.45E-05	4.00E-04	5.80E-09	1.00E+00	5.80E-09		
N	5.80E-08	4.00E-04	2.32E-11	1.00E+00	2.32E-11		
MEI-N	4.00E-09	4.00E-04	1.60E-12	1.00E+00	1.60E-12		
P	1.50E-08	5.00E-04	7.50E-12	1.00E+00	7.50E-12		
MEI-P	2.40E-12	5.00E-04	1.20E-15	1.00E+00	1.20E-15		
		total lcf	5.80E-08				
	Hydrogen burn in waste tank						
9.00E-07	per year x	2.30E+01	years x	2.50E+01	tanks =	5.18E-04	probability
	dose	LCF/rem	LCF	probability	LCF risk		
receptor	personrem				point esti		
W	2.18E+05	n/a	n/a	5.18E-04	5.18E-04		
MEI-W	2.18E+04	n/a	n/a	5.18E-04	5.18E-04		
N	2.45E+04	4.00E-04	9.80E+00	5.18E-04	5.07E-03		
MEI-N	1.74E+03	n/a	n/a	5.18E-04	5.18E-04		
P	3.70E+03	5.00E-04	1.85E+00	5.18E-04	9.57E-04		
MEI-P	4.23E+00	5.00E-04	2.12E-03	5.18E-04	1.09E-06		
		total lcf	2.17E+01				

EX SITU/ IN SITU COMBINATION							
	Mispositioned Jumper (spray release 207 psi)						
1.10E-02	per year x	2.30E+01	years =	2.53E-01	probability		
	dose	LCF/rem	LCF	probability	LCF risk		
receptor	personrem				point esti		
W	1.40E+03	8.00E-04	1.12E+00	2.53E-01	2.83E-01		
MEI-W	1.40E+02	8.00E-04	1.12E-01	2.53E-01	2.83E-02		6.15E-01
N	2.50E+03	4.00E-04	1.00E+00	2.53E-01	2.53E-01		
MEI-N	6.70E+01	8.00E-04	5.36E-02	2.53E-01	1.36E-02		
P	6.20E+02	5.00E-04	3.10E-01	2.53E-01	7.84E-02		
MEI-P	2.90E-01	5.00E-04	1.45E-04	2.53E-01	3.67E-05		
		total lcf	2.43E+00				
	Loss of Filtration (HEPA filter blowout)						
8.80E-06	per year x	2.30E+01	years =	2.02E-04	probability		
	dose •	LCF/rem	LCF	probability	LCF risk		
receptor	personrem				point esti		
W	3.70E+04	n/a	n/a	2.02E-04	2.02E-04		
MEI-W	3.70E+03	n/a	n/a	2.02E-04	2.02E-04		
N	1.04E+03	4.00E-04	4.16E-01	2.02E-04	8.42E-05		
MEI-N	2.42E+01	8.00E-04	1.94E-02	2.02E-04	3.92E-06		
P	1.56E+02	5.00E-04	7.80E-02	2.02E-04	1.58E-05		
MEI-P	1.04E-01	5.00E-04	5.20E-05	2.02E-04	1.05E-08		
		total lcf	1.05E+01				
	Seismic Induced Line Break in Vault						
6.00E-05	per year x	2.00E+01	years =	1.20E-03	probability		
	dose	LCF/rem	LCF	probability	LCF risk		
receptor	personrem				point esti		
W	3.40E+01	4.00E-04	1.36E-02	1.20E-03	1.63E-05		
MEI-W	3.40E+00	4.00E-04	1.36E-03	1.20E-03	1.63E-06		
N	7.10E+00	4.00E-04	2.84E-03	1.20E-03	3.41E-06		
MEI-N	2.90E-01	4.00E-04	1.16E-04	1.20E-03	1.39E-07		
P	2.70E+00	5.00E-04	1.35E-03	1.20E-03	1.62E-06		
MEI-P	4.50E-04	5.00E-04	2.25E-07	1.20E-03	2.70E-10		
		total lcf	1.78E-02				
		Breached Canister					
6.00E-01	per year x	2.00E+01	years =	1.20E+01	probability		
	dose	LCF/rem	LCF	probability	LCF risk		
receptor	personrem				point esti		
W	1.45E-04	4.00E-04	5.80E-08	1.00E+00	5.80E-08		
MEI-W	1.45E-05	4.00E-04	5.80E-09	1.00E+00	5.80E-09		
N	5.80E-08	4.00E-04	2.32E-11	1.00E+00	2.32E-11		
MEI-N	4.00E-09	4.00E-04	1.60E-12	1.00E+00	1.60E-12		
P	1.50E-08	5.00E-04	7.50E-12	1.00E+00	7.50E-12		
MEI-P	2.40E-12	5.00E-04	1.20E-15	1.00E+00	1.20E-15		
		total lcf	5.80E-08				
	Hydrogen burn in waste tank						
9.00E-07	per year x	2.30E+01	years x	2.50E+01	tanks =	5.18E-04	probability
	dose	LCF/rem	LCF	probability	LCF risk		
receptor	personrem				point esti		
W	2.18E+05	n/a	n/a	5.18E-04	5.18E-04		
MEI-W	2.18E+04	n/a	n/a	5.18E-04	5.18E-04		
N	2.45E+04	4.00E-04	9.80E+00	5.18E-04	5.07E-03		
MEI-N	1.74E+03	n/a	n/a	5.18E-04	5.18E-04		
P	3.70E+03	5.00E-04	1.85E+00	5.18E-04	9.57E-04		
MEI-P	4.23E+00	5.00E-04	2.12E-03	5.18E-04	1.09E-06		
		total lcf	2.17E+01				

PHASED IMPLEMENTATION ALTERNATIVE - PHASE 1							
	Mispositioned Jumper (spray release 207 psi)						
1.10E-02	per year x	1.00E+01	years =	1.10E-01	probability		
	dose	LCF/rem	LCF	probability	LCF risk		
receptor	personrem				point esti		
W	1.40E+03	8.00E-04	1.12E+00	1.10E-01	1.23E-01		
MEI-W	1.40E+02	8.00E-04	1.12E-01	1.10E-01	1.23E-02		
N	2.50E+03	4.00E-04	1.00E+00	1.10E-01	1.10E-01		2.67E-01
MEI-N	6.70E+01	8.00E-04	5.36E-02	1.10E-01	5.90E-03		
P	6.20E+02	5.00E-04	3.10E-01	1.10E-01	3.41E-02		
MEI-P	2.90E-01	5.00E-04	1.45E-04	1.10E-01	1.60E-05		
		total lcf	2.43E+00				
	Seismic Induced Line Break in Vault						
6.00E-05	per year x	1.00E+01	years =	6.00E-04	probability		
	dose	LCF/rem	LCF	probability	LCF risk		
receptor	personrem				point esti		
W	3.40E+01	4.00E-04	1.36E-02	6.00E-04	8.16E-06		
MEI-W	3.40E+00	4.00E-04	1.36E-03	6.00E-04	8.16E-07		
N	7.10E+00	4.00E-04	2.84E-03	6.00E-04	1.70E-06		
MEI-N	2.90E-01	4.00E-04	1.16E-04	6.00E-04	6.96E-08		
P	2.70E+00	5.00E-04	1.35E-03	6.00E-04	8.10E-07		
MEI-P	4.50E-04	5.00E-04	2.25E-07	6.00E-04	1.35E-10		
		total lcf	1.78E-02				
		Breached Canister					
1.00E-02	per year x	1.00E+01	years =	1.00E-01	probability		
	dose	LCF/rem	LCF	probability	LCF risk		
receptor	personrem				point esti		
W	0.00E+00	4.00E-04	0.00E+00	1.00E-01	0.00E+00		
MEI-W	0.00E+00	4.00E-04	0.00E+00	1.00E-01	0.00E+00		
N	2.30E-04	4.00E-04	9.20E-08	1.00E-01	9.20E-09		
MEI-N	2.70E-05	4.00E-04	1.08E-08	1.00E-01	1.08E-09		
P	5.80E-05	5.00E-04	2.90E-08	1.00E-01	2.90E-09		
MEI-P	1.80E-08	5.00E-04	9.00E-12	1.00E-01	9.00E-13		
		total lcf	1.21E-07				
	Hydrogen burn in waste tank						
9.00E-07	per year x	1.00E+01	years x	2.50E+01	tanks =	2.25E-04	probability
	dose	LCF/rem	LCF	probability	LCF risk		
receptor	personrem				point esti		
W	2.18E+05	n/a	n/a	2.25E-04	2.25E-04		
MEI-W	2.18E+04	n/a	n/a	2.25E-04	2.25E-04		
N	2.45E+04	4.00E-04	9.80E+00	2.25E-04	2.21E-03		
MEI-N	1.74E+03	n/a	n/a	2.25E-04	2.25E-04		
P	3.70E+03	5.00E-04	1.85E+00	2.25E-04	4.16E-04		
MEI-P	4.23E+00	5.00E-04	2.12E-03	2.25E-04	4.76E-07		
		total lcf	2.17E+01				

PHASED IMPLEMENTATION ALTERNATIVE - TOTAL ALTERNA							
	Mispositioned Jumper (spray release 207 psi)						
1.10E-02	per year x	2.20E+01	years =	2.42E-01	probability		
	dose	LCF/rem	LCF	probability	LCF risk		
receptor	personrem				point esti		
W	1.40E+03	8.00E-04	1.12E+00	2.42E-01	2.71E-01		
MEI-W	1.40E+02	8.00E-04	1.12E-01	2.42E-01	2.71E-02		5.88E-01
N	2.50E+03	4.00E-04	1.00E+00	2.42E-01	2.42E-01		
MEI-N	6.70E+01	8.00E-04	5.36E-02	2.42E-01	1.30E-02		
P	6.20E+02	5.00E-04	3.10E-01	2.42E-01	7.50E-02		
MEI-P	2.90E-01	5.00E-04	1.45E-04	2.42E-01	3.51E-05		
		total lcf	2.43E+00				
	Loss of Filtration (HEPA filter blowout)						
8.80E-06	per year x	2.20E+01	years =	1.94E-04	probability		
	dose	LCF/rem	LCF	probability	LCF risk		
receptor	personrem				point esti		
W	3.70E+04	n/a	n/a	1.94E-04	1.94E-04		
MEI-W	3.70E+03	n/a	n/a	1.94E-04	1.94E-04		
N	1.04E+03	4.00E-04	4.16E-01	1.94E-04	8.05E-05		
MEI-N	2.42E+01	8.00E-04	1.94E-02	1.94E-04	3.75E-06		
P	1.56E+02	5.00E-04	7.80E-02	1.94E-04	1.51E-05		
MEI-P	1.04E-01	5.00E-04	5.20E-05	1.94E-04	1.01E-08		
		total lcf	1.05E+01				
	Seismic Induced Line Break in Vault						
6.00E-05	per year x	2.60E+01	years =	1.56E-03	probability		
	dose	LCF/rem	LCF	probability	LCF risk		
receptor	personrem				point esti		
W	3.40E+01	4.00E-04	1.36E-02	1.56E-03	2.12E-05		
MEI-W	3.40E+00	4.00E-04	1.36E-03	1.56E-03	2.12E-06		
N	7.10E+00	4.00E-04	2.84E-03	1.56E-03	4.43E-06		
MEI-N	2.90E-01	4.00E-04	1.16E-04	1.56E-03	1.81E-07		
P	2.70E+00	5.00E-04	1.35E-03	1.56E-03	2.11E-06		
MEI-P	4.50E-04	5.00E-04	2.25E-07	1.56E-03	3.51E-10		
		total lcf	1.78E-02				
		Breached Canister					
6.00E-01	per year x	2.60E+01	years =	1.56E+01	probability		
	dose	LCF/rem	LCF	probability	LCF risk		
receptor	personrem				point esti		
W	1.45E-04	4.00E-04	5.80E-08	1.00E+00	5.80E-08		
MEI-W	1.45E-05	4.00E-04	5.80E-09	1.00E+00	5.80E-09		
N	5.80E-08	4.00E-04	2.32E-11	1.00E+00	2.32E-11		
MEI-N	4.00E-09	4.00E-04	1.60E-12	1.00E+00	1.60E-12		
P	1.50E-08	5.00E-04	7.50E-12	1.00E+00	7.50E-12		
MEI-P	2.40E-12	5.00E-04	1.20E-15	1.00E+00	1.20E-15		
		total lcf	5.80E-08				
	Hydrogen burn in waste tank						
9.00E-07	per year x	2.20E+01	years x	2.50E+01	tanks =	4.95E-04	probability
	dose	LCF/rem	LCF	probability	LCF risk		
receptor	personrem				point esti		
W	2.18E+05	n/a	n/a	4.95E-04	4.95E-04		
MEI-W	2.18E+04	n/a	n/a	4.95E-04	4.95E-04		
N	2.45E+04	4.00E-04	9.80E+00	4.95E-04	4.85E-03		
MEI-N	1.74E+03	n/a	n/a	4.95E-04	4.95E-04		
P	3.70E+03	5.00E-04	1.85E+00	4.95E-04	9.16E-04		
MEI-P	4.23E+00	5.00E-04	2.12E-03	4.95E-04	1.05E-06		
		total lcf	2.17E+01				

TWRS EIS
CALCULATION COVER SHEET

DISCIPLINE & TITLE Safety: LCFs from Transportation Accidents RADTRAN 4

ORIGINATOR Michael Harker DATE 02/12/95

REVISION NO. _____

OBJECTIVE Show LCFs from Radiological accidents. Using RADTRAN 4 for the integrated population and the worst urban population. Replaces Old Calcs.

METHODOLOGY See attachment

ASSUMPTIONS See attachment

(Continue on another sheet if necessary)

3/15/96
SIGNATURE/DATE

3/15/96
CHECKED/DATE

CALCULATION & RESULTS
ATTACHED

Battelle
Pacific Northwest Laboratories
Battelle Boulevard
P.O. Box 999
Richland, Washington 99352

FACSIMILE TRANSMITTAL

DATE: February 9, 1996

To: Mike Harker
Company: Jacobs Engineering
City/State:
Facsimile #: 736-7504
Telephone #: 736-0616

From: Phil Daling
Facsimile #: 372-4378
Telephone #: 372-4239

Transmittal Consists of [2] Page(s) including cover page.

COMMENTS:

Mike

Here are the revised impact results for the calcination alternative (changed number of cask-loads from 27,100 to 41,500). The revised numbers you will need include the routine worker and public doses and accident risks, both in person-rem and LCFs, and the revised probability of the maximum credible accident in an urban area. These values are in BOLD in the attached spreadsheet. Call me if you have any questions.

Phil

PS I just checked TRANSNET again and they are still down. The attached table was created by multiplying the previous results by the ratio of the new number of shipments to the old number of shipments. I will run the revised case when TRANSNET is available, hopefully some time today.

Revised Calcination Alternative Impacts 2/9/98

Ratio method used as approximation: TRANSNET system down on 2/9/96 so RADTRAN runs not possible

NO SEPARATIONS - CALCINATION

	ROUTINE EXPOSURES						ACCIDENTS		
	Exposures		Health Effects		Latent Cancers		Exposures	Conv.	Latent
Material	Worker	Public	Conversion		Worker	Public	Public	Factor	Cancers
MUST	7.60E-01	2.12E-01	4.00E-04	5.00E-04	3.04E-04	1.06E-04	3.43E-03	4.00E-04	1.37E-06
SST	3.04E-01	8.45E-02	4.00E-04	5.00E-04	1.22E-04	4.23E-05	1.58E-02	4.00E-04	6.32E-06
Cs capsul	2.47E-02	7.37E-03	4.00E-04	5.00E-04	9.88E-06	3.69E-06	1.33E-05	4.00E-04	5.32E-09
Sr capsule	3.01E-02	8.97E-03	4.00E-04	5.00E-04	1.20E-05	4.49E-06	2.02E-08	4.00E-04	8.08E-12
HLW	**1.82E+04**	**8.73E+02**	4.00E-04	5.00E-04	**7.28E+00**	**4.37E-01**	**3.64E-01**	5.00E-04	**1.77E-04**
	1.82E+04	**8.73E+02**			**7.28E+00**	**4.37E-01**	**3.73E-01**		**1.85E-04**

Integrated

Numbers in BOLD are revised values calculated using the ratio of old shipments (27100) to new shipments (41500). See spreadsheet W3TLOAD2.XLS, Sheet labeled COMPARISON

Revised Max Credible Accident Probability

Old ships	New Ships	Ratio	Old Prob.	New Prob	Urban Pop Dose	LCFs
27100	41500	1.531366	2.00E-05	**3.1E-05**	3.40E+03	1.70E+00
			6.00E-09	**9.2E-09**	1.60E+04	0.00E+00

Population doses and LCFs remain the same as before. Only the accident probabilities change.

[4] From: Philip M Daling at ~PNL5 2/7/96 10:16AM (104682 bytes: 1 ln, 1 fl)
To: ^Jacobs Engineering Group at ~DOE_HANFORD_1
cc: Paul S Stansbury at ~PNL41
Subject: TWRS-EIS Transportation Document
---------- Message Contents ----------

Text item 1:

ATTN: Mike Harker

The file containing the revised TWRS-EIS transportation impact results is attached. I will follow this with a formal letter and the computer files on a 3.5-inch disk. The formal package will go out in today's mail.

Thanks

Phil

ATTACHMENT 1

REVISED TRANSPORTATION IMPACT RESULTS

FOR THE TWRS EIS

REVISED TRANSPORTATION IMPACT CALCULATIONS FOR THE TWRS EIS

This attachment provides the revised transportation impact analysis in support of the Tank Waste Remediation System (TWRS) Environmental Impact Statement. The results presented in this attachment include the population dose and latent cancer fatality estimates for the routine (or incident-free) transport, accident risk estimates for potential offsite shipments, and population doses for the maximum credible transportation accidents for the following alternatives:

- **No Separations** including both Vitrification and Calcination subalternatives.
- **Intermediate Separations**, including four subalternatives: base-case waste loading in the high-level tank waste glass without the addition of Cs and Sr from the Waste Encapsulation and Storage Facility (WESF); base-case loading with Cs and Sr from WESF incorporated into the tank waste glass; 15% waste loading without additional Cs and Sr from WESF; and 40% waste loading without Cs and Sr from WESF.
- **Extensive Separations** without Cs and Sr from WESF.
- **Ex-Situ/In-Situ Combination** without Cs and Sr from WESF.
- **Phased-Implementation** without Cs and Sr from WESF.
- **Overpack and Ship Cs and Sr Capsules to Repository.**

Results from the previous analysis[1] are also included that examined two other Cs/Sr capsule disposition options, including; 1) creating HLW glass with Cs and Sr capsule material and, 2) overpacking the capsules and storing them onsite. The revised Cs and Sr source term and overpack inventory will not affect the transportation impacts for the onsite Cs and Sr capsule disposition option. Furthermore, the option of vitrifying the Cs and Sr capsule material in separate campaign from the tank wastes need not be revised.

This attachment presents re-calculated population doses for maximum credible accidents in urban areas, routine (or incident-free) exposures, and integrated accident risk estimates for all the alternatives. Population doses from transportation accidents the correspond to an accident probability of 1 in 1,000,000 (1E-06) over the entire shipping campaign are also provided. This information was not provided in the October letter.

The results presented include offsite transport of treated tank wastes as well as the onsite and offsite transport of Cs and Sr capsules, onsite transport of Miscellaneous Underground Storage (MUST)

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1 See letter from P. M. Daling to Mike Harker dated October 17, 1995.

liquids, and onsite transport of SST residuals, where appropriate. There were no changes to the input data for onsite transport of MUST liquids, SST residuals, and Cs and Sr capsules so the transportation impact results are unchanged from those transmitted to you in October[2].

DESCRIPTION OF REVISIONS

The main revisions to the analysis have resulted from changes in the radionuclide inventories, shipment capacities, and the addition of new subalternatives. The revisions are described below:

- Significant changes have been made to the treated tank waste radionuclide compositions which have resulted in significant changes in the per-shipment radionuclide inventories used in the transportation impact calculations.

- Treated tank waste shipping configurations have been revised. The revised configuration for all tank wastes includes a 0.62 m^3 canister packaged within a Hanford Multi-Purpose Canister (HMPC). One HMPC is shipped per railcar to the repository. A dedicated train would be used, with a total of ten railcars per train shipment, to transport the loaded HMPCs to the repository.

- A sensitivity study to evaluate a range of vitrified waste loadings was performed. The sensitivity study examined three waste loadings, including 20% waste oxide (base-case), 15% oxides, and 40% oxides. This assumption was applied in the Intermediate Separations Alternative. With respect to transportation impact calculations, the waste loading assumptions affect the per-shipment radionuclide inventories and number of shipments.

- A sensitivity study to evaluate the impacts of adding Cs and Sr capsule material to the vitrification feed was examined. This assumption was applied in the Intermediate Separations Alternative. This affects the per-shipment radionuclide inventories but was assumed not to affect the number of shipments.

- Slight revisions were made to the inventories of Cs-137 and Sr-90 in the WESF capsules. The shipping configuration for overpacked Cs and Sr capsules was also revised. The analysis now assumes that five capsules are to be packaged within canisters that are in turn placed in a HMPC. A total of four canisters are to be placed in each HMPC which would then be shipped in ten-car dedicated trains to the repository. A total of 100 HMPCs (ten train shipments) containing overpacked Cs and Sr capsules were assumed to be shipped.

- The other RADTRAN 4 input parameters (shipping distances, population densities, release fractions, accident rates, etc.) are the same as described in WHC-SD-TP-RPT-016 and the previous revision[2].

[2] See letter from P. M. Daling to Mike Harker dated October 17, 1995.

REVISED TRANSPORTATION DATA

There were two main revisions to the transportation-related data used in the impact analysis. These included the radionuclide inventory data that were used to determine the shipping cask radionuclide contents and the shipping cask design configuration, which determines the volume of waste per shipment and the number of shipments required to transport the treated tank waste materials offsite.

The basic radionuclide inventory data for the treated tank waste forms (Ci/m^3) were provided by Jacobs Engineering. These data were used to develop per-shipment radionuclide inventories that were input to the RADTRAN 4 computer code. It was assumed that the treated tank wastes would be packaged within 0.62 m^3 canisters which would then be loaded into a Hanford Multi-purpose Canister (HMPC). A total of four canisters would be placed in each HMPC. One HMPC would be placed on a railcar and transported offsite to a disposal facility via dedicated trains (i.e., trains with no other cargo). Each dedicated train was assumed to contain ten HMPC railcars. Even though the shipping scenarios assume the use of dedicated train shipments, each individual cask-load was modeled as a separate shipment. This is the configuration used for transporting treated tank wastes and overpacked Cs and Sr capsules in all the alternatives.

Based on these assumptions and the revised radionuclide inventory data provided by Jacobs Engineering, revised radionuclide source terms (Ci/cask-load) were developed. The revised inventories used in the RADTRAN 4 computer calculations are presented in Table 1. Revised numbers of shipments in each alternative are presented in Table 2. Note that Table 2 includes both the number of cask-loads of material and the number of ten-car dedicated trains required to transport the number of cask-loads produced in each alternative.

RESULTS

The population dose estimates in urban areas for the maximum credible accident scenarios from the RADTRAN 4 calculations are summarized in Table 3. The maximum credible scenarios were defined as those with probabilities greater than one in one-million (1E-06) over the entire shipping campaign. As shown, there were no accident scenario probabilities close to 1E-06 for some of the alternatives. In these situations, the accident scenarios with probabilities nearest to 1E-06 are shown in the table. The table includes the estimated annual frequencies of the maximum credible accidents for which the population doses are reported. These were computed by RADTRAN 4 using the same accident rates (accidents/km), travel fractions in urban population zones, and conditional probabilities of accidents of various severities that were reported in the TWRS EIS transportation impact support document.[3] The revised numbers of shipments reported in Table 2 were used in the calculations. Table 3 also shows the calculated latent cancer fatalities, obtained by multiplying the population dose by 5E-04 LCFs/person-rem, as was done for the support document.

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3 See WHC-SD-TP-RPT-016 for a description of the input parameters used to calculate the probabilities of transportation accidents.

Table 1. Radionuclide Inventories for Treated Tank Waste Shipments

Radionuclide	Per-shipment Radionuclide Inventory, Ci/shipment		
	No Separations, Vitrified HLW	No Separations, Calcined HLW	Intermediate Separations, base-case loading w/o Cs and Sr material
Am-241	7.08E-01	3.84E+00	1.13E+01
Am-243	2.26E-04	1.23E-03	3.60E-03
Cm-244	8.04E-04	4.35E-03	6.64E-03
Cs-137	2.38E+02	1.29E+03	4.17E+03
Ni-63	1.83E+00	9.93E+00	3.15E+01
Np-237	4.75E-04	2.57E-03	7.43E-03
Pu-238	7.35E-03	3.99E-02	1.24E-01
Pu-239	1.80E-01	9.74E-01	2.93E+00
Pu-240	4.56E-02	2.47E-01	7.55E-01
Pu-241	5.10E-01	2.76E+00	8.78E+00
Ru-106	2.58E-07	1.40E-06	4.28E-06
Sm-151	4.29E+00	2.33E+01	7.43E+01
Sn-126	4.27E-03	2.31E-02	5.63E-02
Sr-90	2.97E+02	1.61E+03	6.31E+03
Tc-99	2.19E-01	1.18E+00	7.10E-01
U-233	8.24E-08	4.47E-07	1.35E-06
U-234	1.44E-06	7.82E-06	2.37E-05
U-235	1.40E-04	7.60E-04	2.37E-03
U-238	3.28E-03	1.78E-02	5.41E-02
Zr-93	2.68E-02	1.45E-01	4.62E-01

Radionuclide	Per-shipment Radionuclide Inventory, Ci/shipment		
	Intermediate Separations, base-case loading w/ Cs and Sr material	Intermediate Separations, 15% oxides loading w/o Cs and Sr material	Intermediate Separations, 40% oxides loading w/o Cs and Sr material
Am-241	1.13E+01	8.45E+00	2.25E+01
Am-243	3.60E-03	2.70E-03	7.21E-03
Cm-244	6.64E-03	4.98E-03	1.33E-02
Cs-137	1.04E+04	3.13E+03	8.33E+03
Ni-63	3.15E+01	2.37E+01	6.31E+01
Np-237	7.43E-03	5.57E-03	1.49E-02
Pu-238	1.24E-01	9.29E-02	2.48E-01
Pu-239	2.93E+00	2.20E+00	5.86E+00
Pu-240	7.55E-01	5.66E-01	1.51E+00
Pu-241	8.78E+00	6.59E+00	1.76E+01
Ru-106	4.28E-06	3.21E-06	8.56E-06
Sm-151	7.43E+01	5.57E+01	1.49E+02
Sn-126	5.63E-02	4.22E-02	1.13E-01
Sr-90	9.02E+03	4.73E+03	1.26E+04
Tc-99	7.10E-01	5.32E-01	1.42E+00
U-233	1.35E-06	1.01E-06	2.70E-06
U-234	2.37E-05	1.77E-05	4.73E-05
U-235	2.37E-03	1.77E-03	4.73E-03
U-238	5.41E-02	4.05E-02	1.08E-01
Zr-93	4.62E-01	3.46E-01	9.23E-01

Radionuclide	Per-shipment Radionuclide Inventory, Ci/shipment		
	Extensive Separations	Phased Implementation	Ex-Situ/In-Situ Combination
Am-241	2.64E+02	1.24E+01	1.73E+01
Am-243	8.45E-02	3.98E-03	6.63E-03
Cm-244	2.91E-01	6.64E-03	1.25E-02
Cs-137	8.87E+04	4.17E+03	7.33E+03
Ni-63	1.07E+01	3.15E+01	5.05E+01
Np-237	1.77E-01	7.43E-03	1.38E-02
Pu-238	2.72E+00	1.28E-01	9.84E-02
Pu-239	6.63E+01	3.12E+00	3.67E+00
Pu-240	1.68E+01	7.90E-01	9.15E-01
Pu-241	1.88E+02	8.85E+00	9.94E+00
Ru-106	9.57E-05	4.28E-06	3.17E-06
Sm-151	0.00E+00	7.43E+01	1.07E+02
Sn-126	1.58E+00	5.63E-02	8.22E-02
Sr-90	1.35E+05	6.36E+03	8.82E+03
Tc-99	8.12E+01	3.82E+00	1.28E+00
U-233	4.65E-08	1.35E-06	2.16E-06
U-234	8.54E-07	2.37E-05	3.83E-05
U-235	8.30E-05	2.37E-03	4.30E-03
U-238	1.93E-03	5.41E-02	9.73E-02
Zr-93	1.21E-01	4.62E-01	6.19E-01

Table 2. Number of Offsite Shipments in Each Alternative

Alternative	No. Of 0.62 m^3 Canisters	No. of Cask-loads[a]	No. Of Dedicated Train Shipments[b]
No Separations			
- Vitrification	587,000	146,860	14,690
- Calcination	108,388	27,100	2,710
Intermediate Separations			
- Base-case	33,400	8,350	840
- 15% Waste Loading	44,500	11,130	1,110
- 40% Waste Loading	16,700	4,170	420
Extensive Separations	1,570	390	40
Phased Implementation	33,400	8,350	840
Ex-Situ/In-Situ Combination	16,700	4,170	420

(a) Shipping casks are loaded with one Hanford Multi-purpose Canister per railcar. Four canisters are contained within a single HMPC.

(b) Ten railcars per dedicated train were assumed.

Table 3. Population Dose Estimates for The Maximum Credible Transportation Accidents In Urban Areas

Alternative	Material	Population Dose, person-rem	No. Of Expected Accidents	Population Risk, LCFs
Intermediate Separations Alternative	HLW glass with Cs and Sr (base-case loading)	9.4E+03	6E-06	5
	HLW glass w/o Cs and Sr (base-case loading)	4.2E+03	6E-06	2
	HLW glass at 15% waste loading, w/o Cs and Sr	3.3E+03	8E-06	2
	HLW glass at 40% waste loading, w/o Cs and Sr	7.9E+03	3E-06	4
No Separations Alternative	HLW calcined w/0 Cs and Sr	3.4E+03 1.6E+04	2E-05 6E-09	2 8
	HLW vitrified w/o Cs and Sr	3.2E+02 3.3E+03	1E-04 3E-08	None (0.2) 2
Extensive Separations	HLW glass w/o Cs and Sr	1.0E+03	2E-06	None (0.5)
Ex-Situ/In-Situ Combination	HLW glass w/o Cs and Sr	7.0E+03	3E-06	4
Phased-Implementation Alternative	HLW glass w/o Cs and Sr	4.2E+03	6E-06	2
Applicable to several alternatives	Overpacked Cs/Sr capsules	4.5E-01 1.5E+02	4E-07 7E-08	None (2E-04) None (0.07)

(a) The frequencies and population doses for two accident severity categories are provided for some shipments because there were no severity category frequencies near 1E-06/yr, the definition of a credible accident used in this study. For these situations, the severity categories closest to 1E-06 expected accidents are shown in the table.

An alternative approach to characterizing the consequences of the maximum credible accident was also explored. RADTRAN 4 offers the option of generating data that can be used to plot a cumulative distribution function of consequences. The data represent the cumulative probabilities of accidents that have consequences equal to or less than the specified value. Therefore, the consequences of accident scenarios whose cumulative probabilities are less than are equal 1E-06 can be can be taken from the curve represented by the cumulative distribution function generated by RADTRAN 4. This has the effect of improving the comparison of alternatives because the accident scenario probability is 1E-06 for all the alternatives, rather than the probabilities given in Table 3. However, it is a more complex concept than that represented by the results in Table 3 and would be far more difficult to explain in an EIS. Consequently, no recommendation is made here on which form of the maximum credible accident results should appear in the EIS.

The cumulative distribution function generated by RADTRAN 4 for the Extensive Separations alternative is shown in Figure 1 for illustration purposes. The points plotted on the figure were calculated by RADTRAN 4 and the figure was created using spreadsheet graphics software. The consequences corresponding to a cumulative probability of 1E-06 were found to be approximately 3E+04 person-rem. This value was reported in Table 4. Similar plots for all the alternatives presented in Table 4 were created using RADTRAN 4 output data and the appropriate consequences were taken from the plots.

As a result of the revised inventories and shipping cask information, all of the routine exposure and accident impact results for each of the alternatives were updated. The revised routine exposures are shown in Table 5 and revised accident impacts are presented in Table 6. Tables 7 and 8 provide the revised routine exposure and accident impact results for the Cs and Sr disposition alternatives. Only the results for the alternative involving overpacking and offsite shipment have changed from the previous analysis.

Table 4. Population Dose Estimates that Correspond to An Accident Probability of 1E-06 Over the Entire Shipping Campaign

Alternative	Material	Population Dose, person-rem	Population Risk, LCFs
Intermediate Separations Alternative	HLW glass with Cs and Sr (base-case loading)	1E+04	5
	HLW glass w/o Cs and Sr (base-case loading)	6E+03	3
	HLW glass at 15% waste loading, w/o Cs and Sr	5E+03	3
	HLW glass at 40% waste loading, w/o Cs and Sr	1E+04	5
No Separations Alternative	HLW calcined w/0 Cs and Sr	4E+03	2
	HLW vitrified w/o Cs and Sr	8E+02	None (0.4)
Extensive Separations	HLW glass w/o Cs and Sr	3E+04	15
Ex-Situ/In-Situ Combination	HLW glass w/o Cs and Sr	9E+03	5
Phased-Implementation Alternative	HLW glass w/o Cs and Sr	6E+03	3
Applicable to several alternatives	Overpacked Cs/Sr capsules	2E+01	None (0.01)

(a) Consequence estimates represent the expected population dose for accident scenarios whose probability of occurrence is 1 in 1,000,000 (1E-06) when integrated over the entire shipping campaign.

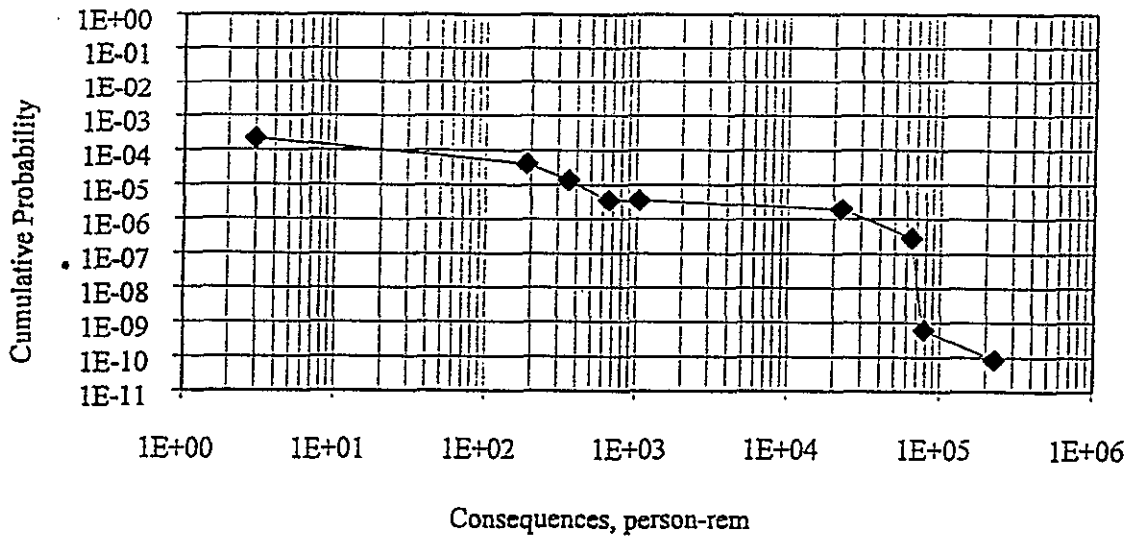

Figure 1. Cumulative Distribution Function for Treated Tank Waste Shipments in the Extensive Separations Alternative

Table 5. Revised Transportation Routine Exposure Results

Material	Population Dose, person-rem		Latent Cancer Fatalities	
	Worker	Public	Worker	Public
Intermediate Separations, Base-case Loading, Cs/Sr Not Added to HLW Glass				
MUST	7.60E-01	2.12E-01	3.04E-04	1.06E-04
SST	3.04E-01	8.45E-02	1.22E-04	4.23E-05
Cs capsules	2.47E-02	7.37E-03	9.88E-06	3.69E-06
Sr capsules	3.01E-02	8.97E-03	1.20E-05	4.49E-06
HLW	3.65E+03	1.75E+02	1.46E+00	8.76E-02
TOTAL	**3.65E+03**	**1.76E+02**	**1.46E+00**	**8.78E-02**
Intermediate Separations, Base-Case Loading, Cs/Sr Added to HLW glass				
MUST	7.60E-01	2.12E-01	3.04E-04	1.06E-04
SST	3.04E-01	8.45E-02	1.22E-04	4.23E-05
Cs capsules	2.47E-02	7.37E-03	9.88E-06	3.69E-06
Sr capsules	3.01E-02	8.97E-03	1.20E-05	4.49E-06
HLW	3.65E+03	1.75E+02	1.46E+00	8.76E-02
TOTAL	**3.65E+03**	**1.76E+02**	**1.46E+00**	**8.78E-02**
Intermediate Separations Alternative, 15% Waste Oxide Loading				
MUST	7.60E-01	2.12E-01	3.04E-04	1.06E-04
SST	3.04E-01	8.45E-02	1.22E-04	4.23E-05
Cs capsules	2.47E-02	7.37E-03	9.88E-06	3.69E-06
Sr capsules	3.01E-02	8.97E-03	1.20E-05	4.49E-06
HLW	4.87E+03	2.34E+02	1.95E+00	1.17E-01
TOTAL	**4.87E+03**	**2.34E+02**	**1.95E+00**	**1.17E-01**
Intermediate Separations Alternative, 40% Waste Oxide Loading				
MUST	7.60E-01	2.12E-01	3.04E-04	1.06E-04
SST	3.04E-01	8.45E-02	1.22E-04	4.23E-05
Cs capsules	2.47E-02	7.37E-03	9.88E-06	3.69E-06
Sr capsules	3.01E-02	8.97E-03	1.20E-05	4.49E-06
HLW	1.83E+03	8.77E+01	7.32E-01	4.38E-02
TOTAL	**1.83E+03**	**8.80E+01**	**7.32E-01**	**4.40E-02**

Material	Population Dose, person-rem		Latent Cancer Fatalities	
	Worker	Public	Worker	Public
No Separations Alternative - Vitrified Tank Waste				
MUST	7.60E-01	2.12E-01	3.04E-04	1.06E-04
SST	3.04E-01	8.45E-02	1.22E-04	4.23E-05
Cs capsules	2.47E-02	7.37E-03	9.88E-06	3.69E-06
Sr capsules	3.01E-02	8.97E-03	1.20E-05	4.49E-06
HLW	6.43E+04	3.09E+03	2.57E+01	1.54E+00
TOTAL	**6.43E+04**	**3.09E+03**	**2.57E+01**	**1.54E+00**
No Separations Alternative - Calcined Tank Waste				
MUST	7.60E-01	2.12E-01	3.04E-04	1.06E-04
SST	3.04E-01	8.45E-02	1.22E-04	4.23E-05
Cs capsules	2.47E-02	7.37E-03	9.88E-06	3.69E-06
Sr capsules	3.01E-02	8.97E-03	1.20E-05	4.49E-06
HLW	1.19E+04	5.70E+02	4.76E+00	2.85E-01
TOTAL	**1.19E+04**	**5.70E+02**	**4.76E+00**	**2.85E-01**
Ex-Situ/In-Situ Combination Alternative				
MUST	7.60E-01	2.12E-01	3.04E-04	1.06E-04
SST	3.04E-01	8.45E-02	1.22E-04	4.23E-05
Cs capsules	2.47E-02	7.37E-03	9.88E-06	3.69E-06
Sr capsules	3.01E-02	8.97E-03	1.20E-05	4.49E-06
HLW	1.83E+03	8.77E+01	7.32E-01	4.38E-02
TOTAL	**1.83E+03**	**8.80E+01**	**7.32E-01**	**4.40E-02**
Extensive Separations Alternative				
MUST	7.60E-01	2.12E-01	3.04E-04	1.06E-04
SST	3.04E-01	8.45E-02	1.22E-04	4.23E-05
Cs capsules	2.47E-02	7.37E-03	9.88E-06	3.69E-06
Sr capsules	3.01E-02	8.97E-03	1.20E-05	4.49E-06
HLW	1.71E+02	8.19E+00	6.84E-02	4.10E-03
TOTAL	**1.72E+02**	**8.50E+00**	**6.88E-02**	**4.25E-03**

Material	Population Dose, person-rem		Latent Cancer Fatalities	
	Worker	Public	Worker	Public
Phased Implementation Alternative				
MUST	7.60E-01	2.12E-01	3.04E-04	1.06E-04
SST	3.04E-01	8.45E-02	1.22E-04	4.23E-05
Cs capsules	2.47E-02	7.37E-03	9.88E-06	3.69E-06
Sr capsules	3.01E-02	8.97E-03	1.20E-05	4.49E-06
HLW	3.65E+03	1.75E+02	1.46E+00	8.76E-02
TOTAL	**3.65E+03**	**1.76E+02**	**1.46E+00**	**8.78E-02**

Table 6. Revised Integrated Population Risks From Transportation Accidents

Material	Population Dose, person-rem	Latent Cancer Fatalities	Material	Population Dose, person-rem	Latent Cancer Fatalities
Intermediate Separations, Base-case Loading, Cs and Sr not added to HLW glass			Intermediate Separations, Base-case Loading, Cs and Sr added to HLW glass		
MUST	3.43E-03	1.37E-06	MUST	3.43E-03	1.37E-06
SST	1.58E-02	6.32E-06	SST	1.58E-02	6.32E-06
Cs capsules	1.33E-05	5.32E-09	Cs capsules	1.33E-05	5.32E-09
Sr capsules	2.02E-08	8.08E-12	Sr capsules	2.02E-08	8.08E-12
HLW	9.25E-02	4.63E-05	HLW	2.06E-01	1.03E-04
TOTAL	**1.12E-01**	**5.39E-05**	**TOTAL**	**2.25E-01**	**1.11E-04**
Intermediate Separations, 15% Waste Oxide Loading			Intermediate Separations, 40% Waste Oxide Loading		
MUST	3.43E-03	1.37E-06	MUST	3.43E-03	1.37E-06
SST	1.58E-02	6.32E-06	SST	1.58E-02	6.32E-06
Cs capsules	1.33E-05	5.32E-09	Cs capsules	1.33E-05	5.32E-09
Sr capsules	2.02E-08	8.08E-12	Sr capsules	2.02E-08	8.08E-12
HLW	9.52E-02	4.76E-05	HLW	8.60E-02	4.30E-05
TOTAL	**1.14E-01**	**5.53E-05**	**TOTAL**	**1.05E-01**	**5.07E-05**

Material	Population Dose, person-rem	Latent Cancer Fatalities	Material	Population Dose, person-rem	Latent Cancer Fatalities
No Separations, Vitrified Tank Waste			No Separations, Calcined Tank Waste		
MUST	3.43E-03	1.37E-06	MUST	3.43E-03	1.37E-06
SST	1.58E-02	6.32E-06	SST	1.58E-02	6.32E-06
Cs capsules	1.33E-05	5.32E-09	Cs capsules	1.33E-05	5.32E-09
Sr capsules	2.02E-08	8.08E-12	Sr capsules	2.02E-08	8.08E-12
HLW	1.21E-01	6.05E-05	HLW	2.31E-01	~~1.16E-04~~ 1.77E-0
TOTAL	**1.40E-01**	**6.82E-05**	**TOTAL**	**2.50E-01**	~~1.23E-04~~ 1.85E-0
Ex-Situ/In-Situ Combination			Extensive Separations		
MUST	3.43E-03	1.37E-06	MUST	3.43E-03	1.37E-06
SST	1.58E-02	6.32E-06	SST	1.58E-02	6.32E-06
Cs capsules	1.33E-05	5.32E-09	Cs capsules	1.33E-05	5.32E-09
Sr capsules	2.02E-08	8.08E-12	Sr capsules	2.02E-08	8.08E-12
HLW	7.64E-02	3.82E-05	HLW	6.59E-02	3.30E-05
TOTAL	**9.56E-02**	**4.59E-05**	**TOTAL**	**8.51E-02**	**4.06E-05**
Phased Implementation					
MUST	3.43E-03	1.37E-06			
SST	1.58E-02	6.32E-06			
Cs capsules	1.33E-05	5.32E-09			
Sr capsules	2.02E-08	8.08E-12			
HLW	9.27E-02	4.64E-05			
TOTAL	**1.12E-01**	**5.40E-05**			

Table 7. Revised Transportation Routine Dose Impacts from Cs/Sr Disposition Alternatives

	Population Dose, Person-rem		Latent Cancer Fatalities	
	Worker	Public	Worker	Public
Cesium and Strontium Vitrified				
Cs capsules	2.47E-02	7.37E-03	9.88E-06	3.69E-06
Sr capsules	3.01E-02	8.97E-03	1.20E-05	4.49E-06
Glass	1.97E+01	9.46E-01	7.88E-03	4.73E-04
TOTAL	**1.98E+01**	**9.62E-01**	**7.90E-03**	**4.81E-04**
Cesium and Strontium Overpacked, Shipped Offsite for Disposal				
Cs capsule	2.47E-02	7.37E-03	9.88E-06	3.69E-06
Sr capsule	3.01E-02	8.97E-03	1.20E-05	4.49E-06
Overpacked capsules	4.38E+01	2.11E+00	1.75E-02	1.06E-03
TOTAL	**4.39E+01**	**2.13E+00**	**1.75E-02**	**1.06E-03**
Cesium and Strontium Overpacked, Stored Onsite				
Cs capsules	2.47E-02	7.37E-03	9.88E-06	3.69E-06
Sr capsules	3.01E-02	8.97E-03	1.20E-05	4.49E-06
Overpacks	0.00E+00	0.00E+00	0.00E+00	0.00E+00
TOTAL	**5.48E-02**	**1.63E-02**	**2.19E-05**	**8.17E-06**

Table 8. Transportation Accident Impacts of Cs and Sr Disposition Alternatives

Material	Population Risk, person rem	Latent Cancer Fatalities
Cesium and Strontium Vitrified		
Cs capsules	1.33E-05	5.32E-09
Sr capsules	2.02E-08	8.08E-12
Glass	3.10E-02	1.55E-05
TOTAL	**3.10E-02**	**1.55E-05**
Cesium and Strontium Overpacked, Shipped Offsite for Disposal		
Cs capsule	1.33E-05	5.32E-09
Sr capsule	2.02E-08	8.08E-12
Overpacked Capsules	3.44E-05	1.72E-08
TOTAL	**4.77E-05**	**2.25E-08**
Cesium and Strontium Overpacked, Stored Onsite		
Cs capsules	1.33E-05	5.32E-09
Sr capsules	2.02E-08	8.08E-12
Overpacks Offsite	0.00E+00	0.00E+00
TOTAL	**1.33E-05**	**5.33E-09**

RADTRAN4 OUTPUT FILES

RADTRAN4 OUTPUT FILES

The attached 3.5-inch disk provides the RADTRAN4 output files that were developed to model offsite shipments of treated tank wastes and packaged cesium and strontium capsules (filename RADTRAN2.OUT). The output files contain an input echo as the first part of the file so the attached files document both the input parameters used in the calculations as well as the output. The table below is a key to the attached files, listing the files in the order they appear in the file on the attached disk, plus presents the filename and a brief description of the material analyzed in each file. Also on the enclosed disk are the spreadsheet files used to perform some of the calculations documented in this study. These include WSTLOAD2.XLS (calculated per-shipment radionuclide inventories and numbers of shipments), RESULTS5.XLS (calculates total routine exposures and integrated accident risks), and MAX-CRED.XLS (risk curves for each material).

No.	RADTRAN4 Filename	Alternative and Material Analyzed
1	COMBO2.OUT	Ex-situ/In-situ combination alternative, vitrified tank waste without Cs and Sr capsule materials.
2	CSSROP2.OUT	Overpacked Cs and Sr capsules.
3	EXTSEP2.OUT	Extensive separations alternative, vitrified tank waste without Cs and Sr capsule materials.
4	INT152.OUT	Intermediate separations alternative, vitrified tank waste at 15% waste oxide loading.
5	INT402.OUT	Intermediate separations alternative, vitrified tank waste at 40% waste oxide loading.
6	INTBW2.OUT	Intermediate separations alternative, vitrified tank waste at base-case (20%) waste oxide loading.
7	INTBWO2.OUT	Intermediate separations alternative, vitrified tank waste at base-case (20%) waste oxide loading. Cs and Sr capsule material vitrified with tank wastes.
8	NOSEPCW2.OUT	No separations alternative, calcined tank wastes without Cs and Sr capsule materials.
9	NOSEPVW2.OUT	No separations alternative, vitrified tank wastes without Cs and Sr capsule materials.
10	PHASED2.OUT	Phased-implementation alternative, vitrified tank wastes without Cs and Sr capsule materials.

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. Klymke 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 Bromson

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}	$\times 10^{-15}$	$= 2.61\times10^{-7}$	$\div 6.0\times10^{-4}$	$= 4.35\times10^{-4}$
I-129 →	1.29×10^{10}	$\times 10^{-15}$	$= 1.29\times10^{-5}$	$\div 6.0\times10^{-4}$	$= 2.15\times10^{-2}$
C-14 →	6.06×10^{8}	$\times 10^{-15}$	$= 6.06\times10^{-7}$	$\div 6.0\times10^{-4}$	$= 1.01\times10^{-3}$
U-238 →	1.28×10^{9}	$\times 10^{-15}$	$= 1.28\times10^{-6}$	$\div 6.0\times10^{-4}$	$= 2.13\times10^{-3}$

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

The Result of Doses (mRem) for 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 91-0051 (4/81)

JACOBS ENGINEERING GROUP INC.

DATE 3/6/96

BY AMN CHKD. %

SUBJECT

SHEET NO. 2

JOB NO.

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 7.77
ERDF	7.376185	3.209	0.000918	0.021	223.092	225.30	0.171233	0.365	4.91 228.0
200 W Buried Cat. 1	2.6	1.131	0.068	1.462	0.085	0.086	0.0021	0.0045	0.06 2.68
Cat. 2	1685.985	733.40	0.831703	17.88	3392.042	3426.0	114.1553	243.20	94.85 4420.

↓

3.426 Rem?

4659.85

Say 4.7 rem

1) Concentrations are in Pci/L

2) Dose are in mrem

Enclosed:

The Predicted Maximum Groundwater Concentration

Environmental Science & Engineering, Inc.

A CH2M HILL Company

Alex — Source terms for GW

FACSIMILE

DATE:	3/5/96	TIME:	
TO:	Phil Brauson	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) 790-1411

	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. 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 – 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. 01K47/01

Items calculated within this calculation

1 Table B.10.0.3 Page

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 16

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 Hillside 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 01 005 1 (4/84)

Because of required changes in the $TiNaO_3$ 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 - Changes 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 Closure 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 cannisters, HMPCs, and shielding units for interim storage.

Number of Cannisters 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)(1.97) 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

= 730563 m^2

4 (452) (146) = 65992

5 (452) (146) = 65992

6 (452) (102) = 46104

174.098

1 (423) (350) = 148050

2 (255) (325) = 133875

3 (160) (525) = 84000

Σ = 365925

Σ+Σ = 544013 m^2

× 186,500 m

JACOBS ENGINEERING GROUP INC.

DATE 2-15-96 SUBJECT SHEET NO. 5 of 48

BY PDW CHKD. JOB NO. 01K47101

8. b. Continued

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

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

Closure Concrete assumed to remain unchanged

∴ Total Concrete = operations + Construction quantities + Closure

= 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

FORM 81.005.1 (4/81)

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

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

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

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

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

$\times 1m = 53160$

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

$\Sigma = 846.58\ m^3$

add 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 2/26/96

2. Raw water usage for operational increases

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 Glass 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)

JACOBS ENGINEERING GROUP INC.

DATE 2-15-96 SUBJECT SHEET NO. 8 of 48

BY RDW CHKD. JOB NO. 01K47101

4. Increased Energy use

Ratio × value = Increased use of energy.

(2.50)(1.66E+04) = 4.15 E+04 Btu/h

total Energy = (4.15 E+04) + (8.9 E+04) = 4.16 E+04 Btu/h

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) = 2.4E+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)(9.36 E+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) = 8.48E+05 m³

FORM 91-005-1 (4/81)

JACOBS ENGINEERING GROUP INC.

DATE 2-15-96 SUBJECT SHEET NO. 9 of 48

BY RDW CHKD. JOB NO. 01K 47101

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

HLW: (570 Canisters) (0.75 Mg/Can) = 4.34E+02 M Tons stainless steel
(1570 ") (0.75 ") = 1.2 E+03 M Tons stainless steel.

LAW: 60 vaults increase.
operations Concrete increase = (4300 m³/vault)(60 vaults)
= 2.58 E+05 m³
added to item for shell pads 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 M Tons.

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 = (79 vaults)(1213 boxes/vault) = 125037
Steel = (125037)(0.144)(7) = 126037.29 Mg. = 1.26 E+05 M Tons.

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

Rebar = (20)(250)
(50)(100)

A = π d²/4 = 0.0001227 m² for assumed rebar.

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

Carbon Steel for ops = (1.62 E+04) + (3.0 E+04) + (1.26 E+05) M Tons
= 1.72 E+05 M tons

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

FORM 91-005-1 (4/81)

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

Kerosene ratio = 2.5 Oxygen for Hg 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) = 1.32 E+06 mTons

12. Calculate the increase in materials for the Sulfur cement used 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 water usage
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

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

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

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 increased 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 increased 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

Total Electricity = (1.55E+04)+(7.4E+01) = 1.56 E+04 Bwh

5. The gasoline usage for constructing extra vaults.

(60)(240)(3.786) ÷ 10^3 = 5.46 E+01 m^3

6. Calculate the increased diesel usage estimated for the change in the waste glass product.

additional Canisters
additional HMPCs
additional Shielding casks.
• additional vaults.

vaults = (60)(25530)(3.786) ÷ 10^3
= 5.8 E+03 m^3

handling of extra Canisters, 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 school 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

JACOBS ENGINEERING GROUP INC.

DATE 2-15-96 SUBJECT SHEET NO. 13 of 48

BY R. Dell CHKD. JOB NO. 01K47101

assumed Concrete 0.2 meter 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 metric tons

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 metric tons

Carbon Steel for Construction

= (1.07 E+05) + (7.72 E+00) = 1.07 E+05

FORM 91.005-1 (4/81)

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.

JACOBS ENGINEERING GROUP INC.

DATE 2-15-95 SUBJECT SHEET NO. 15 of 48

BY RDW CHKD. JOB NO. 01K47101

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 need have changed. Corrections 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) − (6.88E+04)

= 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: ExSitu / InSitu combination alternative.

~~1. The total committed land use assumed to remain the same and the borrow pit disturbed area remained unchanged.~~

Land use Revisions calculated Separately.

FORM 01.0051 (4/91)

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 m tons
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 = 2.8
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 = (6.5 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 (4/83)

JACOBS ENGINEERING GROUP INC.

DATE 2-15-96 SUBJECT SHEET NO. 17 of 48

BY RAW CHKD. JOB NO. 01K4701

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) (4.13 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

C = 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 (4/83)

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

$= (220)(550)(0.0001227) = 14.8\ m^3$ APW

$= (110)(1100)(0.0001227) = 14.8\ m^3$

$\rho = 7\ Mg/m^3$ $\Sigma = 29.7\ m^3$

$= (29.7)(7) = 2.08E+02$ 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 $= (5.36E+04) + (206E+04)$

$= 7.42E+04$ 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 ops 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: In 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. 01K 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 change for additional shielding casks and the additional storage pad needed.

(2829840) Mg

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 × 212 m = 111300 m^2

volume @ 0.2 meter thick = 2.23 E+04 m^3 [(325)(393) 206325 m^2]

(41265 m^3)

FORM 91.005.1 (4/91)

JACOBS ENGINEERING GROUP INC.

DATE 2-15-96 SUBJECT SHEET NO. 21 of 48

BY RDW CHKD. JOB NO. 01847101

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 m tons

(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)

FORM 91-005-1 (4/81)

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 m³
new number of Canisters 0.61 m³ = 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 m³
old number of Canisters = 6.82E+03 0.56 m³
old number of HMPCs = 1705
old number of Shielding Casks. = 1705

JACOBS ENGINEERING GROUP INC.

DATE 2-15-96 SUBJECT SHEET NO. 23 of 48

BY RAW CHKD. JOB NO. 01K47101

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

Combined HLW + LAW Ratio = $\frac{(5.45\ E+04) + (8.07\ E+05)}{(2.47\ E+04) + (4.83\ E+05)}$

= $\frac{6.62\ E+05}{5.08\ E+05}$ = 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

FORM 91-005-1 (4/81)

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 = 7.55 E+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 ÷ 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 RDH 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.

$\rho = 1.6\ Mg/m^3 \quad = (602701.5)/1.6 = 376688.43\ m^3$

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 cover 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 ←

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BY R.Jw CHKD. JOB NO. 01K47101

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 I 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

FORM 91-005-1 (4/81)

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DATE 2-15-96 SUBJECT SHEET NO. 28 of 48

BY RDW CHKD. JOB NO. 01K47101

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 Conservation 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

FORM 91-005-1 (4/81)

JACOBS ENGINEERING GROUP INC.

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BY RDW CHKD. JOB NO. 01K4710

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)
   $m^3 = (2.13)(3.1E+06\ m^3) = 6.60\ E+06\ m^3$
   Sanitary Water = $6.60\ E+06\ m^3$

   Total Sanitary water = $(6.0\ E+04) + (6.60\ E+06) + (5.0\ E+05)$
   $= 7.16\ E+06\ m^3$

3. Calculate the increase in the raw water usage.
   (Comb. Ratio) (operations usage)
   Raw water $= (2.13)(1.07\ E+07) = 2.78\ E+07\ m^3$
   Raw water $= 2.78\ E+07\ m^3$

   Total Raw water = NR + $(2.78E+07)$ + NR
   $= 2.78\ E+07\ m^3$

4. Calculate the total water usage
   total = RW Total + SW Total
   $= (2.78E+07)(7.16\ E+06)$
   $= 3.5E+07\ m^3$

5. Calculate the increased energy use due to the reduced loading and the blending factor application.
   (Comb. ratio) (Energy usage for operations)
   Energy $= (2.13)(9.0E+03) = 1.92\ E+04$
   $= 1.92\ E+04$ Kwh

   Total Energy $= (1.92E+04) + (7.4E+01) = 1.93\ E+04$
   $= 1.93\ E+04$ Kwh.

FORM 91-005-1 (4/81)

JACOBS ENGINEERING GROUP INC.

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BY RDW CHKD. JOB NO. 01K47101

6. Calculate the Gasoline requirements for the construction of the LAW storage vaults.

(# 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

(# 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.

(Cons. Ratio) (Kerosene originally)

= (2.13)(5.08 E+04) = 1.08 E+05 m^3

= 1.08 E+05 m^3

FORM 91-005-1 (4/81)

JACOBS ENGINEERING GROUP INC.

DATE 2-15-96 SUBJECT SHEET NO. 31 of 48

BY R.DW CHKD. JOB NO. 01K47101

9 Calculate the increased concrete requirements for the additional vaults, addition 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) = 62500 m²

use 0.2 meter thick concrete

Vol = (62500)(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 metric tons of rebar.

FORM 81-005-1 (4/81)

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. $\rho = 7\ mg/m^3$

(125)(500 ÷ 0.2)(0.0001227)(7) = 268.4 m tons

= 536.8 metric tons.

Steel for the 4.2 Cubic meter LAW waste boxes.

$(1263)(124)(0.144\ m^3/hr)(7\ mg/m^3) = 157865$ m tons

= 1.58 E+05 M Tons.

Construction Steel = (2.68.4 m tons) + (1.07 E+05)

= 1.07 E+05 m tons

Operations Steel = (1.58 E+05) + (4.25 E+04) + (HR)

= 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 m^3 connectors required for the HLW glass

(4.45 E+04)(0.75) = 3.34 E+04 m tons.

0.62 m^3 Connectors = 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 formers 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.

Increase oxygen = (1.91 E+05)(2.13) = 4.07 E+05

= 4.07 E+05 in Tons.

• Process Chemicals = (4.07 E+05) + (1.90 E+05)

= 5.97 E+05 in Tons.

Note

to add O_2 to the original case

= (1.90 E+05) + (1.91 E+05)

= 3.81 E+05 in Tons.

14. Calculate the quantities of material needed for the sulfur cement based on the changes in the LAW glass loading.

Sulfur = (1.3 E+05)(2.13) = 2.77 E+05 in Tons ←

Dicyclopentadiene = (3.4 E+03)(2.13 = 7.24 E+03 in Tons. ←

Oligomer = (3.4 E+03)(2.13) = 7.24 E+03 in Tons. ←

H. The following calculations are performed for the intermediate separations alternative using the following bases:

HLW - 40 weight % waste oxides loading

- Blending factor of 1.5

LAW - 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 car 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 m Tons
- 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 m Tons
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 m Tons
new volume of glass = 2.63 E+E+05 m^3
new number of vaults = 50

old mass of glass = 3.87 E+05 m Tons
old volume of glass = 2.1 E+05 m^3
old number of vaults = 40

$\rho = 1.84 Mg/m^3$

Combined ratio = $[(2.72E+04) + (4.84\ E+05)]/[(3.87E+05) + (2.47E+04)]$

$= (5.11\ E+05)/(4.12\ E+05)$

$= 1.24$

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BY RDW CHKD. JOB NO. 01K47101

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.

(Combine 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 Kwh)
= 1.12 E+04 Kwh.

total Energy = (1.12 E+04) + (7.4 E+01)
= 1.13 E+04 Kwh.

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 = (2.24E+03) + (6.62E+04) + (2.1E+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

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BY RDW CHKD. JOB NO. OK 47101

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

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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 LAW waste boxes 4.2 m³
= (50)(1263)(0.144)(7) = 63655.2 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 canister 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 $= (1.24)(1.3E+05) = 1.61E+05$ 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. In 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: 0.31E+05

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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 - 1-5; Const + ops - 146
c. Borrow pit disturbed acres: 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)
= (1.17 E+06) + (4.55 E+05) + (1.43 E+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

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BY PDW CHKD. JOB NO. 01K47101

operations — Sand = 9.52E+05 m³
gravel = 9.52E+05 m³
total = 19.04E+05 m³

operations total = 1.9E+06 m³
Construction total = (4.46E+04) + (1.23E+05)
= 1.68E+05 m³

total = (1.68E+05) + (1.9E+06) + (1.17E+06)
= 3.24E+06 m³

7. Ex Situ Extension Separations alternative
a. Land committed permanently: total - 46; op & const - 34; closure 72
b. Land temporarily committed: total - 112, op & const - 88; closure —
c. Borrow pit disturbed: McGee Ranch - 25, pit 30 - 68;
Vernita quarry - 31.
d. Borrow pit Silt - 6.45E+05
e. Borrow pit Sand and gravel - closure - 1.5E+06
f. Borrow pit Basalt - 9.31E+05
g. Calculate the Borrow Site Sand and gravel for operations, construction and total.

Construction - Sand = 2.58E+05
gravel = 2.58E+05
Existing value = 3.72E+05
total = 9.88E+05 m³

operations - Sand = 8.11E+03
gravel = 8.11E+03
total = 1.622E+04 m³

total = (1.5E+06) + (1.622E+04) + (8.88E+05)
= 2.4E+06 m³

8. Phased Implementation alternative - Phase I
a. Land temporarily committed: total - 32; Const & op - 32
b. Borrow pit disturbed: McGee Ranch - 1, pit 30 - 1

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BY PDW CHKD. JOB NO. 01447101

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 - 52; 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

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Construction - sand = 1.98 E+05 m^3
- gravel = 1.98 E+05 m^3
Existing value = 1.71 E+05 m^3
total = 5.67 E+05 m^3

total = (7.54E+05) + (1.36E+06) + (5.67E+05)
= 26.81E+05 = 2.7E+06

J. Calculation of values 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 m^3 = (912000 yds^3)
Silt = none Required
Rip Rap = none required

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BY RDW CHKD. JOB NO. OK 47101

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

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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

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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 = 3.54E+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

*. 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 page 3-103 or B-160 of the Draft EIS under modification January - February 1996.

I. 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. Ex situ intermediate separations

quantity = [(new quantity) ÷ (old quantity)] (Value in table)

= [(1.67E+06) ÷ (7.20E+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. Ex situ 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

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JACOBS ENGINEERING GROUP INC.

DATE 2-15-96 SUBJECT SHEET NO. U7 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) = 1706280 ft^3

= 1.71E+06 ft^3

e. Ex Situ/In Situ Combination

quantity = (6.61/3.74)(410000) m^3

= 724625.63 = 725000 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)

Riprap = 931,000 (3.3E+07)

aggregate/Sand = 744,000 (2.7E+07)

Numbers from Colin Henderson Calc 1-30-96

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JACOBS ENGINEERING GROUP INC.

DATE 2-15-96 SUBJECT SHEET NO. 47 of 48

BY RDW CHKD. JOB NO. 01K4701

b. Ex situ / 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.

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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	~~5.6E~~ 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~~ 1.56E+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~~ 2.46E+01
	Closure	N/A	N/A	3.0E+02	3.0E+02	3.9E+02

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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 ~~3.82~~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	9.53 ~~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 ~~3.8~~E+04
Materials: Concrete (cubic meters)	Total	N/A	3.5E+05	1.9E+04	1.3E+05 (1.67)	1.94E+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	1.73E+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~~ 5.14 E+04
	Closure	N/R	N/A	N/R	N/R	1.9E+04 ??
Stainless Steel (mt)	~~Total~~ 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	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 5.78 5.78	2.21 ~~1.30~~E+05 ~~3.4~~E+03 ~~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

OPERATIONS

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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~~ ~~8.38~~ 8.38	~~1.35E+07~~ 2.06	2.8E+06	~~1.08E+07~~ 1.81
Water, Sanitary (cubic meters)	Total	4.13 ~~2.34E+06~~	3.6E+05	8.76 ~~3.9E+06~~	5.71 ~~2.5E+06~~	6.3E+05	5.02 ~~3.08E+06~~
	Construction	2.39E+05	2.39E+05	5.29E+05	4.19E+05	3.9E+05	2.54E+05
	Operation	3.85 ~~2.06E+06~~	2.08E+06	8.03E+06 ~~3.21E+06~~	5.24 ~~3.08E06~~	2.2E+05	4.77 ~~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	8.64 ~~4.62E+05~~	8.58E+04	7.5 ~~3.0E+07~~	1.49 ~~1.1E+07~~	2.2E+06	1.31 E+07 ~~5.51E+06~~
	Construction	N/R	N/R	N/R	5.5E+06	N/R	N/R
	Operation	8.64 ~~4.62E+05~~	8.58E+04	7.5 ~~3.0E+07~~	9.35 ~~5.5E+06~~	2.2E+06	1.31 E+07 ~~7.7E+06~~
	Closure	N/R	N/R	N/R	N/R	N/R	N/R

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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 ~~4.72E+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~~	7.65 ~~4.5E+03~~	1.6E+03	1.04E+04 ~~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	1.02 ~~1.0E+04~~	3.0E+05	6.8E+03	5.18 ~~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~~ 5.46E+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	~~6.70~~ 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+01~~ 1.06E+05	8.05E+04 1.05E+04	~~9.36E+04~~ 2.34E+05	~~2.9E+04~~ 4.93	9.8E+02	3.0E+04 5.1
Materials: Concrete (cubic meters)	Total	9.62 ~~2.33E+06~~	2.24 ~~1.27E+06~~	~~8.48~~ 9.35 ~~6.69E+05~~ 8.66	6.61 ~~3.74E+05~~	2.4E+04	6.4E+05 ~~6.5E+04~~
	Construction	4.32 ~~2.66E+05~~	2.88 ~~2.66E+05~~	5.0E+05	2.74 ~~2.7E+05~~	2.4E+04	3.28 ~~2.9E+04~~
	Operation	~~2.13~~ 9.17 ~~2.04E+06~~	1.93E+06 ~~9.8E+05~~	~~1.58~~ 4.16 ~~1.5E+05~~ 3.47	3.68E+05 ~~8.5E+04~~	4.4E+02	~~1.7E+04~~ 5.83E+05
	Closure	1.9E+04	1.9E+04	1.9E+04	1.9E+04	0	1.9E+04

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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
Stainless Steel (mt)	TOTAL Construction	~~1.26E+04~~ 4.53E+05	~~1.26E+04~~ 9.39E+04	2.1E+04	~~9.5E+03~~ 2.2E+04	1.5E+04	~~1.15E+04~~ 3.66E+04
Hastelloy/Inconel (mt)	OPERATION Construction	~~1.51E+03~~ 4.4E+05	~~1.51E+03~~ 8.13E+04	~~1.80E+03~~ 1.2E+03	~~1.15E+03~~ 1.25E+04	~~2.6E+03~~	~~1.15E+04~~ 2.51E+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	~~1.2E+05~~ 2.04E+05
dicyclopentadine (mt)		N/A	N/A 1.12E+04	~~4.46E+03~~ 2.88	~~2.65E+03~~ 2.88	~~7.4E+02~~ 3.74E+02	~~3.4E+03~~ 5.78E+03
oligomer (mt)		N/A	N/A 1.12E+04	~~4.46E+03~~	~~1.70E+03~~ 2.89	~~6.8E+02~~ 3.84E+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~~ 3.04	~~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

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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

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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 1.02	Aggregate 4.32 / 2.66 → Aggregate	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	481543 (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

Notes:
N/A = Not Applicable

651900 (2.34 E+07)

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 Rev 2-15-96
& 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~~ ~~25~~ 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	~~51~~ 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

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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~~ ~~1.36E+06~~ 1.5E+06
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

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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

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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 sulfur (mt) dicyclopentadine (mt) oligomer (mt)	Operation	 N/A N/A N/A	 N/A N/A N/A	 1.7E+05 4.46E+03 4.46E+03	 6.5E+04 2.65E+03 1.70E+03	 5.2E+04 7.4E+02 6.8E+02	 1.2E+05 3.4E+03 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

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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 att. 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

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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.

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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					
				Glass Stream	
				Σ W oxides	
		m NaOx ÷ (.2)		(1.5)	= mass
				2.63	
				Cut 0.9 = volume	

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	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		166,150 ~~108388~~
Number of 0.62 m^3 canisters per HMPC			4		4
Number of trips to the repository			14686	14674	4150 ~~2710~~
Based on 10 HMPCs per train					
Note: Curies from decay daughter products not included					
					108388
					-587000
					5 = 478612
				0.815	81.5%

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

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			

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		

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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	418	416

(4 to HMPC per trip)

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

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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		

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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					2.39E+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			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										

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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.

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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		

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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			

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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

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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				

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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						

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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						

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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						

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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

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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		

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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%

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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%

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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	

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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									
CR203					2.11E+02			5.79E+01		
CR(OH)4-		1.19E+02								
CS+	9.25E-02	8.19E-01								

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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					2.94E-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		

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%		
Na2O	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		

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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		

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.

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 (4 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

Allowing for 1 year to upgrade the demo. plants. leaves 11 years in which to operate the upgraded LAW Plants during Phase 2.

The modified LAW Plants would process:

LAW = 2 x 40 mt/day x 11 yrs x 365 day/yr x 0.85
= 273,000 mt LAW.

The Phase 2 High Capacity Plants must then process

LAW = 719400 - 273,000 mt LAW = 446400 mt
HLW = 52210 mt HLW.

The High Capacity Plants must then be sized at:

$$LAW = \frac{446400 \text{ mt}}{13 \text{ yrs} \times 365 \text{ day/yr} \times .85} = 110 \text{ mt/day}$$

$$HLW \text{ Plant} = \frac{\overset{53080}{\cancel{52210}} \text{ mt}}{17 \text{ yrs} \times 365 \text{ day/yr} \times .85} = \overset{10.07}{\cancel{9.9}} \sim 10 \text{ mt/day.}$$

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Table 5.1.1 Key Geology and Soil Impact Parameters

Alternatives		Mineral Resources m^3 (yd^3)			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)

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.

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TWRS EIS
CALCULATION COVER SHEET

DISCIPLINE & TITLE ENGR/COST Proposed Draft EIS Alternatives

ORIGINATOR D. Stein DATE 2/20/96

REVISION NO. 0

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

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)

D L Stein
SIGNATURE

CALCULATION & RESULTS ATTACHED
99 pages total excluding cover sheet.

JACOBS\FORMS\CALCVR.SHT

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

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

JACOBS ENGINEERING GROUP INC.

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

BY DZS 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

Category	# previous	ratio used	$ Δ
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	159,300,000 × 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	$\frac{33586}{6800}$ = 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 91-005-1 (4/81)

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 unit. requires 1.1E+07 staff-hrs

LAW unit. requires 1.1E+07 staff-hrs

total staff hrs (everything) → 3.1E+07

$\frac{\$1,700,000,000}{3.1E+07 \text{ hrs}} \Rightarrow \$55/hr$

2.2E+07 total

new HLW hrs = $(1.1E+07) \times \frac{12}{14} = 0.94E+07$

new LAW hrs = $(1.1E+07) \times \frac{19}{14} = 1.49E+07$

2.43E+07 new

vs 2.2E+07 previous

Δ labor cost = $(2.43E+07) - (2.2E+07) \times \$55/hr$

Δ labor cost = $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 (4/81)

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
Canister's – 44,500
above/below from mass balance info

Low Bounding Case HLW glass

total now — total prev. — formers prev.

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

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

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

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

total now — total prev — formers prev

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

ratio glass formers: $\frac{11.0}{2.81} = 3.91$

ratio glass product: $\frac{12.1}{3.87} = 3.13$

JACOBS ENGINEERING GROUP INC.

DATE 2/13/96 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	159,300	× 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

	$ previous (thousands)	HLW ratio	LAW ratio	$ (thousands) Δ
vaults	225,000	—	$\frac{124}{40} = 3.10$	472,500
canisters	68,200	$\frac{47500}{6800} = 6.54$	—	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

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 cost = (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 = $7.8 billion

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)
(total prod, total prec, formers prec)
2.72E+04 MT glass product

ratio glass formers	ratio glass product
$\frac{1.57}{1.36} = 1.15$	$\frac{2.72}{2.51} = 1.08$

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	ratio glass product
$\frac{3.78}{2.81} = 1.35$	$\frac{4.84}{3.87} = 1.25$

JACOBS ENGINEERING GROUP INC.

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

BY DLS 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	$\frac{16,700}{6800}=2.46$	—	99,572
Containers	42,625	2.46	—	62,232
Casks	102,300	2.46	—	149,358
pads	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 DLS CHKD. JOB NO.

Δ labor costs

new HLW hrs = $(1.1E+07) \times \frac{7}{14} = 0.55E+7$

new LAW hrs = $(1.1E+07) \times \frac{11}{14} = 0.86E+7$

1.41 E+7 vs 2.2 E+7

Δ labor costs = (1.41 E+7) − (2.2 E+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 = $5.0 billion

FORM 91-005-1 (4/81)

10-

JACOBS ENGINEERING GROUP INC.

DATE 2/13/96 SUBJECT

BY DLS CHKD.

SHEET NO. 10-10

JOB NO.

million $ ...

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	16,700
# vaults	124	83	50
Δ HLW op. cost	225.6	139.6	9.6
Δ LAW op. costs	343.0	175.5	40.4
Δ labor op. costs	649.0	115.5	-434.5
Δ other op. costs (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	7,800	6,500	5,000
Op. yrs. HLW	17	12	7
LAW	26	19	11

FORM 91-005-1 (4/81)

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	$10,397	$8,741
M+M	$1	$1	$1
Repository Fee	$7,800	$6,500	$5,000
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 3921

check (see calcs) 2/13/96

check (see calcs) 2/13/96

* 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	0.184745233
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	

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			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									

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	1,210,000		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	

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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	Unit	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

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Table F-37. Operating Cost for Consumables.

		Unit	Pretreatment/LLW		HLW		Total	
Material	Units	Cost	Amount	Cost	Amount	Cost	Amount	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

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Table F-38. Other Operating Costs.

		Unit	Pretreatment/LLW		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

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JACOBS ENGINEERING GROUP INC.

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

BY DLS CHKD. JOB NO.

EZ Sitz 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

$\frac{5.64E+05}{2.50E+05} = 2.26$

ratio glass product

$\frac{6.71E+05}{3.57E+05} = 1.88$

Δ cost for glass formers

category	previous $ (Thous)	ratio	Δ $ (Thous)
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

JACOBS ENGINEERING GROUP INC.

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

BY DJS CHKD. JOB NO.

other op. cost Δ

587,426 canisters, 0.62 m³ each
vs. 21,400 canisters, 10 m³ each previous

Add

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

Subtract

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

pads not listed in Ato Sep. data pkg but assume one 10 m³ canister occupies ~7.5 times area as 0.62 m³ 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

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NO Sig

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

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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.

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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.

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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).

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

Notes (Continued):

[5]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.

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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.

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			

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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	1.164E5		
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

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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 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 $10 m^3$ to $0.62 m^3$ each.

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

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

$4,315,000,000

previous op cost 3,233,000,000

$7,548,000,000

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

FORM 91-005-T (4/81)

TWRS EIS
CALCULATION COVER SHEET

DISCIPLINE & TITLE Engineering / Number of Canisters, Trips, and Curie Concentrations in the HLW for Feedstream 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 att. calculated based on % recovered on an isotope by isotope basis.

ASSUMPTIONS Noted.

(Continue on another sheet if necessary)

C Henderson

SIGNATURE

CALCULATION & RESULTS ATTACHED

JACOBS\FORMS\CALCVR.SHT

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% 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.

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		3.32 E1 ÷ 36 HES =	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		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		

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			

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

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	418	416

4 to HMPC per trip

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

JACOBS ENGINEERING GROUP INC.

DATE 2/19/96 SUBJECT SHEET NO. 1-3

BY DLS CHKD. JOB NO.

Extensive Separations
Proposed DEIS

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

from mass balance info
8.73E +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	ratio glass product
$\frac{2.11E+03}{8.73E+02} = 2.42$	$\frac{2.56E+03}{1.32E+03} = 1.94$

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	ratio glass product
$\frac{6.83 E+05}{2.65 E+05} = 2.58$	$\frac{8.04 E+05}{3.86 E+05} = 2.08$

JACOBS ENGINEERING GROUP INC.

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

BY DLS CHKD. JOB NO.

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

category	previous $ (see attached Ext. Sep tables) (thousands)	ratio	Δ $ (thou)
B_2O_3	57,500	2.58	$90,850
LiO_2	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 (same electricity ratio new/prev. as used for inter-sep)	398,400
			$608,383

~ same duration of operation as before

Therefore Δ labor = 0

JACOBS ENGINEERING GROUP INC.

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

BY DLS CHKD. JOB NO.

△ Other Op. Costs

	$ previous	ratio	$ △ (Thous)
Vaults	190,000	83/38 = 2.18	$224,200
Canisters	4,480	1572/448 = 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

Extensive Separations

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%
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

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

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

	Construction	Operating Labor	Operating Equipment	Materials and Supplies			LLW Vaults	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.

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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

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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 these canisters, per TRW report are 68 x 457 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.

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	Operation Labor	Operation Equipment	Materials and Supplies Start-up	Materials and Supplies D&D	Materials and Supplies Operation	LLW Vaults	HLW Canisters	R&D	Ancillary Facilities	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.

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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.

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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

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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

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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.

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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

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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.

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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.

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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

JACOBS ENGINEERING GROUP INC.

DATE 2/20/96 revision SUBJECT SHEET NO. 1-4

BY DLS CHKD. JOB NO.

Phased Implementation
Proposed DETS

HLW glass - 45% waste oxide loading, 1.5 blend factor
LAW glass - 15% sodium oxide loading, 1.25 blend factor

Assign all extra op. costs due to canister size, # canisters, containers, casks, vaults, extra glass, electricity, kerosene, etc. to phase 2. Δ op. cost will be same as for inter. sep.

Phase 2 op costs ($ Thousands)

Δ HLW	$ 139,628	
Δ LAW	175,529	
Δ labor	66,000	(½ Δ of inter. sep. since ~ ½ size inter. sep.)
Δ other op. costs (vaults, canisters, etc)	1,177,978 *	
total Δ op. cost	$1,559,135	
previous op. cost	$1,330,000	
new op. cost phase 2	$2,889,135	

* previously reported in error at $1,246,100,000 (2/6/96)

Decrease op. cost of demo. plants in phase 2 because HLW plant not operating now.

$117 million - $58 D&D already taken - 14 startup already taken = $45 million

new op cost of demo plants in phase 2 = 960 - 45 million
= $915,000,000

all other op. costs & capital remain the same

FORM 91-005-1 (4/81)

JACOBS ENGINEERING GROUP INC.

DATE 2/20/94 SUBJECT SHEET NO. 2-4

BY DLS CHKD. JOB NO.

Phased Impl (Phase 2)

Capital

option 1

increase capacity of LAW vitrification in phase 2 from 2-20 MT/D to 2-40 MT/D

Assume upgrade would be the same as adding 2-20 MT/D vitr. units as in Phase 1 case. This would be less expensive than scrapping 2-20 MT/D units and adding 2-40 MT/D units.

Estimated cost Δ:

$$\Delta = \frac{\$248 \text{ million}}{20 \text{ MT/D unit}} \times 2 \text{ units} = \$496 \text{ million}$$

option 2

increase capacity of phase 2 LAW vitr. plant from 100 MT/D base case to 150 MT/D. This would add 50 MT/D (40 MT/D planned for phase 1 plants in phase 2 and 10 MT/D needed for phase 2 plant).

Per previous capital for ext. sep 200 MT/D vitr plant of $1300 million, but 2 trains, so 100 MT/D plant would cost $650 million. Then by 0.6 rule,

$$C_{150} = \frac{C_{100}}{\left(\frac{100}{150}\right)^{.6}} = \frac{650}{(.667)^{.6}} = \frac{650}{.784} = \$830 \text{ million}$$

Estimated cost $\Delta = \$830 - 650 = \$180$ million

FORM 91-005-1 (4/81)

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JACOBS ENGINEERING GROUP INC.

DATE 2/20/96 SUBJECT SHEET NO. 3-4

BY DL CHKD. JOB NO.

Choose option 2 which costs less capital in phase 2 now

$1980 million + $180 = $2160 million

previous Δ

FORM 91-005-1 (4/81)

Phased Implementation Rev 3

PROPOSED DEIS

Cost Component	Phase 1	Phase 2	Total	Basis/Assumptions
Current Operations	$4,900	$3,700	$8,600	
Transfer System Upgrades(in current ops)				
Research and Development				
Waste Retrieval and Transfer		$190		R&D included only for retrieval and transfer
Treatment		$0		
Total R&D	$0	$190	$190	
Capital				
Waste Retrieval and Transfer		$2,280		Identical to retrieval and transfer capital under Int Separations
Treatment	$1,425	$2,160		Cap cost from ex situ portion of combination alt. with contingency reduced from 40% to 20%
Closure	$41	$170		Closure same as Intermediate Separations
Total Capital Costs	$1,466	$4,610	$6076	
Operating				
Waste Retrieval and Transfer		$3,990	$7,889	Ex Situ Int Separations red. for shorter ops period 5% reduction for improvement
Combined Ops. Phase 1 demo plants		$915	$7,794	Extended ops of phase 1 plants reduced by 15% for no startup, other efficiencies taken
Treatment	$1,500	~~$2,958~~	~~$9,365~~	Phase 2 treatment = ex situ portion of Combination alt efficiency improved
Total Operating Costs	$1,500	~~$7,865~~	~~$9,365~~ $9294	
Repository Fee		$6,500	$6,500	Same as Intermediate Separations
Sub Total	$7,866	~~$22,865~~ $22,794		
Total Cost			~~$30,729~~ $30,660	

Current Operations	=	$8,600
Total R&D	=	$190
Total Capital Costs	=	$6,076
Total Operating Costs	=	~~$9,365~~ 9294
Repository Costs	=	$6,500
Total Cost (millions)	=	~~$30,729~~ $30,660

2/20/96 revision

2/6/96 D. Stein

4-4-96

JACOBS ENGINEERING GROUP INC.

DATE 2/7/96 SUBJECT ~~Phased~~ Implementation SHEET NO. 1-3

BY D Stein CHKD. JOB NO.

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~~Phase 2 at 60% vs 85% used in proposed DEIS~~

After Phase 1 demo operation, still need to produce 719,400 MT LAW and 53,086 MT HLW

Using same yrs operation as Inter. Sep. for same glass type and loadings

$$LAW = \frac{719{,}400\ MT}{19\ yrs \times 365\ D/y \times .6\ eff.} = 173\ MT/D$$

$$HLW = \frac{53{,}086\ MT}{12\ yrs \times 365\ D/y \times .6\ eff} = 20\ MT/D$$

Option 1

Therefore, Inter. Sep. plants at 200 MT/D + 20 MT/D would satisfy production requirements. Shutdown phase 1 plants during phase 2.

$$\frac{173\ MT/D\ required\ LAW}{200\ MT/D\ design} = .87$$

Note that 13% saving in LAW production over inter sep case.

Effect is to save $915 million of Phase 1 operating in Phase 2

Option 2

Continue to operate phase 1 plants (LAW only) in phase 2

Include $915 million of phase 1 operating costs in phase 2 operations

FORM 91-005-1 (4/81)

JACOBS ENGINEERING GROUP INC.

DATE 2/7/96 SUBJECT 60% eff. in Phase 2 vs 85% previous SHEET NO. 2-3

BY D Stein CHKD. JOB NO.

81-

	Phase 1	Inter. Sep. Used for Phase 2	Total Phased Impl. Using Inter Sep. for Phase 2	Total Phased Impl. Using Inter. Sep. for Phase 2 but with 20% savings for lessons learned *	
				option 1	option 2
Current Op	4900	3700	8600	8600	
total R+D	0	190	190	190	
Capital					
WR+T	—	2280	2280	2280	
Treat.	1425	3600	5025	4305	
Closure	41	170	211	211	
total Cap	1466	6050	7516	6796	
Operating					
WR+T	—	3990	3990	3990	
Treat.	1500	5577	7077	5962 +915 ↓	⇒ 6877
Total Op.	1500	10397	11067	9952 +915	⇒ 10867
Repository Fee	—	6500	6500	6500	
total	$7,866	$26,837	$33,873	$32,038 +915	⇒ 32,953

Keep LAW plants from phase 1 op. in phase 2

* 20% reduction in Phase 2 Treatment Capital and Operating Costs based on info gathered in Phase 1 demo operations. Demo plants shut down after phase 1.

FORM 91-005-1 (4/81)

JACOBS ENGINEERING GROUP INC.

DATE 2/7/96 SUBJECT SHEET NO. 3-3

BY DSkin CHKD. JOB NO.

Summary

If Phase 2 uses 60% eff. instead of 85%

(millions $)	Total Phased Implementation Costs Option 1	Option 2
Current Op.	$8600	$8600
total R+D	$190	$190
total Capital	$6796	$6796
total Operating	$9952	$10867
Repository Fee	$6500	$6500
Total Cost	$32,038	$32,953

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 throughput 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.

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 6 yr

= 1314 mt

Therefore during Phase 2 must process a total of

LAW = 8.07E5 - 87600 = 719400 mt LAW

HLW = 54400 - 1314 = 53,086 mt HLW.

Allowing for 1 year to upgrade the demo plants. leaves 11 years in which to operate the upgraded LAW Plants during Phase 2.

The modified LAW Plants would process:

LAW = 2 x 40 mt/day x 11 yrs x 365 day/yr x 0.85
= 273,000 mt LAW.

The Phase 2 High Capacity Plants must then process

LAW = 719400 - 273,000 mt LAW = 446400 mt
HLW = 53086 mt HLW.

The High Capacity Plants must then be sized at:

$$LAW = \frac{446400 \text{ mt}}{13 \text{ yrs} \times 365 \text{ day/yr} \times .85} = 110 \text{ mt/day}$$

$$HLW \text{ Plant} = \frac{53086 \text{ mt}}{17 \text{ yrs} \times 365 \text{ day/yr} \times .85} = 10.06 \approx 10 \text{ mt/day}$$

Phased Implementation

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							

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					2.94E-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		

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%	
Na2O	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								
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	

89-

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	

Junior Combo

2/15/96 90-
1-7

Subject: New Ex Situ/In Situ Combination alternative (Junior Combo)

Assumptions

1. Selection process for identifying tanks for ex situ processing results in retrieval of the waste from 23 tanks and filling and capping 154 tanks.
2. Based on the tanks identified and the Dec. 1995 waste status report, the volume of waste in the 23 tanks is 14.8 million gallons out of a total 56 million gallon inventory in all 177 tanks.
3. Use the Ex Situ Intermediate Separations alternative process and waste loading. The Ex Situ Int. Sep. Alt. produces: 54,400 mt HLW @ 20 wt. % waste oxide loading (less Si & Na) at a blending factor of 1.5, 8.07E+05 mt LAW @ 15 wt. % Na2O loading at a blending factor of 1.25.
4. The amount of HLW and LAW produced by the Junior Combo alternative can be determined using a ratio of the inventory volumes to be processed (14.8 Mgal/56 Mgal = .26). Therefore, the volume of HLW and LAW produced for the Junior Combo would be:
   HLW = 0.26 x 54,400 mt HLW = 14,140 mt HLW
   LAW = 0.26 x 8.07E+05 mt LAW = 210,000 mt LAW
5. Schedule assumptions based on TPA milestones and Phased Implementation are:
   Start up= 2002-2003.5 (1.5 years)
   Phase 1 Operations = 2003.5-2011 (7.5 years)
   Upgrades = 2011-2013 (2 years)
   Phase 2 Operations
      LAW= 2013-2024 (11 years)
      HLW = 2013-2028 (15 years)
6. Assume the Phase 1 treatment facilities would be the same as the Phased Implementation alternative:
   HLW = 1 mt/day
   LAW = 20 mt/day x 2 plants = 40 mt/day
7. Operating efficiency
   Phase 1 = 60 percent
   Phase 2 = 70 percent
8. The Phase 1 treatment facilities would be upgraded following Phase 1 to increase capacity as required to increase the capacity and operating efficiency for Phase 2. No new plants would be constructed for Phase 2 processing.
9. Assume separations processes ar 1/3 of the way between Intermediate Separations and Extensive Separations (same assumption as Phased Implementation)
10. The number of HLW canisters for disposal would be 1/3 of the Intermediate Separations alternative.

Calculations:

1. Phase 1 production:
   LAW = 40 mt/day x 0.6 (OE) x 365 day/yr x 7.5 yr.= 65,700 mt LAW
   HLW = 1 mt/day x 0.6 (OE) x 365 day/yr x 7.5 yr = 1,640 mt HLW

2. Phase 2 production would then need to produce:
   LAW= 210,000 mt LAW - 65,700 mt = 144,300 mt LAW
   HLW = 14,140 mt - 1,640 mt = 12,500 mt HLW

3. Phase 2 treatment facilities must then be sized to produce:
   LAW = 144,300 mt/(0.7x365day/yr x 11 yr) = 51.3 ~ 52 **mt/day (or 26 mt/day per LAW plant)**
   HLW = 12,500 mt/(0.7 x 365 day/yr x 15 yr) = 3.2 ~ 4 **mt/day**

4. HLW disposal requirement:
Number of canisters to be disposed of = 1/3 x 33,400 = 8,700 canisters @ 0.62 m3

5. Waste Retrieval and Transfer requirements:

This alternative retrieves 26% of the total waste volume from 13% of the tanks which include 11 SSTs and 12 DSTs.

Therefore by tank type would retrieve wastes from 11/149 = 7.4 % of the SSTs, and 12/28 = 43% of the DSTs.

Based on WR&T backup to table 5-13:
SST (w/o subsurface barriers):

Capital = 1,857
Op Staff hrs = 50,148,578
Op Cost = 3,965
M&M Cost = 0
R&D Cost = 135
Total Cost=5,957 million 1995

DST

Capital = 964
Ops Staff Hrs = 9,513,418 hrs
Ops Cost = 752
M&M = 0
R&D = 48
Total Cost = 1,764 million 1995

R&D = 135+48 =183 million , shouldn't change

From the WR&T data pkg. labor is 85% of the cost of retrieval , therefore, operating cost equals scaled labor + 15% to account for materials and supplies.

JACOBS ENGINEERING GROUP INC.

DATE 2/15/96 SUBJECT Ex Situ / In Situ (Junior Combo) SHEET NO. 3-7

BY DG CHKD. JOB NO.

Capital Costs (Ex Situ Treatment)

Need to Construct
2 LAW plants at 20 MT/D size
1 HLW plant at 1 MT/D size
2 central facilities
2 Separation plants at 20 MT/D size

for Phase 1 operate above plants @ 60% O.E. for 7.5 yr

for Phase 2 upgrade above plants to achieve 70% O.E. + expand so that

26 MT/D for LAW + central
4 MT/D HLW
separation plants should be O.K.

For capital costing purposes, assume costs for following:
2 - 26 MT/D LAW plants, central facilities, + 2 - 2 MT/D HLW plants along with 10% extra for upgrades at end of phase 1

LAW plant

$$C_{26} = \frac{C_{100}}{\left(\frac{100}{26}\right)^{.6}} = \frac{650}{(3.85)^{.6}} = \frac{650}{2.25} = \$289 \text{ million}$$

centralized facilities

$$C_{26} = \frac{C_{100}}{\left(\frac{100}{26}\right)^{.6}} = \frac{260}{2.25} = \$116 \text{ million}$$

pretreat (separation plant)

$$C_{26} = \frac{C_{100}}{\left(\frac{100}{26}\right)^{.6}} = \frac{652}{2.25} = \$290 \text{ million}$$

FORM 91-005-1 (4/81)

JACOBS ENGINEERING GROUP INC.

DATE 2/15/96 SUBJECT SHEET NO. 4-7

BY DLS CHKD. JOB NO.

HLW plant

$$C_2 = \frac{C_{20}}{\left(\frac{20}{2}\right)^{.6}} = \frac{1400}{10^{0.6}} = \frac{1400}{3.98} = \$352 \text{ million}$$

Capital costs (summary) treatment (ex situ)

2 - 26 T/D LAW	289 x 2	=	578
2 - 26 T/D sep	290 x 2	=	580
2 - 26 T/D central	116 x 2	=	232
2 - 2 T/D HLW	352 x 2	=	704
			2094
upgrades @ 10% above			209
total capital (ex situ treatment)			$2303 million

in practice, probably will build 20 T/D LAW, sep + central + 1 T/D HLW plants for phase 1 and for phase 2 upgrade to 26 T/D LAW, sep + central + 4 T/D HLW.

op. costs for canisters/containers/casks/pads both phases

vaults	$5,000,000 each	x	(83 x 1/3)	=	$138,000,000
canisters	$10,000 each	x	8700	=	87,000,000
containers	$25,000 each	x	8700/4	=	54,375,000
casks	$60,000 each	x	8700/4	=	130,500,000
pads	$20,000,000 each	x	8700 / 170.5 base	=	130,000,000
			total		$539,875,000

or $540 million

FORM 91-005-1 (4/81)

JACOBS ENGINEERING GROUP INC.

DATE 2/15/96 SUBJECT SHEET NO. 5-7

BY DLS CHKD. JOB NO.

Treatment Operations Labor Estimate

	yrs	staff/yr	staff yrs
Phase 1 op. (2 sep/LAW/central + 1 HLW)	7.5	578	4335
Phase 2 op. (2 sep/LAW/central + 1 HLW)	11	578	6358
(1 HLW/central)	4	42	168
(D&D)	2	961	1922
			12,783
			x $102,000
total labor			$1304 million

Op. cost	Inter Sep (case) (proposed DEIS)	Ex Site of Combo
utilities + materials	370 + 316 = $686 million (base)	$686 x 1/3 = $228
equip (based on $3600 capital)	322	322 x 2303 (cap) / 3600 cap = 206
startup	173	173 x 2303/3600 = 111
D&D	886	886 x 2303/3600 = 567
labor	1815	(estimated) 1304
vaults/canisters/casks/pads	464 + 1,178 = 1642	(estimated) (also 1/3 x 1642) 540
	$5524 million	$2956 million

FORM 97-0051 (6/83)

JACOBS ENGINEERING GROUP INC.

DATE 12/28 SUBJECT SHEET NO. 6-7 95-

BY _____ CHKD. _____ JOB NO. _____

Waste Retrieval & Transfer.

This alt. retrieves 26% of the Waste Volume from 13% of the tanks including 11 SSTs and 12 DSTs.

∴ By tank type ⇒ 7.4% of the SSTs & 43% of DSTs

Based on WR&T Backup to Table 5-13.

	Capital	Op. Staff Hrs	Op Cost	M&M Cost	R&D Cost	Total Cost
SST (w/o Subsurf. Barrier)	1857	50,148,578	3965	0	135	5957
DST	964	9,513,418	752	0	48	1764

Capital SST = $(.074)^{.6}(1857) = 389$

Capital DST = $(.43)^{.6}(964) = 581$

$970 million ✓

R&D = 135 + 48 = 183 ⇐ No Change ✓

From Fig 7 WR&T Staffing Costs 828 million & from the WR&T data package Labor is 85% of the cost of retrieval ∴ increase the 828 by an additional 15% to account for Equipment Materials and Supplies.

Retrieval Operating Cost is then $952 million ✓

Closure = 116 + (152 − 116) x .26 = $125 ✓

build barriers — disposal vault

FORM 81-0064 (4/81)
FEB-14-1996 10:17 5097367504 95% P.05

JACOBS ENGINEERING GROUP INC.

DATE 2/15/96 SUBJECT Junior Combo SHEET NO. 7-7

BY DLS CHKD. JOB NO.

Total Alternative Cost Summary

Current op.		$8600
R+D		183
Capital		
In Situ Fill+Cap	23	
WR+T	970	
Treatment	2303	
Closure	125	
Total		3421
Operating		
WR+T	952	
Treatment	2956	
Dry+Fill (in situ)	219	
Total		4127
Repository Fees		4000
Total		$20,331

estimated from 2/1/96 graph consistent with other alternatives

Current Operations - $8600 (same schedule as TPA, so assume same)

In Situ Fill+Cap (154 tanks, 87%)

Capital $= 25(.87)^{.6} = \$23$

Treatment $= 127 + 147$

evap. DST fill tanks w/gravel

$= 127(1-.43) + 147 = \$219$

FORM 91-005-1 (4/81)

Stein, David

From: Stein, David
To: Henderson, Colin
Subject: RE: New Alternative
Date: Thursday, February 15, 1996 2:42PM

Following is the cost summary for the new alternative (Junior Combo), cost uncertainty to follow Friday morning:

Current Operations		$8,600
R&D		183
Capital		
In Situ Fill & Cap	23	
WR & T	970	
Treatment	2,303	
Closure	125	
Total		3,421
Operating		
In Situ Fill & Cap	219	
WR & T	952	
Treatment	2,956	
Total		4,127
Repository Fee		4,000
Total Cost		$20,331 million

From: Henderson, Colin
To: Stein, David
Subject: New Alternative
Date: Wednesday, February 14, 1996 9:43AM

Dave,
Attached is the write up for the new combination alternative that is supposed to go into Chapt. 3 of the EIS. Please check assumptions and calcs, develop a new estimated cost and run the cost uncertainty model to get a cost range. The uncertainty inputs should be similar to the current combination alternative?

Thanks, Colin

<<File Attachment: JUNIOR.DOC>>

98-

JACOBS ENGINEERING GROUP INC.

DATE 2/7/96 SUBJECT SHEET NO.

BY D Stein 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	974
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

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

99 -

TWRS EIS
CALCULATION COVER SHEET

DISCIPLINE & TITLE ENGR/COST - TANK WASTE ALTERNATIVES - COST UNCERTAINTY

ORIGINATOR D. Stein DATE 2/8/96

REVISION NO. 0

OBJECTIVE DETERMINE RANGE ESTIMATE FOR ALTERNATIVES

METHODOLOGY USE DECISION SCIENCE CORP (DSC) RANGE ESTIMATING PROGRAM for PERSONAL COMPUTERS (REP/PC)

ASSUMPTIONS RANGES FOR CRITICAL COST ITEMS ASSUMED, PROBABILTY OF COST EQUAL TO OR LESS ASSUMED PER ATTACHED BASES.

OUTPUT FILES INCLUDED

(Continue on another sheet if necessary)

D L Stein
SIGNATURE

CHECKED: CHP 2/21/96.

CALCULATION & RESULTS ATTACHED

JACOBS\FORMS\CALCVR.SHT

JACOBS ENGINEERING GROUP INC.

DATE 2/8/96 SUBJECT SHEET NO. 1-2

BY D Stern CHKD. JOB NO.

Cost Uncertainty

Cost uncertainty for the various tank waste treatment alternatives has been evaluated using Decision Science Corporation's (DSC) Range Estimating Program for personal computers (REP/PC). Typically, Range Estimating applies to one time decisions such as capital investments, engineering cost estimates, and competitive bids. The Range Estimating Program has enjoyed a long and successful record of use since its introduction by DSC in the early 1970s. It has been applied to thousands of diverse problems

JACOBS ENGINEERING GROUP INC.

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

BY D Stern CHKD. JOB NO.

by thousands of users. A small sampling of industries using REP/PC includes government, defense, engineering, construction, and research.

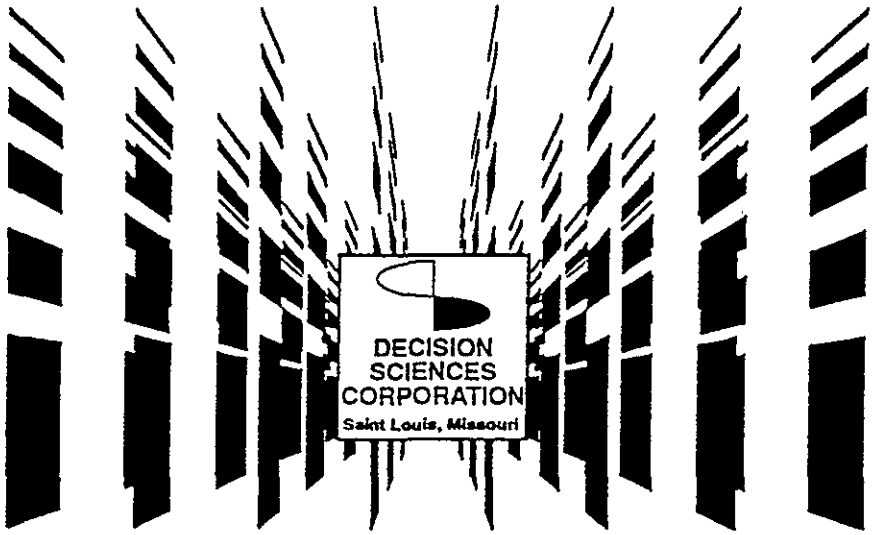
Range Estimating is user friendly and its input heuristics allow the user to specify a simple range rather than require selection of a probability density function. Range Estimating's output heuristics clearly identify, quantify, and rank the risks and opportunities in the decision making problem.

REP/PC™

Range Estimating Program for personal computers

User's Guide

Version 4.0
(July 1993)



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First Edition
July 1993

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JACOBS ENGINEERING GROUP INC.

DATE 2/5/96 SUBJECT HANFORD TWRS PROPOSED DEIS SHEET NO. 1-4

BY D Stein CHKD. JOB NO.

BASIS FOR PROB/RANGE ELEMENTS

NUM	ELEMENT
1	CURRENT OPERATIONS (ALL ALTERNATIVES)
	PROB 50%
	RANGE -20%, +20%
	COMMENT: CONTINUATION OF CURRENT OPERATIONS BASED ON HISTORICAL COSTS. BASIC AMBIVALENCE SHOWN IN PROBABILITY AND RANGE.
2	R+D (WASTE RET. + TRANSFER)
3	R+D (TREATMENT)
6	CAPITAL (CLOSURE)
9	M+M
	COMMENT: NON-CRITICAL FOR ALL ALTERNATIVES

NOTE: THE BASES ESTIMATED HEREIN WERE DISCUSSED AND AGREED UPON IN 2/4/96 MEETING OF → Stein, C. Henderson, D. Murray (all from JEG). Reviewed and confirmed by L. Selby (JEG cost engr/estimator) on 2/8/96.

JACOBS ENGINEERING GROUP INC.

DATE 2/5/94 SUBJECT SHEET NO. 2-4

BY D. Stern CHKD. JOB NO.

NUM	ELEMENT
4	CAPITAL (WASTE RET. + TRANSFER) (ALL ALTERNATIVES)
	PROB 50%
	RANGE −20%, +70%
7	OPERATING (WASTE RET. + TRANSFER) (ALL ALTERNATIVES)
	PROB 50%
	RANGE −20%, +70%

COMMENT: BASIC AMBIVALENCE RE PROBABILITIES. PESSIMISTIC VIEW OF HIGH RANGE DUE TO DIFFICULTY WITH METHODS TO RETRIEVE AND TRANSFER FOR CERTAIN TANKS AND HIGHER CAPITAL REQUIREMENTS AND LONGER OPERATIONAL PERIOD.

JE® JACOBS ENGINEERING GROUP INC.

SHEET NO. 3-4

JOB NO.

SUBJECT

DATE 2/5/96

BY D Stein CHKD.

NUM	ELEMENT	ALTERNATIVE: LONG TERM MANAGE	NO SEP VITR.	NO SEP CALC.	INTER SEP + IN SITU / EX SITU COMBO	PHASED IMPL.	EXT. SEP.	In Situ Vitr.
5	CAPITAL (TREATMENT)							
	PROB	50%	50%	50%	40%	40%	30%	15%
	RANGE	-20%, +20%	-20%, +50%	-20%, +50%	-20%, +100%	-20%, +100%	-20%, +150%	-10%, +300%

Comments: STARTING WITH AMBIVALENCE, PROB. DECREASES WITH COMPLEXITY OF PROCESSES + UNKNOWNS. RANGE ON LOW SIDE STANDARD AT 20% DUE TO 40% CONTINGENCY ALREADY INCLUDED IN CAPITAL. ONLY -10% FOR IN SITU VITR. DUE TO PESSIMISM ON PROCESS. RANGE ON HIGH SIDE INCREASES DUE TO COMPLEXITY OF PROCESSES AND UNKNOWNS.

NUM	ELEMENT	LONG TERM MANAGE	NO SEP VITR.	NO SEP CALC.	INTER SEP + IN SITU / EX SITU COMBO	PHASED IMPL.	EXT. SEP.	In Situ Vitr.
8	OPERATING (TREATMENT)							
	PROB	NON-CRITICAL	75%	75%	65%	65%	55%	15%
	RANGE		-80%, +0%	-60%, +0%	-25%, +0%	-25%, +0%	-15%, +0%	-10%, +200%

Comments: PROB. DECREASES WITH LOWER QUANTITIES OF HLW GLASS GENERATED BY ALTERNATIVE DUE TO LARGE COST EFFECT OF # OF CANISTERS WHICH IS NEAR MAXIMUM FOR BASIS USED HEREIN. IN SITU COSTS VIEWED PESSIMISTICALLY. UPPER RANGE OF +0% DUE TO HIGHEST COSTS USED IN BASIS HEREIN (LOWEST WASTE OXIDE LOADING, SMALLEST CANISTER, HIGH STAFFING). LOWER RANGE BASED ON OP. COSTS FOR NOV 1995 SCENARIO (MORE LIKELY). IN SITU VITR. VIEWED PESSIMISTICALLY DUE TO LONGER OPERATION AND ADDITIONAL GLASS RAW MATERIALS.

SHEET NO. 4-4

JOB NO.

JACOBS ENGINEERING GROUP INC.

DATE 2/5/96 SUBJECT

BY [illegible] CHKD.

NUM	ELEMENT	ALTERNATIVE					
		NO. SEP VITR	NO. SEP CALC.	INTER. SEP.	IN SITU/ EXSITU	PHASED IMPL.	EXT SEP.
10	REPOSITORY FEE						
	PROB. RANGE	100% -80%, +0%	100% -60%, +0%	100% -40%, +0%	100% -28%, +0%	100% -40%, +0%	0% -0%, +0%

Comments: WITH THE LOW WASTE OXIDE LOADING USED AS A BASIS HERE, AND THE SMALLEST CANISTER SIZE USED AS A BASIS HERE, IT IS BELIEVED THAT THE REPOSITORY FEES ARE AT THE MAXIMUM PROBABLE. THE EXCEPTION IS EXT. SEP. WHERE REPOSITORY COSTS ARE ESSENTIALLY CONSTANT DUE TO SMALL VOLUME OF HLW WASTE FOR ANY SCENARIO. THE LOW RANGE HAS BEEN SET AT REPOSITORY FEE FOR NOV 1995 REPORT USING LARGER CANISTERS AND HIGHER WASTE OXIDE LOADING.

Degrees of Optimism and Pessimism

EXPENSE ELEMENTS		
Pessimism	Absolute	0%
	Extreme	5%, 10%, 15%
	Moderate	20%, 25%, 30%
	Slight	35%, 40%, 45%
Ambivalence		50%
Optimism	Slight	55%, 60%, 65%
	Moderate	70%, 75%, 80%
	Extreme	85%, 90%, 95%
	Absolute	100%

PROFIT ELEMENTS		
Pessimism	Absolute	100%
	Extreme	85%, 90%, 95%
	Moderate	70%, 75%, 80%
	Slight	55%, 60%, 65%
Ambivalence		50%
Optimism	Slight	35%, 40%, 45%
	Moderate	20%, 25%, 30%
	Extreme	5%, 10%, 15%
	Absolute	0%

The Range

A range of possible values is specified for each critical element in the plan. The range is determined by specifying the lowest and highest values the critical element can assume. These lowest and highest values are set so far apart that there is greater than a 98% probability that the actual value of the critical element will materialize within the resulting range. Specifically, the "lowest" value is set so low that there is less than 1 chance in 100 that the actual value will be any lower; similarly, the "highest" value is set so high that there is less than a 1% probability that the actual value will be any higher. Thinking of it another way, the odds are about 99 to 1 against the actual value being lower than the lowest value. Also, the odds are about 99 to 1 against the actual value being higher than the highest value. Qualitatively speaking, the lowest and highest values are set far enough out such that they capture the "rather improbable" but not the "slightly absurd." Quite obviously, if there is substantial uncertainty about the actual value of the critical element, its range will be quite broad. Conversely, a lesser degree of uncertainty will be reflected as a narrower range for the critical element.

NOTE: The lowest and highest values are completely independent of the probability factor. It is quite possible that a given critical element could have a fairly small difference between its target and lowest value and yet have a high probability of its actual value materializing in that narrow part of the range. Examples of this often occur in expense elements where it is not unusual to have a very small chance of the actual exceeding the target but, if it does, the amount by which it can exceed it is very large. Such a range is said to be "highly skewed."

Some people have difficulty with the idea of supplying a range; some even claim that the range is nothing more than a lot of guesswork. But that's precisely why the range is valuable in decision-making; it involves a lot of educated guessing by qualified people. On the other hand, the single-point value involves only a little guessing -- so little, in fact, that it can lead to serious errors in decision-making. There is nothing wrong with guessing. Nobel prizes have been awarded for shrewd guessing! Put another way: with the range, the decision-maker will be approximately correct; with the traditional single-point value, exactly wrong!

February 8, 1996

To: Mark Nelson/David Stein

From: Larry Selby

Subject: Review of REP-PC Risk Analyses

I have reviewed the input of the ten remediation scenarios and generally find them within reasonable ranges. I changed the input of one of the more complicated senarios, generally widening the spread between low and high, (usually by increasing the high end). The results were reasonably close (within about 5 %) which pretty much verifies the suitability of the variables as entered in the program. Certainly the target estimate numbers are not within an accuracy of 5% of total cost at the Order of Magnitude level of the estimates. At this point, very little is to be gained by changing the model and re-running the program.

I would recommend that at some appropriate future time a group of 4 to 6 individuals, most familiar with each of the processes meet, and re-evaluate the entries used in developing the model and then re-run the program. One of these individuals should be one of the estimating team who is familiar the the details of how the estimate (target amount) was developed. Additionally, the smaller items should be dropped, as they tend to distort the results, although they would not affect the actual total cost. I would also warn to resist the temptation to group the small items and treat them as a single item to make the arithmetic appear correct. This also distorts the results. Having used this program a number of times over the past few years I have found that we are frequently too optimistic in entering the highest cost. This number should be the cost that the group is 99% certain cannot or will not be exceeded by even the worst of circumstances. I would also recommend that at the Order of Magnitude estimate level, the contingency applied by the estimator should be considered as a real cost and not considered in arriving at the highest possible cost. More often than not that contingency is required in progressing to estimates prepared from detailed design documents.

REP/PC (Ver 4.0) - MGMT REPORT 1 RANGE ESTIMATE : 02-06-96

DATA : ExSitu Exten. Case 01
MODEL : BASIC MODEL (SUMMATION)

NUM	ELEMENT	UNIT	TARGET	PROB+	LOW	HIGH
1	Current Operations		14300	50	11440	17160
2	R&D Waste Ret. & Transfer		0		0	0
3	R&D Treatment		0		0	0
4	Capital Waste Ret. & Transfer		0		0	0
5	Capital Treament		0		0	0
6	Capital Closure		0		0	0
7	Operations Waste Ret. & Transfer		0		0	0
8	Operations Treatment		0		0	0
9	M & M		0		0	0
10	Repository Fee		0		0	0
	TOTAL EXPENSE (INPUT TO REP/PC)		14300		11440 (THEORETICALS)	17160

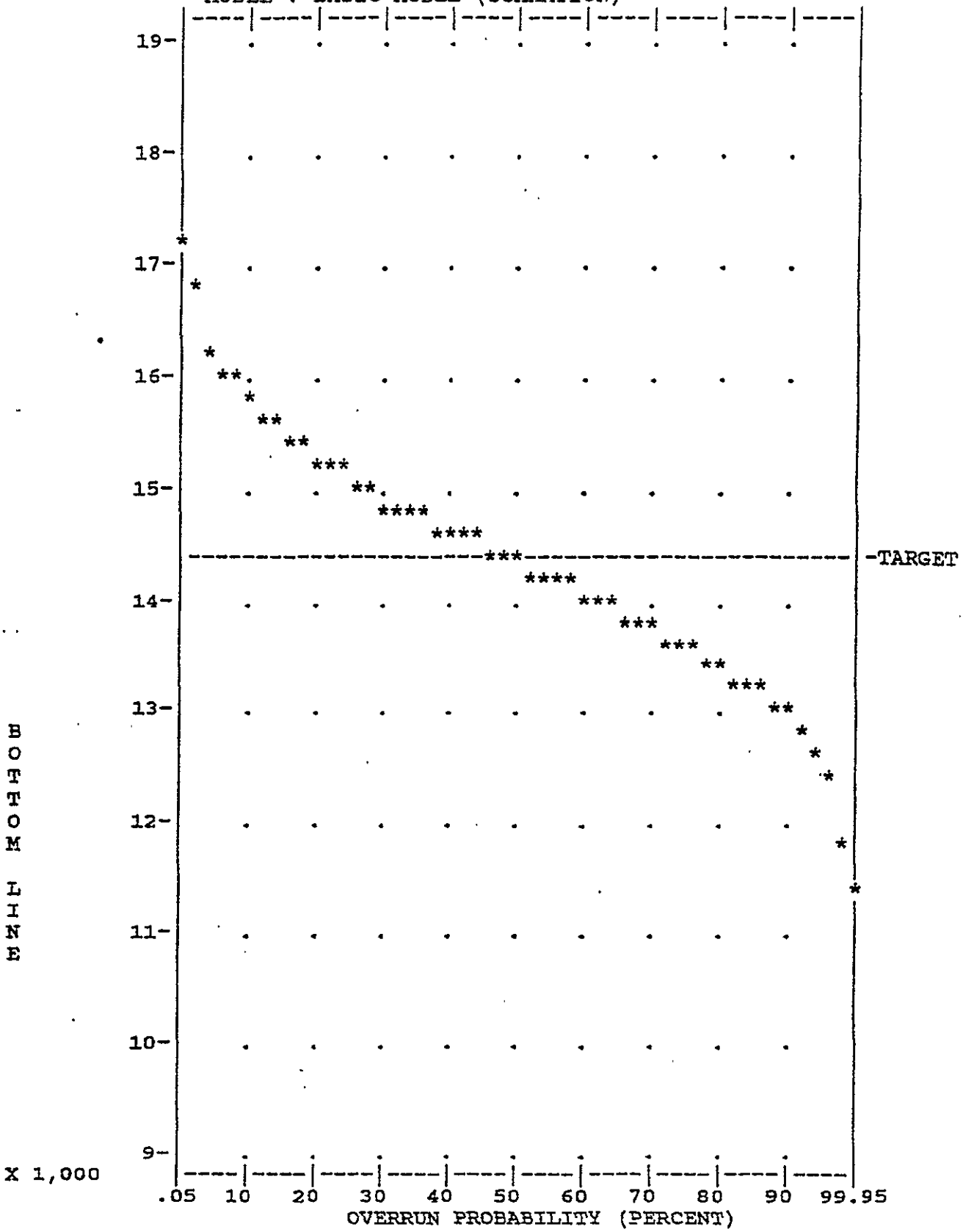
+ PROBABILITY THAT ACTUAL VALUE WILL BE EQUAL TO OR LESS THAN TARGET

output file for
Range Estimate
Tank Waste Alternatives

REP/PC (Ver 4.0) - MGMT REPORT 2 GRAPHICAL OVERRUN PROFILE : 02-06-96

DATA : ExSitu Exten. Case 01

MODEL : BASIC MODEL (SUMMATION)



REP/PC (Ver-4.0) - MGMT REPORT 3 GRAPHICAL PRIORITY PROFILE : 02-06-96

DATA : ExSitu Exten. Case 01
MODEL : BASIC MODEL (SUMMATION)

TOTAL EXPENSE	PROB OF OVERRUN	NET EFFECT OF FROZEN ELEMENTS
14300	51 PCT	0 = .0 PCT

NUM	ELEMENT	UNIT	CORRECT	PROTECT
1	Current Operations NET EFFECT OF FROZEN ELEMENTS		----------|	++++++++++++

REP/PC (Ver-4.0) - MGMT REPORT 4 CONTINGENCY PROFILE : 02-06-96

DATA : ExSitu Exten. Case 01
MODEL : BASIC MODEL (SUMMATION)

TO BE THIS CONFIDENT OF NOT HAVING COST OVERRUN		ADD THIS CONTINGENCY ABSOLUTE	RELATIVE	
100	PCT	2860	20.0	PCT
99.95	"	2849	19.9	"
95	"	1783	12.5	"
90	"	1430	10.0	"
85	"	1176	8.2	"
80	"	954	6.7	"
75	"	797	5.6	"
70	"	578	4.0	"
65	"	450	3.2	"
60	"	311	2.2	"
55	"	177	1.2	"
50	"	15	.1	"
45	"	-123	-.9	"
40	"	-263	-1.8	"
35	"	-382	-2.7	"
30	"	-576	-4.0	"
25	"	-716	-5.0	"
20	"	-896	-6.3	"
15	"	-1167	-8.2	"
10	"	-1377	-9.6	"
5	"	-1745	-12.2	"
0.05	"	-2839	-19.8	"
0	"	-2860	-20.0	"

(ABOVE RESULTS DERIVED FROM 1000 SIMULATIONS)

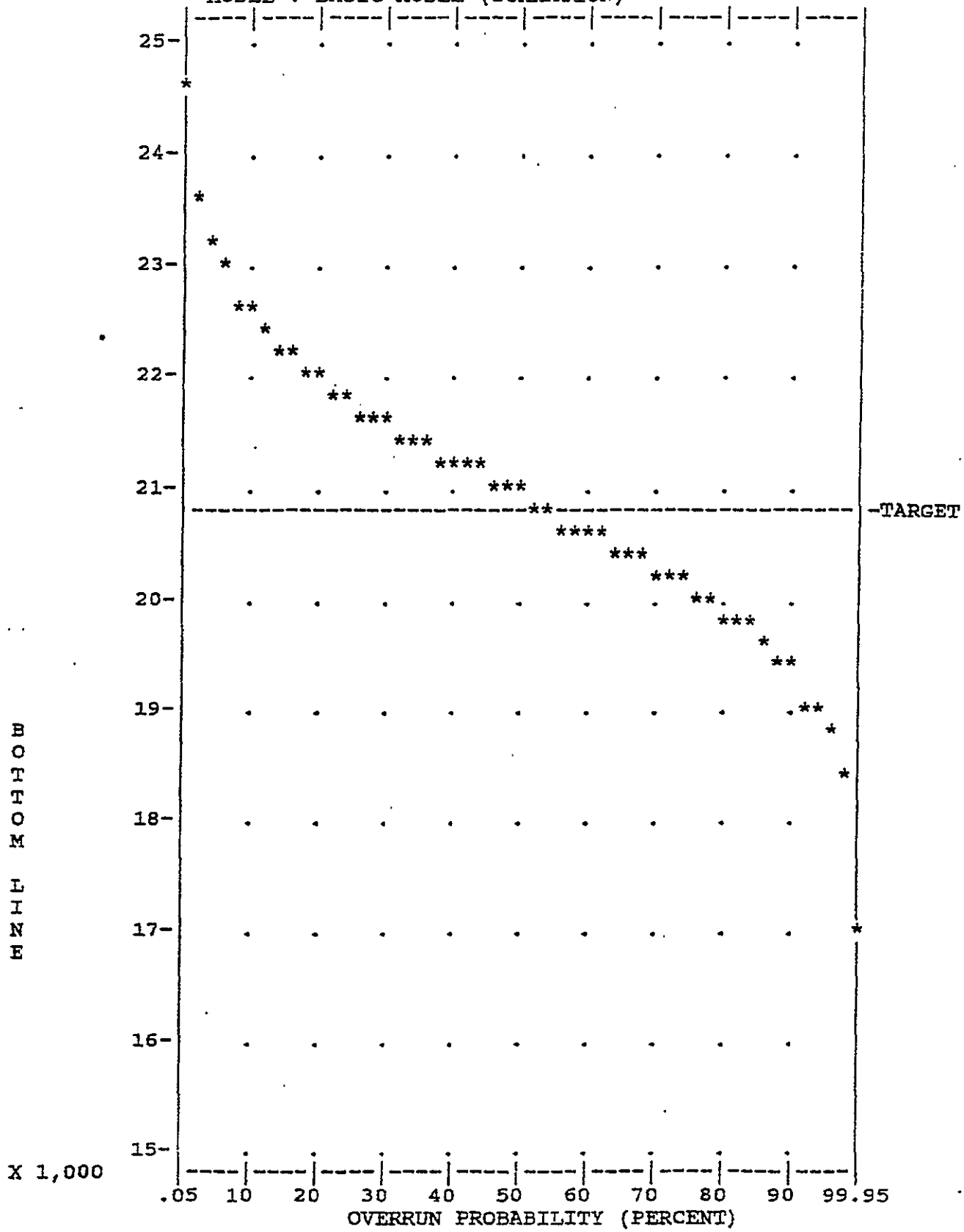
REP/PC (Ver 4.0) - MGMT REPORT 1 RANGE ESTIMATE : 02-06-96

DATA : ExSitu Exten. Case 02
MODEL : BASIC MODEL (SUMMATION)

NUM	ELEMENT	UNIT	TARGET	PROB+	LOW	HIGH
1	Current Operations		14300	50	11440	17160
2	R&D Waste Ret. & Transfer		100.00		100.00	100.00
3	R&D Treatment		0		0	0
4	Capital Waste Ret. & Transfer		1930	50	1544	3281
5	Capital Treament		4000	50	3200	4800
6	Capital Closure		0		0	0
7	Operations Waste Ret. & Transfer		440		440	440
8	Operations Treatment		0		0	0
9	M & M		0		0	0
10	Repository Fee		0		0	0
	TOTAL EXPENSE (INPUT TO REP/PC)		20770		16724 (THEORETICALS)	25781

+ PROBABILITY THAT ACTUAL VALUE WILL BE EQUAL TO OR LESS THAN TARGET

REP/PC (Ver-4.0) - MGMT REPORT 2 GRAPHICAL OVERRUN PROFILE : 02-06-96
DATA : ExSitu Exten. Case 02
MODEL : BASIC MODEL (SUMMATION)



REP/PC (Ver 4.0) - MGMT REPORT 3 GRAPHICAL PRIORITY PROFILE : 02-06-96

DATA : ExSitu Exten. Case 02
MODEL : BASIC MODEL (SUMMATION)

TOTAL EXPENSE	PROB OF OVERRUN	NET EFFECT OF FROZEN ELEMENTS
20770	54 PCT	0 = .0 PCT

NUM	ELEMENT	UNIT	CORRECT	PROTECT
1	Current Operations		----------	++++++++++++
4	Capital Waste Ret. & Transfer		-------	++
5	Capital Treament		----	++++
	NET EFFECT OF FROZEN ELEMENTS			

REP/PC (Ver 4.0) - MGMT REPORT 4 CONTINGENCY PROFILE : 02-06-96

DATA : ExSitu Exten. Case 02
MODEL : BASIC MODEL (SUMMATION)

TO BE THIS CONFIDENT OF NOT HAVING COST OVERRUN		ADD THIS CONTINGENCY ABSOLUTE	RELATIVE	
100	PCT	5011	24.1	PCT
99.95	"	3750	18.1	"
95	"	2327	11.2	"
90	"	1771	8.5	"
85	"	1413	6.8	"
80	"	1159	5.6	"
75	"	958	4.6	"
70	"	741	3.6	"
65	"	597	2.9	"
60	"	442	2.1	"
55	"	301	1.5	"
50	"	141	.7	"
45	"	-30	-.1	"
40	"	-201	-1.0	"
35	"	-360	-1.7	"
30	"	-512	-2.5	"
25	"	-697	-3.4	"
20	"	-886	-4.3	"
15	"	-1109	-5.3	"
10	"	-1464	-7.0	"
5	"	-1894	-9.1	"
0.05	"	-3857	-18.6	"
0	"	-4046	-19.5	"

(ABOVE RESULTS DERIVED FROM 1000 SIMULATIONS)

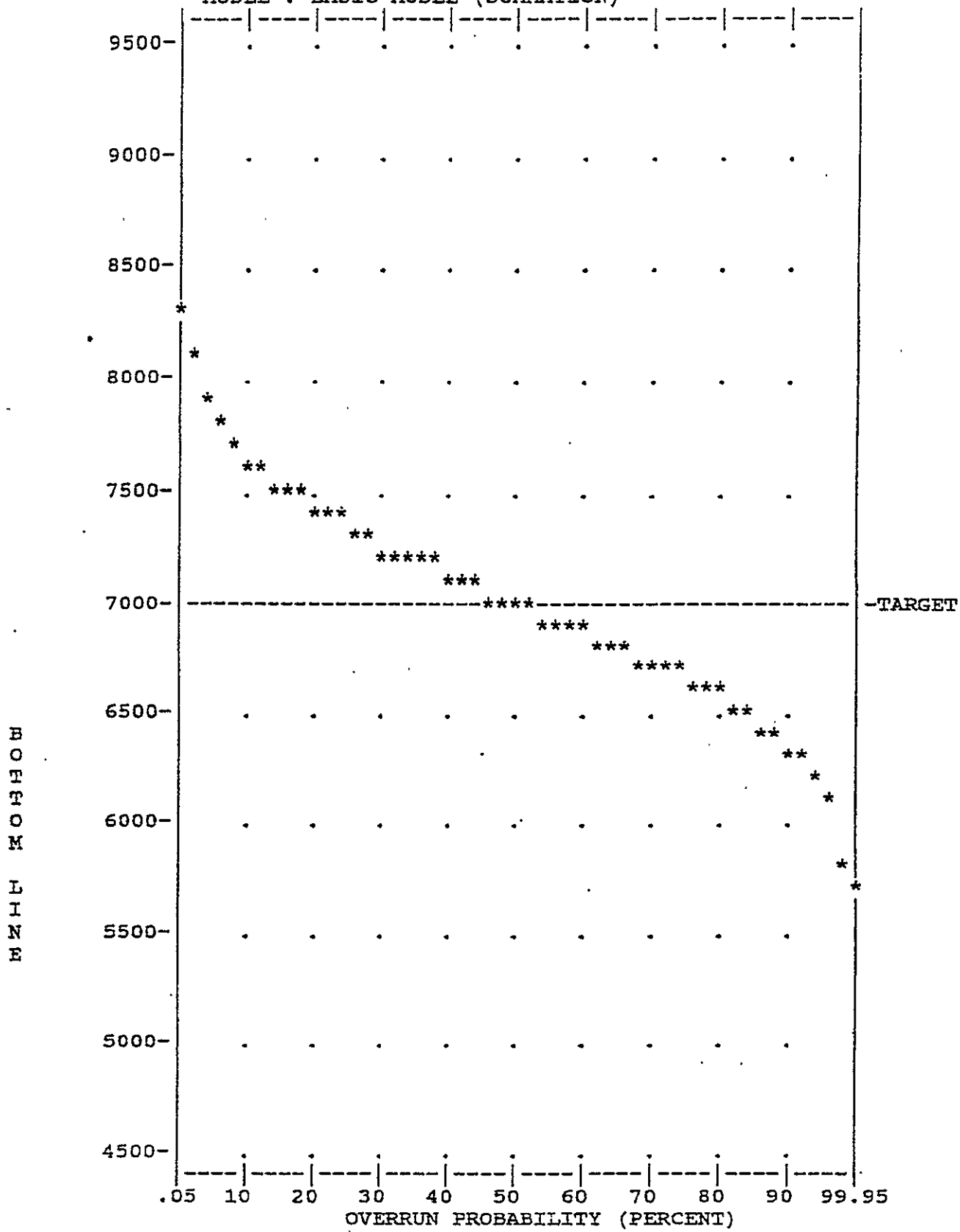
REP/PC (Ver 4.0) - MGMT REPORT 1 RANGE ESTIMATE : 02-06-96

DATA : ExSitu Exten. Case 03
MODEL : BASIC MODEL (SUMMATION)

NUM	ELEMENT	UNIT	TARGET	PROB+	LOW	HIGH
1	Current Operations		6566	50	5253	7879
2	R&D Waste Ret. & Transfer		0		0	0
3	R&D Treatment		0		0	0
4	Capital Waste Ret. & Transfer		0		0	0
5	Capital Treament		25.00		25.00	25.00
6	Capital Closure		116.00		116.00	116.00
7	Operations Waste Ret. & Transfer		0		0	0
8	Operations Treatment		274		274	274
9	M & M		0		0	0
10	Repository Fee		0		0	0
	TOTAL EXPENSE (INPUT TO REP/PC)		6981		5668	8294
					(THEORETICALS)	

+ PROBABILITY THAT ACTUAL VALUE WILL BE EQUAL TO OR LESS THAN TARGET

REP/PC (Ver 4.0) - MGMT REPORT 2 GRAPHICAL OVERRUN PROFILE : 02-06-96
DATA : ExSitu Exten. Case 03
MODEL : BASIC MODEL (SUMMATION)



REP/PC (Ver-4.0) - MGMT REPORT 3 GRAPHICAL PRIORITY PROFILE : 02-06-96

DATA : ExSitu Exten. Case 03
MODEL : BASIC MODEL (SUMMATION)

TOTAL EXPENSE	PROB OF OVERRUN	NET EFFECT OF FROZEN ELEMENTS
6981	51 PCT	0 = .0 PCT

NUM	ELEMENT	UNIT	CORRECT	PROTECT
1	Current Operations NET EFFECT OF FROZEN ELEMENTS		----------|	++++++++++++

REP/PC (Ver-4.0) - MGMT REPORT 4 CONTINGENCY PROFILE : 02-06-96

DATA : ExSitu Exten. Case 03
MODEL : BASIC MODEL (SUMMATION)

TO BE THIS CONFIDENT OF NOT HAVING COST OVERRUN		ADD THIS CONTINGENCY ABSOLUTE	RELATIVE	
100	PCT	1313	18.8	PCT
99.95	"	1308	18.7	"
95	"	818	11.7	"
90	"	657	9.4	"
85	"	540	7.7	"
80	"	438	6.3	"
75	"	366	5.2	"
70	"	265	3.8	"
65	"	206	3.0	"
60	"	143	2.1	"
55	"	81	1.2	"
50	"	7	.1	"
45	"	-57	-.8	"
40	"	-121	-1.7	"
35	"	-175	-2.5	"
30	"	-265	-3.8	"
25	"	-329	-4.7	"
20	"	-411	-5.9	"
15	"	-536	-7.7	"
10	"	-632	-9.0	"
5	"	-801	-11.5	"
0.05	"	-1303	-18.7	"
0	"	-1313	-18.8	"

(ABOVE RESULTS DERIVED FROM 1000 SIMULATIONS)

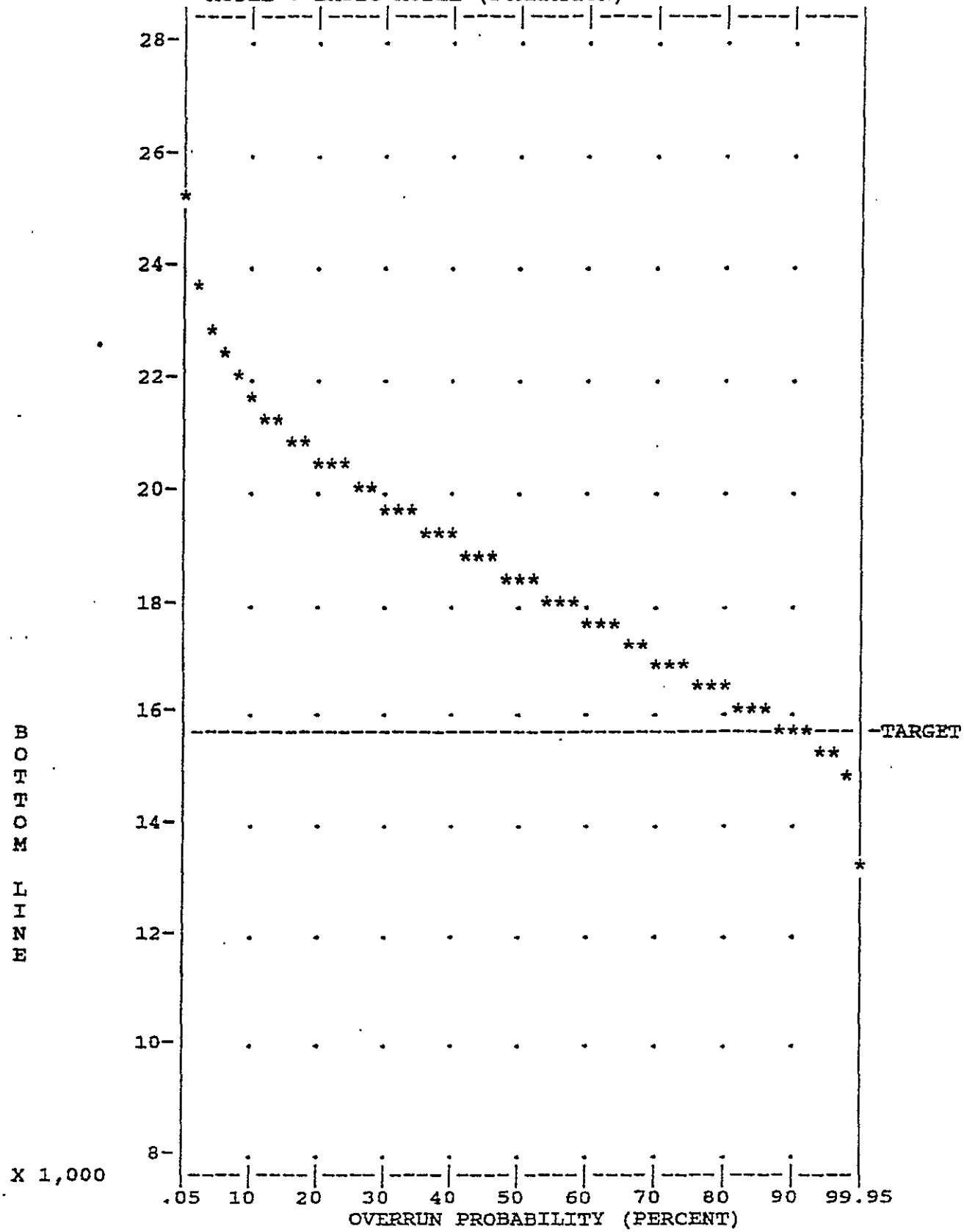
REP/PC (Ver 4.0) - MGMT REPORT 1 RANGE ESTIMATE : 02-06-96

DATA : ExSitu Exten. Case 04
MODEL : BASIC MODEL (SUMMATION)

NUM	ELEMENT	UNIT	TARGET	PROB+	LOW	HIGH
1	Current Operations		7749	50	6199	9299
2	R&D Waste Ret. & Transfer		0		0	0
3	R&D Treatment		70.00		70.00	70.00
4	Capital Waste Ret. & Transfer		0		0	0
5	Capital Treament		4900	15	4410	9600
6	Capital Closure		116.00		116.00	116.00
7	Operations Waste Ret. & Transfer		0		0	0
8	Operations Treatment		2740	15	2466	8220
9	M & M		0		0	0
10	Repository Fee		0		0	0
	TOTAL EXPENSE (INPUT TO REP/PC)		15575		13261 (THEORETICALS)	27305

+ PROBABILITY THAT ACTUAL VALUE WILL BE EQUAL TO OR LESS THAN TARGET

REP/PC (Ver-4.0) - MGMT REPORT 2 GRAPHICAL OVERRUN PROFILE : 02-06-96
DATA : ExSitu Exten. Case 04
MODEL : BASIC MODEL (SUMMATION)



REP/PC (Ver-4.0) - MGMT REPORT 3 GRAPHICAL PRIORITY PROFILE : 02-06-96

DATA : ExSitu Exten. Case 04
MODEL : BASIC MODEL (SUMMATION)

TOTAL EXPENSE	PROB OF OVERRUN	NET EFFECT OF FROZEN ELEMENTS
15575	91 PCT	0 = .0 PCT

NUM	ELEMENT	UNIT	CORRECT	PROTECT
8	Operations Treatment		----------	
5	Capital Treament		----------	
1	Current Operations		--	++
	NET EFFECT OF FROZEN ELEMENTS			

REP/PC (Ver-4.0) - MGMT REPORT 4 CONTINGENCY PROFILE : 02-06-96

DATA : ExSitu Exten. Case 04
MODEL : BASIC MODEL (SUMMATION)

TO BE THIS CONFIDENT OF NOT HAVING COST OVERRUN		ADD THIS CONTINGENCY ABSOLUTE	RELATIVE	
100	PCT	11730	75.3	PCT
99.95	"	9656	62.0	"
95	"	7137	45.8	"
90	"	6031	38.7	"
85	"	5390	34.6	"
80	"	4923	31.6	"
75	"	4556	29.3	"
70	"	4123	26.5	"
65	"	3777	24.3	"
60	"	3485	22.4	"
55	"	3186	20.5	"
50	"	2832	18.2	"
45	"	2499	16.0	"
40	"	2174	14.0	"
35	"	1773	11.4	"
30	"	1404	9.0	"
25	"	1082	7.0	"
20	"	750	4.8	"
15	"	348	2.2	"
10	"	71	.5	"
5	"	-306	-2.0	"
0.05	"	-2201	-14.1	"
0	"	-2314	-14.9	"

(ABOVE RESULTS DERIVED FROM 1000 SIMULATIONS)

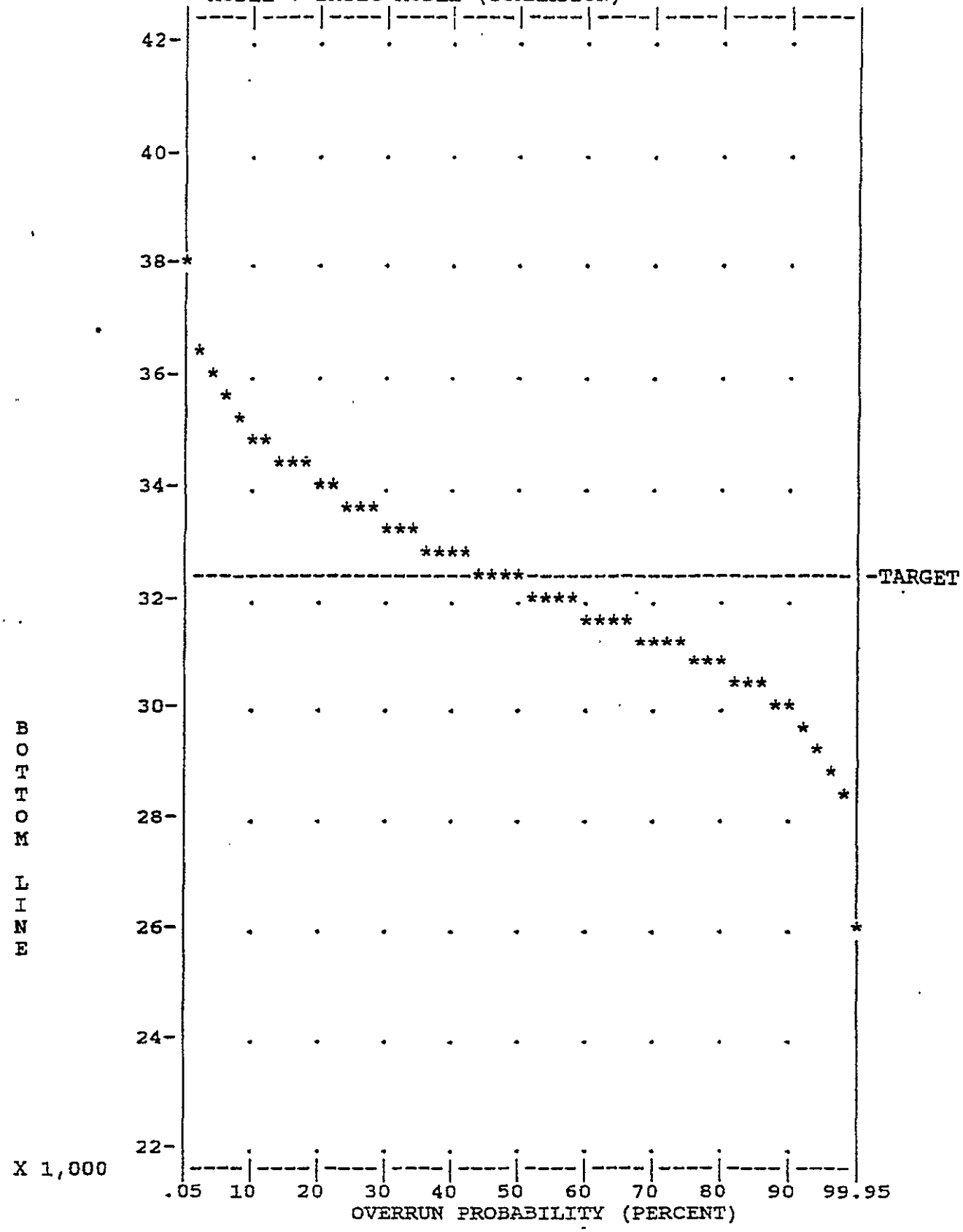
REP/PC (Ver-4.0) - MGMT REPORT 1 RANGE ESTIMATE : 02-06-96

DATA : ExSitu Exten. Case 05
MODEL : BASIC MODEL (SUMMATION)

NUM	ELEMENT	UNIT	TARGET	PROB+	LOW	HIGH
1	Current Operations		8600	50	6880	10320
2	R&D Waste Ret. & Transfer		190.00		190.00	190.00
3	R&D Treatment		630		630	630
4	Capital Waste Ret. & Transfer		2280	50	824	3876
5	Capital Treament		3600	40	2880	7200
6	Capital Closure		169.00		169.00	169.00
7	Operations Waste Ret. & Transfer		4820	50	3856	8194
8	Operations Treatment		5577	65	4183	5578
9	M & M		0		0	0
10	Repository Fee		6500	95	3900	6501
	TOTAL EXPENSE (INPUT TO REP/PC)		32366		23512 (THEORETICALS)	42658

+ PROBABILITY THAT ACTUAL VALUE WILL BE EQUAL TO OR LESS THAN TARGET

REP/PC (Ver 4.0) - MGMT REPORT 2 GRAPHICAL OVERRUN PROFILE : 02-06-96
DATA : ExSitu Exten. Case 05
MODEL : BASIC MODEL (SUMMATION)



REP/PC (Ver-4.0) - MGMT REPORT 3 GRAPHICAL PRIORITY PROFILE : 02-06-96

DATA : ExSitu Exten. Case 05
MODEL : BASIC MODEL (SUMMATION)

TOTAL EXPENSE	PROB OF OVERRUN	NET EFFECT OF FROZEN ELEMENTS
32366	47 PCT	0 = .0 PCT

NUM	ELEMENT	UNIT	CORRECT	PROTECT
5	Capital Treament		----------	++
10	Repository Fee			+++++++++++++
7	Operations Waste Ret. & Transfer		---------	+++
4	Capital Waste Ret. & Transfer		----	++++
1	Current Operations		----	++++
8	Operations Treatment			+++++
	NET EFFECT OF FROZEN ELEMENTS			

REP/PC (Ver 4.0) - MGMT REPORT 4 CONTINGENCY PROFILE : 02-06-96

DATA : ExSitu Exten. Case 05
MODEL : BASIC MODEL (SUMMATION)

TO BE THIS CONFIDENT OF NOT HAVING COST OVERRUN		ADD THIS CONTINGENCY ABSOLUTE	RELATIVE	
100	PCT	10292	31.8	PCT
99.95	"	5824	18.0	"
95	"	3257	10.1	"
90	"	2553	7.9	"
85	"	2094	6.5	"
80	"	1707	5.3	"
75	"	1342	4.2	"
70	"	941	2.9	"
65	"	633	2.0	"
60	"	356	1.1	"
55	"	114	.4	"
50	"	-101	-.3	"
45	"	-335	-1.0	"
40	"	-607	-1.9	"
35	"	-822	-2.5	"
30	"	-1046	-3.2	"
25	"	-1363	-4.2	"
20	"	-1622	-5.0	"
15	"	-1970	-6.1	"
10	"	-2496	-7.7	"
5	"	-3171	-9.8	"
0.05	"	-6481	-20.0	"
0	"	-8854	-27.4	"

(ABOVE RESULTS DERIVED FROM 1000 SIMULATIONS)

REP/PC (Ver-4.0) - MGMT REPORT 1 RANGE ESTIMATE : 02-06-96

DATA : ExSitu Exten. Case 06
MODEL : BASIC MODEL (SUMMATION)

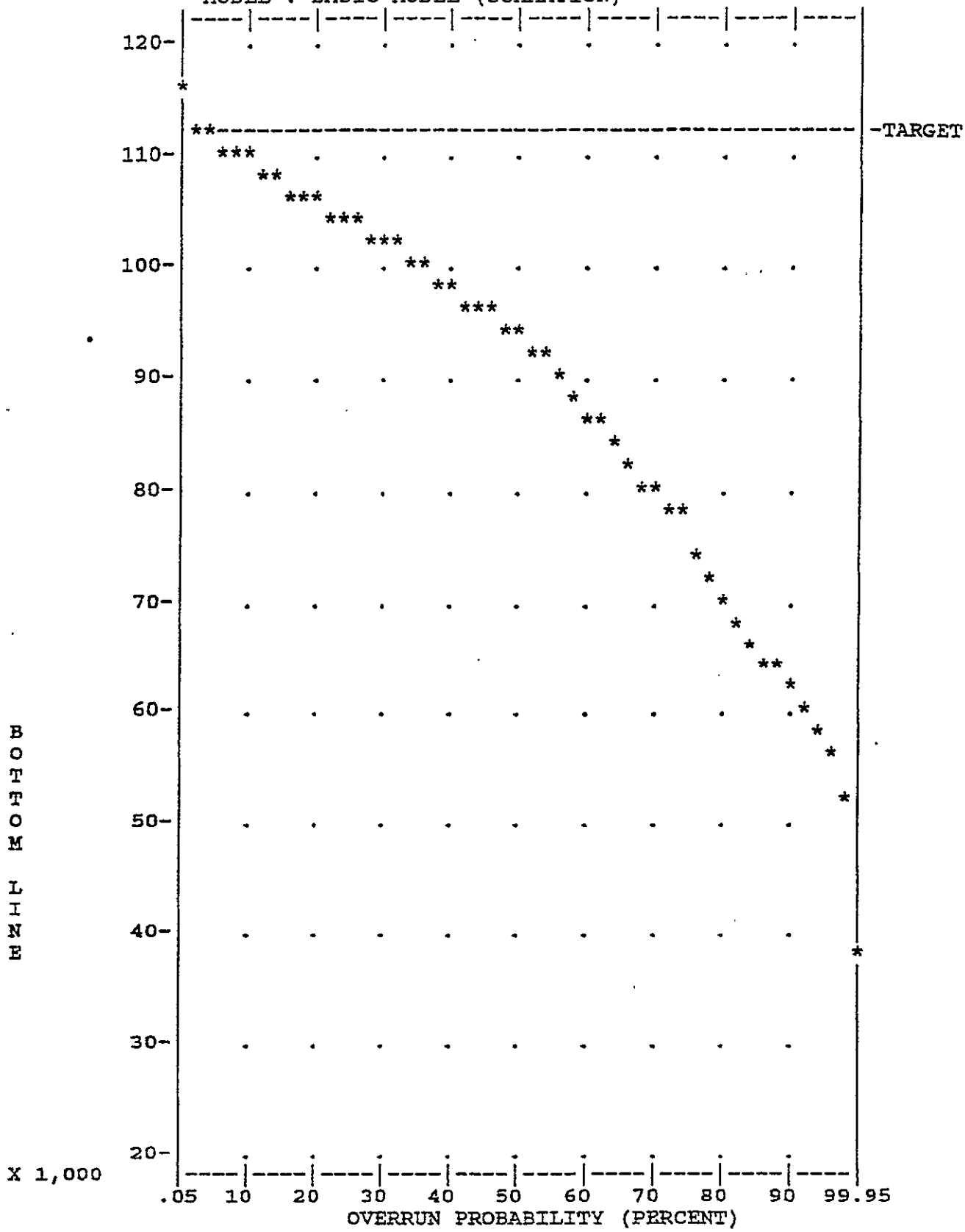
NUM	ELEMENT	UNIT	TARGET	PROB+	LOW	HIGH
1	Current Operations		8325	50	6660	9990
2	R&D Waste Ret. & Transfer		190.00		190.00	190.00
3	R&D Treatment		280		280	280
4	Capital Waste Ret. & Transfer		2280	50	1824	3876
5	Capital Treament		2610	50	2088	3915
6	Capital Closure		152.00		152.00	152.00
7	Operations Waste Ret. & Transfer		4630	50	3704	7871
8	Operations Treatment		23273	75	4654	23274
9	M & M		0		0	0
10	Repository Fee		69500	95	12900	69501
	TOTAL EXPENSE (INPUT TO REP/PC)		111240		32452 (THEORETICALS)	119049

+ PROBABILITY THAT ACTUAL VALUE WILL BE EQUAL TO OR LESS THAN TARGET

REP/PC (Ver-4.0) - MGMT REPORT 2 GRAPHICAL OVERRUN PROFILE : 02-06-96

DATA : ExSitu Exten. Case 06

MODEL : BASIC MODEL (SUMMATION)



REP/PC (Ver 4.0) - MGMT REPORT 3 GRAPHICAL PRIORITY PROFILE : 02-06-96

DATA : ExSitu Exten. Case 06
MODEL : BASIC MODEL (SUMMATION)

TOTAL EXPENSE	PROB OF OVERRUN	NET EFFECT OF FROZEN ELEMENTS
111240	4 PCT	0 = .0 PCT

NUM	ELEMENT	UNIT	CORRECT	PROTECT
10	Repository Fee			++++++++++++++
8	Operations Treatment			+++
7	Operations Waste Ret. & Transfer			
1	Current Operations			
4	Capital Waste Ret. & Transfer			
5	Capital Treament			
	NET EFFECT OF FROZEN ELEMENTS			

REP/PC (Ver 4.0) - MGMT REPORT 4 CONTINGENCY PROFILE : 02-06-96

DATA : ExSitu Exten. Case 06
MODEL : BASIC MODEL (SUMMATION)

TO BE THIS CONFIDENT OF NOT HAVING COST OVERRUN		ADD THIS CONTINGENCY ABSOLUTE	RELATIVE	
100	PCT	7809	7.0	PCT
99.95	"	4241	3.8	"
95	"	-443	-.4	"
90	"	-2133	-1.9	"
85	"	-3809	-3.4	"
80	"	-5983	-5.4	"
75	"	-7390	-6.6	"
70	"	-9245	-8.3	"
65	"	-11539	-10.4	"
60	"	-13489	-12.1	"
55	"	-15771	-14.2	"
50	"	-17923	-16.1	"
45	"	-20529	-18.4	"
40	"	-24826	-22.3	"
35	"	-27942	-25.1	"
30	"	-31478	-28.3	"
25	"	-35387	-31.8	"
20	"	-41332	-37.2	"
15	"	-46128	-41.5	"
10	"	-50031	-45.0	"
5	"	-55069	-49.5	"
0.05	"	-73391	-66.0	"
0	"	-78788	-70.8	"

(ABOVE RESULTS DERIVED FROM 1000 SIMULATIONS)

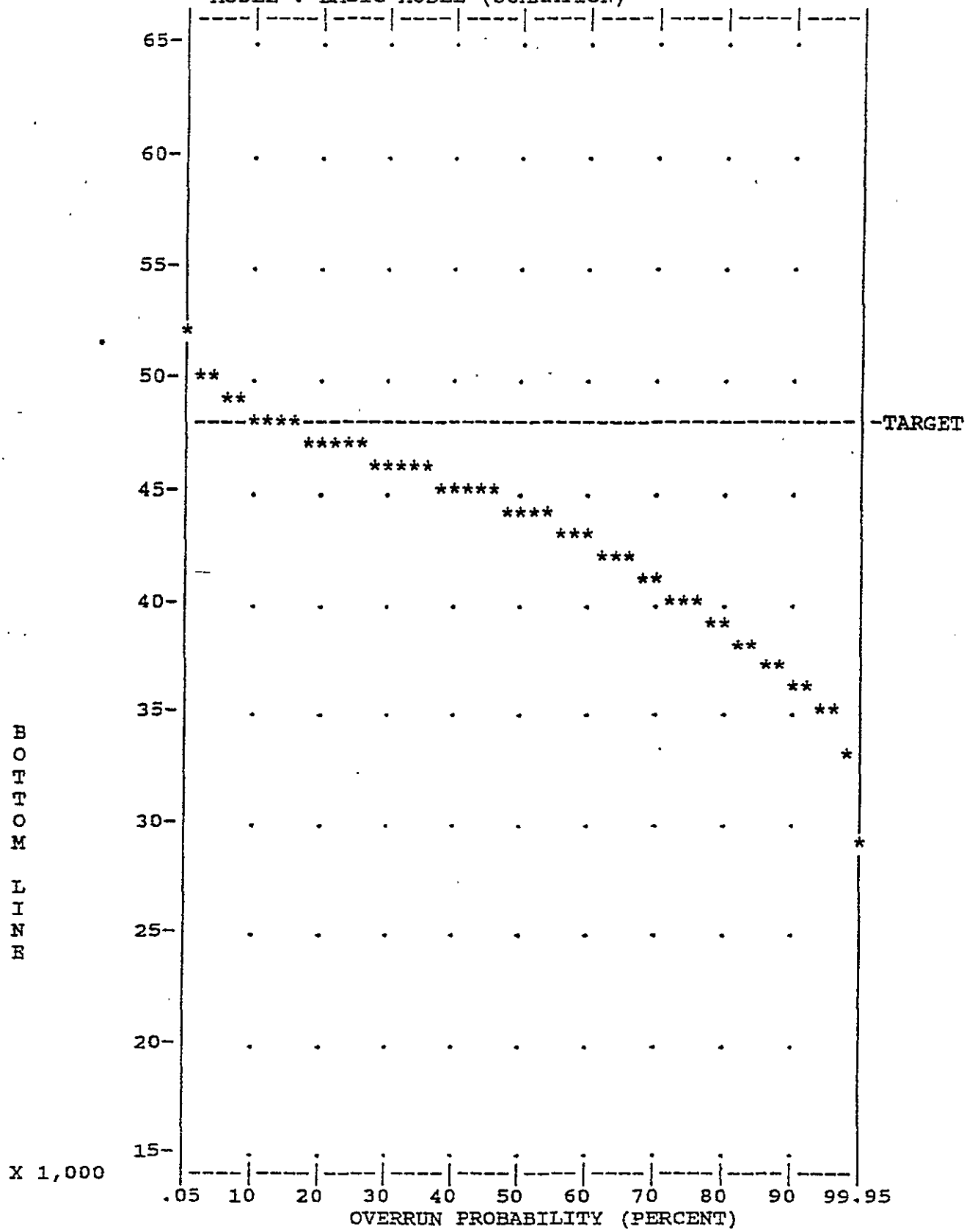
REP/PC (Ver-4.0) - MGMT REPORT 1 RANGE ESTIMATE : 02-06-96

DATA : ExSitu Exten. Case 07
MODEL : BASIC MODEL (SUMMATION)

NUM	ELEMENT	UNIT	TARGET	PROB+	LOW	HIGH
1	Current Operations		8325	50	6660	9990
2	R&D Waste Ret. & Transfer		190.00		190.00	190.00
3	R&D Treatment		280		280	280
4	Capital Waste Ret. & Transfer		2280	50	1824	3876
5	Capital Treament		2610	50	2088	3915
6	Capital Closure		152.00		152.00	152.00
7	Operations Waste Ret. & Transfer		4630	50	3704	7871
8	Operations Treatment		8182	75	3273	8183
9	M & M		0		0	0
10	Repository Fee		21500	95	7800	21501
	TOTAL EXPENSE (INPUT TO REP/PC)		48149		25971 (THEORETICALS)	55958

+ PROBABILITY THAT ACTUAL VALUE WILL BE EQUAL TO OR LESS THAN TARGET

REP/PC (Ver-4.0) - MGMT REPORT 2 GRAPHICAL OVERRUN PROFILE : 02-06-96
DATA : ExSitu Exten. Case 07
MODEL : BASIC MODEL (SUMMATION)



REP/PC (Ver 4.0) - MGMT REPORT 3 GRAPHICAL PRIORITY PROFILE : 02-06-96

DATA : ExSitu Exten. Case 07
MOD MODEL : BASIC MODEL (SUMMATION)

TOTAL EXPENSE	PROB OF OVERRUN	NET EFFECT OF FROZEN ELEMENTS
48149	12 PCT	0 = .0 PCT

NUM	ELEMENT	UNIT	CORRECT	PROTECT
10	Repository Fee			++++++++++++++
8	Operations Treatment			++++
7	Operations Waste Ret. & Transfer		--	
1	Current Operations		-	+
4	Capital Waste Ret. & Transfer		-	
5	Capital Treament		-	
	NET EFFECT OF FROZEN ELEMENTS			

REP/PC (Ver-4.0) - MGMT REPORT 4 CONTINGENCY PROFILE : 02-06-96

DATA : ExSitu Exten. Case 07
MODEL : BASIC MODEL (SUMMATION)

TO BE THIS CONFIDENT OF NOT HAVING COST OVERRUN		ADD THIS CONTINGENCY ABSOLUTE	RELATIVE	
100	PCT	7809	16.2	PCT
99.95	"	4317	9.0	"
95	"	1269	2.6	"
90	"	230	.5	"
85	"	-466	-1.0	"
80	"	-995	-2.1	"
75	"	-1560	-3.2	"
70	"	-2001	-4.2	"
65	"	-2439	-5.1	"
60	"	-2935	-6.1	"
55	"	-3457	-7.2	"
50	"	-3988	-8.3	"
45	"	-4640	-9.6	"
40	"	-5415	-11.2	"
35	"	-6266	-13.0	"
30	"	-7342	-15.2	"
25	"	-8180	-17.0	"
20	"	-9503	-19.7	"
15	"	-10564	-21.9	"
10	"	-11768	-24.4	"
5	"	-13012	-27.0	"
0.05	"	-19153	-39.8	"
0	"	-22178	-46.1	"

(ABOVE RESULTS DERIVED FROM 1000 SIMULATIONS)

REP/PC (Ver 4.0) - MGMT REPORT 1 RANGE ESTIMATE : 02-06-96

DATA : ExSitu Exten. Case 08
MODEL : BASIC MODEL (SUMMATION)

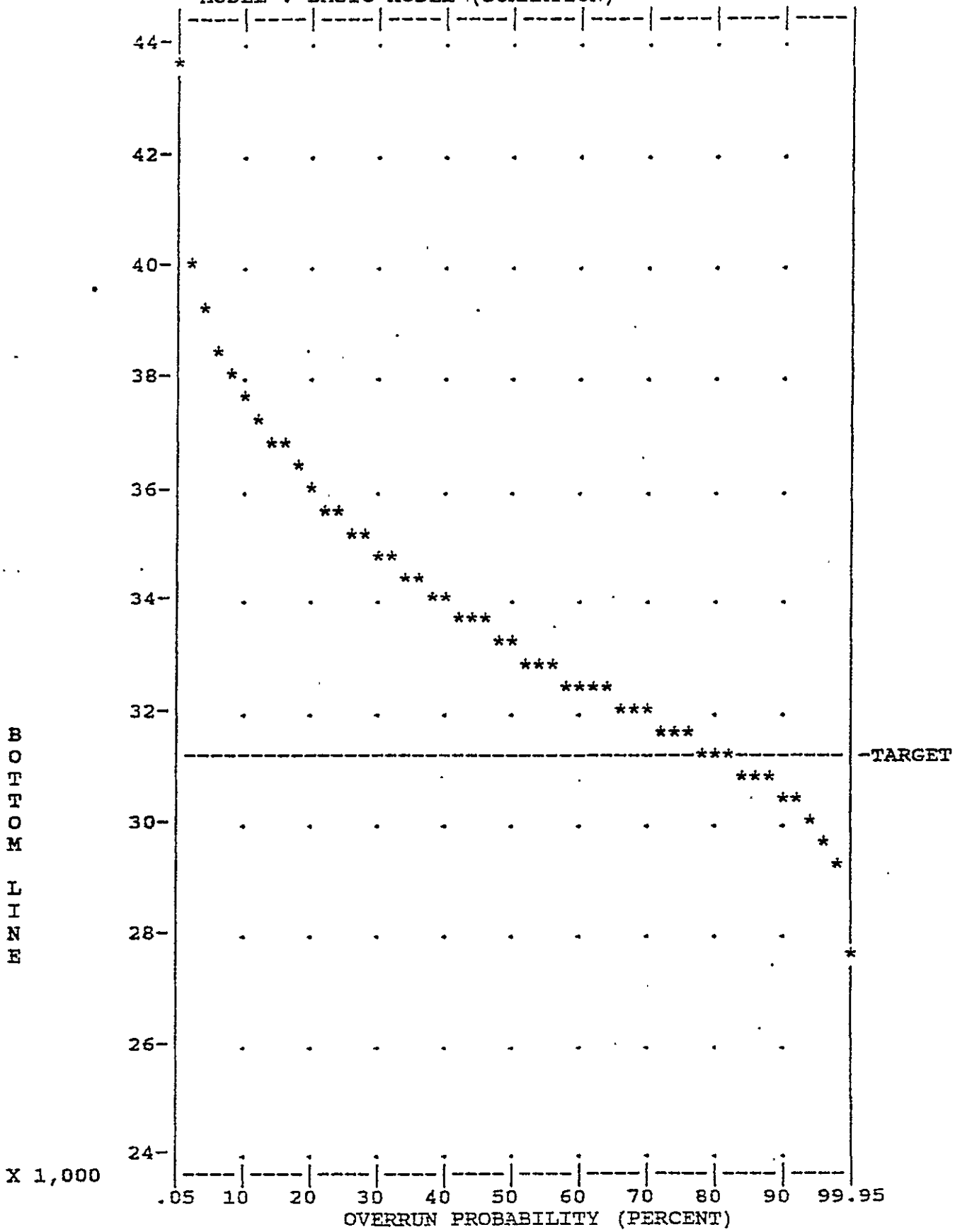
NUM	ELEMENT	UNIT	TARGET	PROB+	LOW	HIGH
1	Current Operations		8600	50	6880	10320
2	R&D Waste Ret. & Transfer		190.00		190.00	190.00
3	R&D Treatment		1300		1300	1300
4	Capital Waste Ret. & Transfer		2280	50	1824	3876
5	Capital Treament		5202	30	4162	13005
6	Capital Closure		170.00		170.00	170.00
7	Operations Waste Ret. & Transfer		4820	50	3856	8194
8	Operations Treatment		5417	55	4604	5418
9	M & M		0		0	0
10	Repository Fee		3400		3400	3400
	TOTAL EXPENSE (INPUT TO REP/PC)		31379		26386 (THEORETICALS)	45873

+ PROBABILITY THAT ACTUAL VALUE WILL BE EQUAL TO OR LESS THAN TARGET

REP/PC (Ver 4.0) - MGMT REPORT 2 GRAPHICAL OVERRUN PROFILE : 02-06-96

DATA : ExSitu Exten. Case 08

MODEL : BASIC MODEL (SUMMATION)



REP/PC (Ver 4.0) - MGMT REPORT 3 GRAPHICAL PRIORITY PROFILE : 02-06-96

DATA : ExSitu Exten. Case 08
MODEL : BASIC MODEL (SUMMATION)

TOTAL EXPENSE	PROB OF OVERRUN	NET EFFECT OF FROZEN ELEMENTS
31379	77 PCT	0 = .0 PCT

NUM	ELEMENT	UNIT	CORRECT	PROTECT
5	Capital Treament		----------	+
7	Operations Waste Ret. & Transfer		----	+
1	Current Operations		--	++
4	Capital Waste Ret. & Transfer		--	+
8	Operations Treatment			+
	NET EFFECT OF FROZEN ELEMENTS			

REP/PC (Ver-4.0) - MGMT REPORT 4 CONTINGENCY PROFILE : 02-06-95

DATA : ExSitu Exten. Case 08
MODEL : BASIC MODEL (SUMMATION)

TO BE THIS CONFIDENT OF NOT HAVING COST OVERRUN		ADD THIS CONTINGENCY ABSOLUTE	RELATIVE	
100	PCT	14494	46.2	PCT
99.95	"	12109	38.6	"
95	"	7497	23.9	"
90	"	6282	20.0	"
85	"	5365	17.1	"
80	"	4615	14.7	"
75	"	3930	12.5	"
70	"	3464	11.0	"
65	"	3018	9.6	"
60	"	2545	8.1	"
55	"	2144	6.8	"
50	"	1739	5.5	"
45	"	1391	4.4	"
40	"	1061	3.4	"
35	"	755	2.4	"
30	"	477	1.5	"
25	"	146	.5	"
20	"	-185	-.6	"
15	"	-497	-1.6	"
10	"	-814	-2.6	"
5	"	-1399	-4.5	"
0.05	"	-3851	-12.3	"
0	"	-4993	-15.9	"

(ABOVE RESULTS DERIVED FROM 1000 SIMULATIONS)

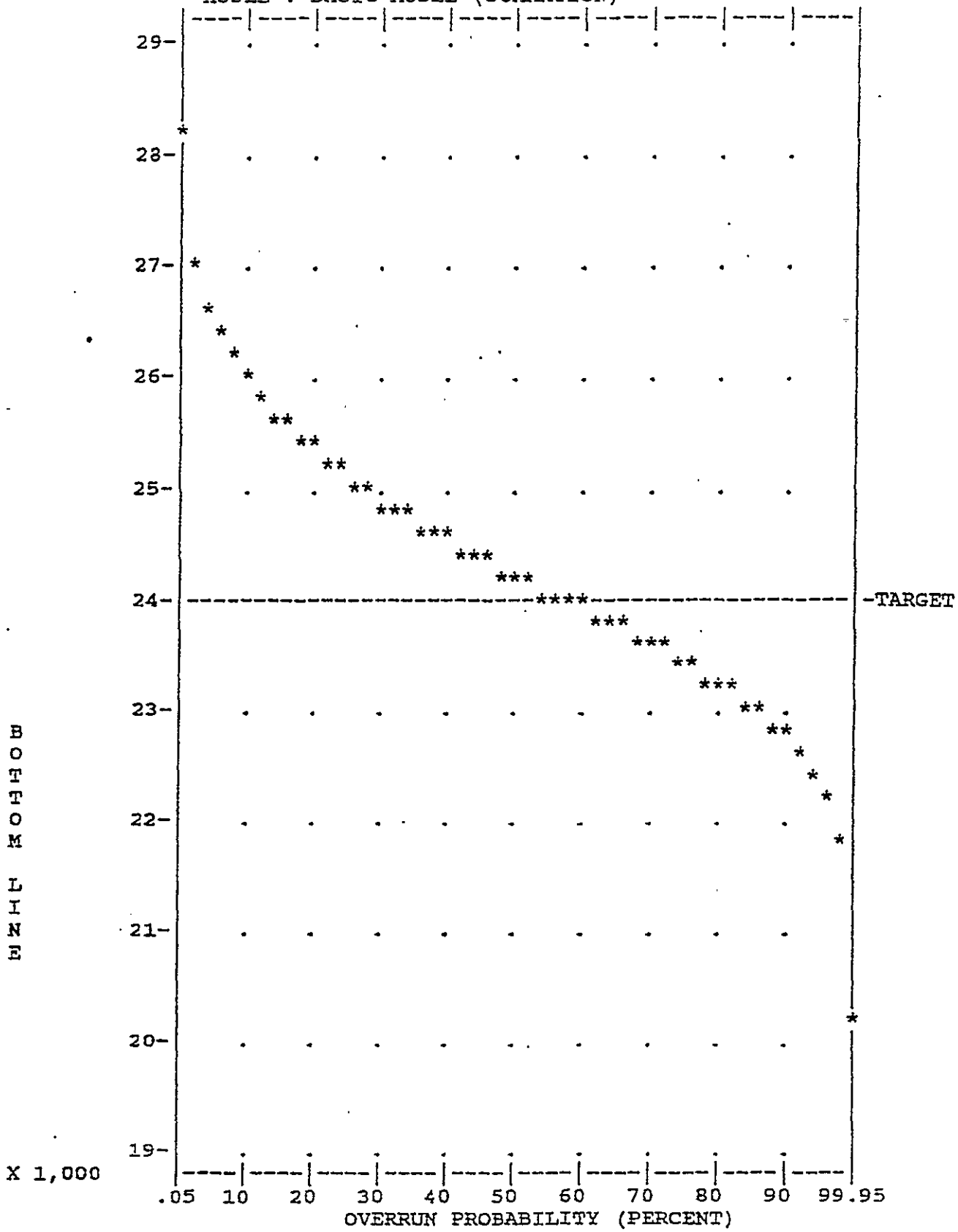
REP/PC (Ver 4.0) - MGMT REPORT 1 RANGE ESTIMATE : 02-06-96

DATA : ExSitu Exten. Sepa.r. Case 09
MODEL : BASIC MODEL (SUMMATION)

NUM	ELEMENT	UNIT	TARGET	PROB+	LOW	HIGH
1	Current Operations		8600	50	6880	10320
2	R&D Waste Ret. & Transfer		186.00		186.00	186.00
3	R&D Treatment		670		670	670
4	Capital Waste Ret. & Transfer		1388	50	1110	2360
5	Capital Treament		2189	40	1751	4378
6	Capital Closure		137.00		137.00	137.00
7	Operations Waste Ret. & Transfer		3166	50	2533	5382
8	Operations Treatment		2672	65	2004	2673
9	M & M		0		0	0
10	Repository Fee		5000	95	3750	5001
	TOTAL EXPENSE (INPUT TO REP/PC)		24008		19021 (THEORETICALS)	31107

+ PROBABILITY THAT ACTUAL VALUE WILL BE EQUAL TO OR LESS THAN TARGET

REP/PC (Ver-4.0) - MGMT REPORT 2 GRAPHICAL OVERRUN PROFILE : 02-06-96
DATA : ExSitu Exten. Sepa.r. Case 09
MODEL : BASIC MODEL (SUMMATION)



REP/PC (Ver-4.0) - MGMT REPORT 3 GRAPHICAL PRIORITY PROFILE : 02-06-96

DATA : ExSitu Exten. Sepa.r. Case 09
MODEL : BASIC MODEL (SUMMATION)

TOTAL EXPENSE	PROB OF OVERRUN	NET EFFECT OF FROZEN ELEMENTS
24008	57 PCT	0 = .0 PCT

NUM	ELEMENT	UNIT	CORRECT	PROTECT
1	Current Operations		--------	++++++++
5	Capital Treament		----------	++
7	Operations Waste Ret. & Transfer		----------	+++
10	Repository Fee			+++++++++++
4	Capital Waste Ret. & Transfer		-----	+
8	Operations Treatment			++++
	NET EFFECT OF FROZEN ELEMENTS			

REP/PC (Ver-4.0) - MGMT REPORT 4 CONTINGENCY PROFILE : 02-06-96

DATA : ExSitu Exten. Sepa.r. Case 09
MODEL : BASIC MODEL (SUMMATION)

TO BE THIS CONFIDENT OF NOT HAVING COST OVERRUN		ADD THIS CONTINGENCY ABSOLUTE	RELATIVE	
100	PCT	7099	29.6	PCT
99.95	"	4167	17.4	"
95	"	2480	10.3	"
90	"	1908	8.0	"
85	"	1582	6.6	"
80	"	1335	5.6	"
75	"	1100	4.6	"
70	"	879	3.7	"
65	"	687	2.9	"
60	"	522	2.2	"
55	"	346	1	
50	"	176	.7	"
45	"	43	.2	"
40	"	-91	-.4	"
35	"	-249	-1.0	"
30	"	-429	-1.8	"
25	"	-613	-2.5	"
20	"	-807	-3.4	"
15	"	-1025	-4.3	"
10	"	-1268	-5.3	"
5	"	-1755	-7.3	"
0.05	"	-3831	-16.0	"
0	"	-4987	-20.8	"

(ABOVE RESULTS DERIVED FROM 1000 SIMULATIONS)

JACOBS ENGINEERING GROUP INC.

DATE 2/12/96 SUBJECT SHEET NO.

BY D Stein CHKD. JOB NO.

Phased Implementation (latest version)

Target Value $32,953

95% Confidence Range $30,226 – $36,542

FORM 81-005-1 (4/81)

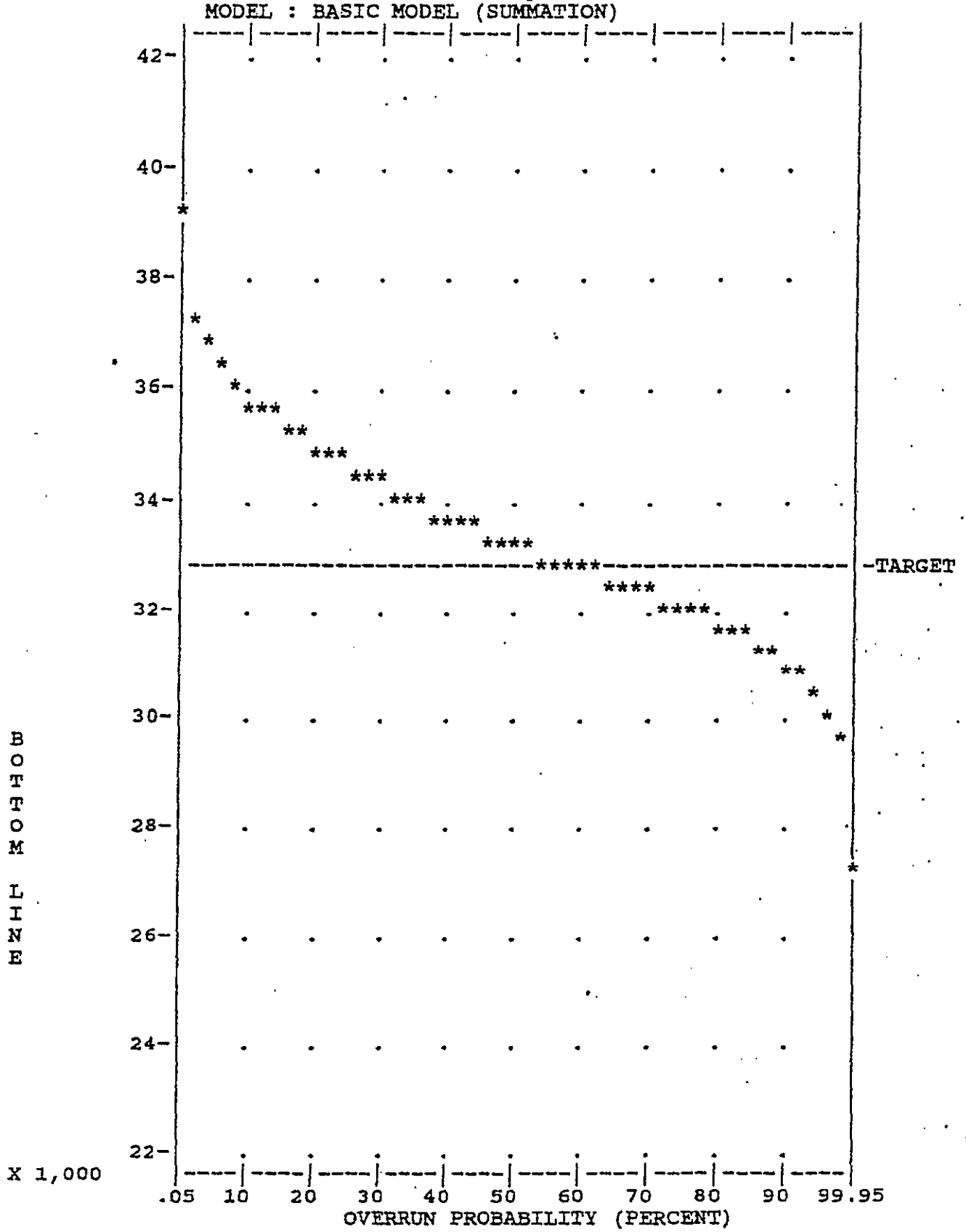
REP/PC (Ver 4.0) - MGMT REPORT 1 RANGE ESTIMATE : 02-12-96

DATA : ExSitu Exten. Sepa.r. Case 10
MODEL : BASIC MODEL (SUMMATION)

NUM	ELEMENT	UNIT	TARGET	PROB+	LOW	HIGH
1	Current Operations		8600	50	6880	10320
2	R&D Waste Ret. & Transfer		190.00		190.00	190.00
3	R&D Treatment		0		0	0
4	Capital Waste Ret. & Transfer		2280	50	1824	3876
5	Capital Treament		4305	40	4244	8610
6	Capital Closure		211.00		211.00	211.00
7	Operations Waste Ret. & Transfer		3990	50	3192	6783
8	Operations Treatment		6877	50	5158	6878
9	M & M		0		0	0
10	Repository Fee		6500	95	3900	6501
	TOTAL EXPENSE (INPUT TO REP/PC)		32953		25599 (THEORETICALS)	43369

+ PROBABILITY THAT ACTUAL VALUE WILL BE EQUAL TO OR LESS THAN TARGET

REP/PC (Ver 4.0) - MGMT REPORT 2 GRAPHICAL OVERRUN PROFILE : 02-12-96
DATA : ExSitu Exten. Sepa.r. Case 10
MODEL : BASIC MODEL (SUMMATION)



REP/PC (Ver 4.0) - MGMT REPORT 3 GRAPHICAL PRIORITY PROFILE : 02-12-96

DATA : ExSitu Exten. Sepa.r. Case 10
MODEL : BASIC MODEL (SUMMATION)

TOTAL EXPENSE	PROB OF OVERRUN	NET EFFECT OF FROZEN ELEMENTS
32953	55 PCT	0 = .0 PCT

NUM	ELEMENT	UNIT	CORRECT	PROTECT
5	Capital Treament		----------	
10	Repository Fee			++++++++++++
7	Operations Waste Ret. & Transfer		-------	++
1	Current Operations		----	++++
4	Capital Waste Ret. & Transfer		----	+
8	Operations Treatment			++++
	NET EFFECT OF FROZEN ELEMENTS			

REP/PC (Ver 4.0) - MGMT REPORT 4 CONTINGENCY PROFILE : 02-12-96

DATA : ExSitu Exten. Sepa.r. Case 10
MODEL : BASIC MODEL (SUMMATION)

TO BE THIS CONFIDENT OF NOT HAVING COST OVERRUN		ADD THIS CONTINGENCY ABSOLUTE	RELATIVE	
100	PCT	10416	31.6	PCT
99.95	"	6159	18.7	"
95	"	3589	10.9	"
90	"	2782	8.4	"
85	"	2385	7.2	"
80	"	1960	6.0	"
75	"	1599	4.9	"
70	"	1282	3.9	"
65	"	935	2.8	"
60	"	709	2.2	"
55	"	422	1.3	"
50	"	223	.7	"
45	"	2	.0	"
40	"	-257	-.8	"
35	"	-452	-1.4	"
30	"	-682	-2.1	"
25	"	-936	-2.8	"
20	"	-1178	-3.6	"
15	"	-1518	-4.6	"
10	"	-1968	-6.0	"
5	"	-2727	-8.3	"
0.05	"	-5765	-17.5	"
0	"	-7354	-22.3	"

(ABOVE RESULTS DERIVED FROM 1000 SIMULATIONS)

TWRS EIS
CALCULATION COVER SHEET

DISCIPLINE & TITLE Engineering / INT Separations Land Use Numbers for Sensitivity Analysis

ORIGINATOR Corin Henderson DATE 2/13/96

REVISION NO. 0

OBJECTIVE For the INT Separations alternative, ~~Land~~ Calculate the change in Land Use for the Sensitivity Cases Shown

METHODOLOGY Noted.

ASSUMPTIONS Noted.

(Continue on another sheet if necessary)

Checked by RDW 2-13-96

J.C. Henderson
SIGNATURE

CALCULATION & RESULTS ATTACHED

JACOBS\FORMS\CALCVR.SHT

JACOBS ENGINEERING GROUP INC.

DATE 2/6/96 SUBJECT INT SAP SENSITIVITY. SHEET NO.

BY CH CHKD. JOB NO.

LAND USE:

LOW LOADING (15 wt% HLW, 10 wt% LAW)

VAULTS = 124
CANISTERS = 44500

From Previous Calc's For Revised Base Case
the Increased Area in going from 40 → 83 vaults
the Increased VAULT Area was 69160 m^2

so the additional LAW Vault area going from
83 to 124 Vaults = 69160 m^2 (7 ha)

Additional HLW Storage = 19000 m^2 (2 ha)

Borrow Material Increases = 15,000 m^3 SILT
126,000 m^3 RIPRAP
138,000 m^3 Aggregate
} Based on same delta in going from 40 → 80 Vaults.

The increase in SAND/Gravel = 311,000 m^3
↑ Based on R. Wead transportation Calc.

TOTAL BORROW SITE INCREASES:
PIT 30 = 15 ha
Venita = 4 ha
SH McGee = 4 ha
23 ha.

JACOBS ENGINEERING GROUP INC.

DATE _____ SUBJECT _____ SHEET NO. _____

BY _____ CHKD. _____ JOB NO. _____

Then the borrow matl required
= Base Case + Change

Temp Area = Base Case + Additional Area

= 250 ha + 23 ha (borrow sites) + 7 ha (Vaults) + 2 ha (HLW Storage)

= 280 ha (700 ac)

Permanent = 49 ha + 7 vaults + 2 (barrier toe)

= 58 ha (140 ac)

High Waste Loading 40% HLW, 25% LAW.

50 Vaults for LAW.
16700 canisters = 4175 HMPC's

Borrow Change from Base Case.

- 103,000 m^3 (Aggregate Sand Const/Ops from Ri Weed Calc)

Based on 75% decrease in going from 80 + 40 Vaults.
80 - 40 = 40
.25 x 40 = 10 = 50 - 40

- 86,250 m^3 SILT Barrier
- 103,500 m^3 (Aggregate Barrier)
- 94 500 m^3 Rip Rap Barrier

Area Temp = 13 ha less than Base Case (Borrow Sites)
= No Change for Interim HLW Storage.
= 69160 m^2 x (.75) x 1/10,000 = 5 ha (13 ac) less for Vault area.
= 18 ha (44 ac) temp.

= 5 ha (Vault) + 2 ha (barrier toe) less permanent

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 Fadtran input. Perform for all Ex Situ alternatives.

ORIGINATOR Colin Henderson DATE 1/27/96

REVISION NO. 1 (2/9/96)

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/m^3 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

Checked by RDW 2-13-96

CALCULATION & RESULTS ATTACHED

JACOBS\FORMS\CALCVR.SHT

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.

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			9.12E-05		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		166,150 ~~108388~~
Number of 0.62 m^3 canisters per HMPC			4		4
Number of trips to the repository			14690		4150 ~~2710~~
Based on 10 HMPCs per train and rounded to nearest 10 trips					
Note: Curies from decay daughter products not included					

Revised 2/9/96

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)	2.20E+05	9.40E+03

Note: Curies from decay daughter products not included

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)	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	840	1110	420
Based on 10 HMPCs per train and rounded to nearest 10 trips			
Note: Curies from decay daughter products not included			

		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	1.57E+03
Number of 0.62 m^3 can/HMPC	4
Number of HMPCs	393
Number of trips to the repository	40

Based on 10 HMPCs per train and rounded to nearest 10 trips

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		3.34E+04
Number of 0.62 m^3 can/HMPC		4
Number of HMPCs		8347
Number of trips to the repository		840
Based on 10 HMPCs per train and rounded to nearest 10 trips		
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	1.67E+04
Number of 0.62 m^3 can/HMPC	4
Number of HMPCs	4174
Number of trips to the repository	420

Based on 10 HMPCs per train and rounded to nearest 10 trips

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

TWRS EIS
CALCULATION COVER SHEET

DISCIPLINE & TITLE Engineering/ In Situ Fill and Cap Cost

ORIGINATOR Colin Henderson DATE 11/3/95

REVISION NO. 0

OBJECTIVE Identify the cost for the In Situ Fill and Cap Alternative discussed in the EIS.

METHODOLOGY Use the In Situ Treatment and disposal data package to identify applicable components to the fill and cap alternative addressed in the EIS. Use Closure package for basis.

ASSUMPTIONS Radio-frequency drying is removed from the fill & cap alternative. Current Ops cost developed from components for Program Management, Upgrades, Characterization from the Intermediate Separations data package. The M&O component of current ops is taken from tank farms operations data for the TWRS EIS (spreadsheet developed by WHC). W-314 Upgrades included in Current Ops.

(Continue on another sheet if necessary)

J.C. Henderson
SIGNATURE

CALCULATION & RESULTS ATTACHED

Characterization Sept 1999.
Upgrades 1998-2004
Safety 9/1998

JACOBS\FORMS\CALCVR.SHT

JACOBS ENGINEERING GROUP INC.

DATE _____ SUBJECT _____ SHEET NO. _____

BY _____ CHKD. _____ JOB NO. _____

SUMMARY:

Current Operations

From TPA Data Package (WHC-SD-WM-EV-104 Rev. B)

Program Management	= $1,180	
*Op & Maint	$2,293	Up thru Yr 2009
Tank Farm Safety	= $440	
Tank Farm Upgrades	= $1,720	
Characterization	$933	
	$6566	

R&D Cost - $0

Capital Cost

Treatment - $25		In Situ Package Table 7-18 Footnote 2
Closure - $116		Closure Package Table 5-9
Total Capital	→ $141	

Operating Cost

Treatment	$274	In Situ Package Table 7-19 Foot Note 2.
Monitoring & Maint.	!	Closure data package Table 5-10.
Total Operating Cost	$275	

Total Cost $6,982

In Situ Treatment and Disposal of Radioactive Waste in Hanford Site Underground Storage Tanks Engineering Data Package for the Tank Waste Remediation System Environmental Impact Statement

C. M. McConville

Date Published
July 1995

RECEIVED
6 1995

Prepared for the U.S. Department of Energy
Office of Environmental Restoration and
Waste Management

Westinghouse Hanford Company P.O Box 1970 Richland, Washington

Management and Operations Contractor for the
U.S. Department of Energy under Contract DE-AC06-87RL10930

Approved for Public Release

Part (2)

JUL 19 1995

ENGINEERING DATA TRANSMITTAL

1. EDT № 6126

2. To: (Receiving Organization) TWRS Compliance Plans	3. From: (Originating Organization) Process Design	4. Related EDT No.: 608728
5. Proj./Prog./Dept./Div.: Tank Waste Remediation System	6. Cog. Engr.: C. M. McConville	7. Purchase Order No.: n/a
8. Originator Remarks: This engineering data package provides supporting data for preparation of the TWRS Environmental Impact Statement (TWRS EIS). Data in this document addresses the In Situ Disposal Alternative for tank waste. Other alternatives addressed in the TWRS EIS include the Tri-Party Agreement Alternative, the No Separations Alternative, the Extensive Separations Alternative, and the No Disposal Action Alternative. Additional data supporting the In Situ Disposal Alternative are provided in the Closure Engineering Data Package (WHC-SD-WM-EV-107). Environmental, Safety, and QA approvals required by WHC-CM-3-5 Section 12.7 were obtained on Rev. B of this document (EDT 608728). Changes in this revision, relative to Rev. B, primarily involved revisions to the data tables and backup data to incorporate updated information relating to staffing requirements for operations, estimated air emissions during construction and operations, radionuclide inventory in the final waste form, construction equipment requirements, and operating costs.		9. Equip./Component No.: n/a 10. System/Bldg./Facility: n/a
11. Receiver Remarks:		12. Major Assm. Dwg. No.: n/a 13. Permit/Permit Application No.: n/a 14. Required Response Date: n/a

15. DATA TRANSMITTED

(A) Item No.	(B) Document/Drawing No.	(C) Sheet No.	(D) Rev. No.	(E) Title or Description of Data Transmitted	(F) Approval Designator	(G) Reason for Transmittal	(H) Originator Disposition	(I) Receiver Disposition
1	WHC-SD-WM-EV-101		0	In Situ Treatment and Disposal of Radioactive Waste in Hanford Site Underground Storage Tanks Engineering Data Package for the Tank Waste Remediation System Environmental Impact Statement	E/S/Q	2	1	1

16. KEY

Approval Designator (F)	Reason for Transmittal (G)	Disposition (H) & (I)
E, S, Q, D or N/A (see WHC-CM-3-5, Sec.12.7)	1. Approval 2. Release 3. Information 4. Review 5. Post-Review 6. Dist. (Receipt Acknow. Required)	1. Approved 2. Approved w/comment 3. Disapproved w/comment 4. Reviewed no/comment 5. Reviewed w/comment 6. Receipt acknowledged

17. SIGNATURE/DISTRIBUTION (See Approval Designator for required signatures)

(G) Reason	(H) Disp.	(J) Name (K) Signature (L) Date (M) MSIN	(J) Name (K) Signature (L) Date (M) MSIN	(G) Reason	(H) Disp.
2	1	Cog.Eng. C. L. McConville			
2	1	Cog. Mgr. J. S. Garfield			
		QA (approved by J. Weber, on EDT 608728) page 2 of this EDT			
		Safety (approved by J. M. Garcia, on EDT 608728) page 2 of this EDT			
		Env. (approved by R. H. Engelmann, on EDT 608728) page 2 of this EDT			

18.	19.	20.	21. DOE APPROVAL (if required)
C. M. McConville Signature of EDT Originator — Date 7-17-95	L. E. Borneman Authorized Representative for Receiving Organization — Date 7/18/95	J. S. Garfield Cognizant Manager — Date 7-17-95	Ctrl. No. [ ] Approved [ ] Approved w/comments [ ] Disapproved w/comments [x] Not Required per Waiver WA-557

Table 7-15. Comparison of Alternatives by Decommissioning of Contaminated Treatment Facilities and Equipment (Metric Tons).[1]

Item	In Situ Chemical Stabilization[2]	Drying and Gravel Fill[3]	In Situ Vitrification[4]
Steel Quantity	2.6 E5	1.6 E3	2.6 E5
Concrete Quantity	3.2 E5	–	3.2 E5
Soil Quantity	8.8 E5	–	8.8 E5
Disposition	low-level waste burial grounds	low-level waste burial grounds	low-level waste burial grounds

Notes:

[1]All Tank Farm Confinement Facilities (TFCF) and everything contained under the TFCFs are assumed to be contaminated.

[2]TFCF = 2.6 E5 metric tons steel
= 3.2 E5 metric tons concrete
= 8.8 E5 metric tons soil

Mixing Equipment = 7.5 E2 metric tons steel

[3]Assumes 20 percent of drying systems become contaminated:
= 1.6 E3 metric tons steel

[4]TFCF = 2.6 E5 metric tons steel
= 3.2 E5 metric tons concrete
= 8.8 E5 metric tons soil

Assumes 90 percent of in situ vitrification equipment becomes contaminated:
= 8.2 E2 metric tons steel

Table 7-16. Comparison of Alternatives by Process Module: Overall Cost (Millions of 1994 Dollars).

Notes: (Continued)

[2]Drying and gravel fill

242-A

Operating cost =	$130 million
Capital cost =	$0

Radio Frequency Drying

Operating cost =	$180 million
Capital cost =	$121 million
Research and development =	$ 10 million

Gravel Fill

Operating cost =	$150 million
Capital cost =	$ 25 million

[3]In Situ Vitrification

242-A

Operating cost =	$130 million
Capital cost =	$0

Vitrification (includes TFCF)

Operating cost =	$2,400 million
Capital cost =	$4,700 million
Research and development =	$ 67 million

See Table 7-18 for Capital Costs and Table 7-19 for Operating Costs.

[4]Due to rounding, totals do not equal sum of numbers in column.

Table 7-18. Comparison of Alternatives by Capital Cost Component (Millions of 1994 Dollars).

Capital Cost Component	In Situ Chemical Stabilization	Drying and Gravel Fill	In Situ Vitrification
Labor	2,600	5	2,800
Materials/Supplies	1,450	11	1,550
Equipment	20	110	50
Local Purchases	260	21	280
Total	4,300	150	4,700

Notes:

[1]Tables M4-5 (Stabilization by Grout Capital Cost) and F7-7 (Tank Farm Confinement Capital Cost) of the *Tank Waste Technical Options Report* (Boomer et al. 1993) were used as a basis.

242-A Evaporator
Capital cost = 0

Tank Farm Confinement Facility
Labor = $2,600 million
M/S = $1,700 million
Equipment = $0
{Local purchases = 0.15(M/S + Equipment)}
Total = $4,300 million

Grout mixing
Labor = $ 5.6 million
M/S = $13 million
Equipment = $21.5 million
{Local purchases = 0.15 (M/S + Equipment)}
Total = $40 million

[2]SD-WM-TI-111 Rev 1 (Higley 1985), was used as a basis for one radio frequency drying system. Forty-five systems are used. Table M5-5 (Stabilization by Gravel Capital Cost Estimate) of the *Tank Waste Technical Options Report* was used as a basis for the Gravel Fill estimate.

242-A Evaporator
Capital cost = 0

Table 7-19. Comparison of Alternatives by Operating Cost Component (Millions of 1994 Dollars). (5 sheets)

Operating Cost Component	In Situ Chemical Stabilization[1]	Drying and Gravel Fill[2]	In Situ Vitrification[3]
Labor	300	200	500
Materials/Supplies	10	28	100
Equipment	110	33	24
Local purchases	20	10	22
Startup	370	92	250
Decontamination and decommissioning	1,600	110	1,600
Total[4]	2,400	274 470	2,500

Notes:

[1]In situ chemical stabilization
242-A Evaporator = 5-year operating life
Total operating cost = $127 million
Annual operating cost = $15 million

Following numbers based on previous operation of 242-A Evaporator:
Labor = 59 Exempt x 130,000 per year = $8 million per year x 5 years = $40 million
60 Nonexempt x 50,000 per year = $3 million per year x 5 years = $15 million
Materials/Supplies = $1 million per year x 5 years = $ 5 million
Equipment (Upgrade cost = $13 million) = $3 million per year x 5 years = $15 million
{Local purchases = 15% of (Materials/Supplies + Equipment)}
Total = $15 million per year = $75 million
Startup = 2 years operating cost
= 2 ($15 million)
= $30 million

Decontamination and decommissioning = 2 years operating labor + 0.3 (capital cost)
= 2 ($11 million) + 0.3(0)
= $22 million

Tank Farm Confinement Facility (TFCF) (Grout) = 2-year operating life
Total operating cost = $2100 million
Annual operating cost = $153 million

Table 7-19. Comparison of Alternatives by Operating Cost Component (Millions of 1994 Dollars). (5 sheets)

Notes: (Continued)

Drying and Gravel Fill

242-A Evaporator = 5-year operating life
Total operating cost = $127 million
Annual operating cost = $15 million

Following numbers based on previous operation of 242-A Evaporator:
Labor = 59 exempt x 130,000 per year = $8 million per year x 5 yr = $40 million
60 nonexempt x 50,000 per year = $3 million per year x 5 yr = $15 million
Materials/Supplies = $1 million per year x 5 yr = $ 5 million
Equipment (Upgrade cost = $13 million) = $3 million per year x 5 yr = $15 million
{Local purchases = 15% of (Materials/Supplies + Equipment)}
Total = $15 million per year = $75 million

Startup = 2 years operating cost
= 2 ($15 million)
= $30 million

Decontamination and decommissioning = 2 years operating labor + 0.3(capital cost)
= 2 ($11 million) + 0.3(0)
= $22 million

Radio Frequency Drying = 9-year operating life
Total operating cost = $183 million
Annual operating cost = $12 million

Labor 13 Exempt x 130,000 per year = $1.7 million per year x 9 yr = $15 million
3 Nonexempt x 50,000 per year = $0.2 million per year x 9 yr = $ 2 million
77 Bargaining units x 90,000 per year = $6.9 million per year x 9 yr = $62 million
Total Labor = $9 million per year = $80 million

Materials/Supplies
Electricity = 1.1E8 kwh x $0.025/kwh = $2.8 million per year x 9 yr = $25 million
Water (includes potable water for all drying and gravel fill staff)
= 1.1 E6 m^3 x $3/$m^3$ = $370,000 per year x 9yr = $ 3 million
Equipment = 0
{Local purchases = 15% of (Materials/Supplies + Equipment)}
Total = $12 million = $108 million
Startup = 2($12 million) = $24 million
Decontamination and decommissioning = 2($9 million) + 0.3($121 million) = $54 million

Gravel Fill = 4-year operating life
Total operating cost = $147 million
Annual operating cost = $19 million

Table 7-19. Comparison of Alternatives by Operating Cost Component (Millions of 1994 Dollars). (5 sheets)

Notes: (Continued)

Following numbers based on Tables M9-5 and M9-6 of the *Tank Waste Technical Options Report*.
Labor 292 exempt x 130,000/year = $38 million per year x 5 yr = $190 million
131 nonexempt x 50,000/year = $ 7 million per year x 5 yr = $ 35 million
437 Bargaining units x 90,000/year = $39 million per year x 5 yr = $195 million
Labor Total = $84 million per year = $420 million

Materials/Supplies
Water (includes potable water for all in situ vitrification staff)
= 1.2 E6 m^3 x $3/$m^3$ = $3.6 million

Electricity	= 4.4 E9 kwh x $0.025/kwh = $110 million
Limestone	= 1.1 E7 kg x $0.09/kg = $990,000
Propane	= 1.1 E7 kg x $0.02/kg = $220,000
Ammonia	= 6.8 E5 kg x $0.38/kg = $260,000
M/S Total	= $23 million per year x 5yr = $115 million
Equipment	= $2.4 million (1993) x 1.05 = $2.5 million per year x 5yr = $ 12.5 million
Total	= $110 million per year = $545 million

Startup = 2($110 million) = $220 million
Decontamination and decommissioning = 2($84 million) + 0.3($4650 million) = $1563 million

Costs associated with routine tank farm operations, TWRS program management, characterization, tank farm upgrades, single shell tank salt well pumping, and tank farm safety issue resolution are not included in these totals.

[a]Due to rounding, totals do not equal sum of numbers in columns.

Boomer, K. D., S. K. Baker, A. L. Boldt, J. D. Galbraith, J. S. Garfield, C. E. Golberg, B. A. Higley, L. J. Johnson, M. J. Kupfer, R. M. Marusich, R. J. Parazin, A. N. Praga, G. W. Reddick, E. J. Slaathaug, L. M. Swanson, T. L. Waldo, C. E. Worcester, 1993, *Tank Waste Technical Options Report*, WHC-EP-0616, Westinghouse Hanford Company, Richland, Washington.

Table 7-21. Comparison of Alternatives by Overall Schedule (Calendar Year Start/Completion Date).

Activity	In Situ Chemical Stabilization	Drying and Gravel Fill	In Situ Vitrification
Construction[1]	1998-2013	2003-2005	1998-2016
Operation[2]	2005-2013	2005-2018	2005-2016
Monitoring and maintenance[3]	2024-2124	2024-2124	2024-2124
Decontamination and decommissioning[4]	2010-2013	2018-2021	2013-2016
Research and development[5]	n/a	2000-2002	1995-2002

Notes:

[1]The construction periods for in situ chemical stabilization and in situ vitrification (ISV) continue throughout operations due to construction of the Tank Farm Confinement Facilities. The in situ drying option requires gravel excavation and construction of the gravel distributor.

[2]The operating periods shown here include an additional 3 years for startup.

[3]Monitoring and maintenance takes place after closure (placement of barriers) for a period of 100 years. Monitoring and maintenance upon completion of in situ disposal is discussed in the *Closure Technical Data Package for the Tank Waste Remediation System Environmental Impact Statement* (Scanlon et al. 1995).

[4]It is assumed that decontamination and decommissioning will take 3 years to complete for all in situ alternatives, and is considered the "shutdown period" mentioned in Table 7-25.

[5]Radio frequency drying will require two years of research and development, based on engineering judgement. The ISV alternative will require seven years research and development as shown in PNL-7499 (Koegler 1990).

Koegler, S. L., 1990, *Underground Tank Vitrification Project Plan*, PNL-7499, Pacific Northwest Laboratory, Richland, Washington.

Scanlon, P. L., H. Hampt, W. A. Skelly, 1995, *Closure Technical Data Package for the Tank Waste Remediation System*, Draft, Westinghouse Hanford Company, Richland, Washington.

8.1 IN SITU VITRIFICATION

The following tables from the *Tank Waste Technical Options Report* (Boomer et al. 1993) were used as a basis for the in situ vitrification option:

Tank Farm Confinement Facility
Table F7-7 Capital Cost Estimate

The Tank Farm Confinement Facility (TFCF) has been sized according to five different tank farm configurations (2x2, 2x3, 3(4)x4, 3x5, 4x5). The 18 tank farms will require:
4 (2x2); 3 (2x3); 9 (3x4); 1 (3x5); 1 (4x5)

Vitrification
Table M9-4 Capital Cost Estimate
Table M9-5 Operating Expense Summary
Table M9-6 Staffing
Table M9-4 was modified to include 4 ISV systems and sand excavation costs.

A percent distribution of ISV operating staff hours over the operating life (including startup and decontamination and decommissioning) is shown in Figure 8-1.

Sand would be excavated onsite to avoid frit purchasing and shipping costs. Existing Pit 30, located between 200 East and 200 West Areas, would be used to excavate 540,000 m^3 of sand required for filling the tank void spaces. This estimate was taken from the in situ chemical stabilization (ISCS) option. It assumes that excavating and crushing equipment will already be in place from other contracts. As a result, no construction work would be necessary.

Total tank volume = 740,000 m^3
Total waste volume = 201,000 m^3
Total void volume = 540,000 m^3 = frit (sand) requirement
(based on the *Technical Options Report and Tank Farm Surveillance and Waste Status Summary Report* for April 1994)

Process water required for the ISV process is assumed negligible.

The entire tank farms would be vitrified to an 18m depth, including areas between the tanks. The total vitrified volume would equal 3.8E6 m^3.

ISV operating life equals 5 years, based on the assumption that it takes 3 weeks to vitrify one tank. Four ISV systems would be purchased with at least 2 in continuous operation at all times.

Seven years of research and development are required before mega-scale ISV could be implemented. This research and development will cost $67,000,000 as shown in PNL-7499 (Koegler 1990).

8.2 IN SITU CHEMICAL STABILIZATION

The in situ chemical stabilization option would use all the materials, equipment, and labor shown for the "grout fill" option of the *Tank Waste Technical Options Report*. However, because the grout fill option is for empty tanks, additional equipment and labor would be required for mixing grout with the waste.

Additional unit process steps:

Construction of 18 TFCF
15-m (48-ft)-diameter dome penetration of 161 tanks
Employment of grout mixing system (4-m [12-ft]-diameter auger with grout injector)

The following tables from the *Tank Waste Technical Options Report* were used as a basis for including the additional steps:

Tank Farm Confinement Facility

Table F7-7 Capital Cost Estimate
Table F7-8 Operating Expense Summary
Table F7-9 Staffing

Dome penetration is considered "operation" rather than "construction." It was assumed that the TFCF operating staff would perform the 15-m (48-ft) dome penetrations; Tables F7-8 and F7-9 were modified accordingly.

Additional TFCF Labor:
35 operations managers (exempt)
120 operators (bargaining unit)

The TFCF has been sized according to five different tank farm sizes (2x2, 2x3, 3(4)x4, 3x5, 4x5). The 18 tank farms will require:
4 (2x2); 3 (2x3); 9 (3x4); 1 (3x5); 1 (4x5)

Grout Mixing

Table M4-5 Capital Cost Estimate
Table M4-6 Operating Expense Summary
Table M4-7 Staffing

Because sand is the largest quantity constituent, it would be excavated onsite from existing Pit 30, located between 200 East and 200 West Areas. The sand excavation estimate is considered a capital cost and assumes that excavating and crushing equipment would already be in place from other contracts.

ISCS operating life = 2 years, based on the following assumptions:

2.5 hours to drill 1 well
37 wells/tank
161 tanks
200 days for moving and setting up
Continuous operation of 2 mixing systems and 2 batch plants at all times

The TFCF operating life must be 12 years because stabilization takes place under the TFCF, and the TFCF operating staff performs the dome penetrations.

The total grouted waste volume is equal to the volume of all 177 tanks = 7.4E5 m^3.

8.3 DRYING AND GRAVEL FILL

The drying and gravel fill option would use all the materials, equipment, and labor shown for the radio frequency drying option in the *Hanford Defense Waste Environmental Impact Statement Working Papers-Existing Tank Waste* (Higley 1985), and the "gravel fill" option of the *Tank Waste Technical Options Report*. However, the radio frequency drying option has been modified with additional labor and equipment to include the DSTs.

The following tables from the *Tank Waste Technical Options Report* were used as a basis for including the gravel fill:

Table M5-5 Capital Cost Estimate
Table M5-7 Operating Expense Summary
Table M5-8 Staffing

A percent distribution of drying and gravel fill operating staff hours over the operating life (including startup and decontamination and decommissioning) is shown in Figure 8-3.

The total dried waste volume = 50,000 m^3. This volume was calculated by estimating a new salt cake volume from the total moles of Na in double-shell slurry feed and dilute noncomplexed waste. The sludge volume was assumed to remain the same.

Total tank volume = 740,000 m^3
Total waste volume = 50,000 m^3
Total void volume = 690,000 m^3 = Total gravel requirement

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UC-2030

Closure Technical Data Package for the Tank Waste Remediation System Environmental Impact Statement

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Date Published
July 1995

Prepared for the U.S. Department of Energy
Office of Environmental Restoration and
Waste Management

Westinghouse Hanford Company P.O Box 1970 Richland, Washington

Management and Operations Contractor for the
U.S. Department of Energy under Contract DE-AC06-87RL10930

Approved for Public Release

(2)

JUL 19 1995

ENGINEERING DATA TRANSMITTAL

1. EDT № 6126

2. To: (Receiving Organization) TWRS Compliance Plans	3. From: (Originating Organization) Geotechnical Development Projects	4. Related EDT No.: n/a
5. Proj./Prog./Dept./Div.: Tank Waste Remediation System	6. Cog. Engr.: P. L. Kline	7. Purchase Order No.: n/a
8. Originator Remarks: This engineering data package provides supporting data for preparation of the TWRS Environmental Impact Statement. Data in this document complements data provided in separate documentation for the No Separations Alternative, the Extensive Separations Alternative, the Tri-Party Agreement Alternative, and the In Situ Disposal Alternative. Environmental, Safety, and QA approvals required by WHC-CM-3-5 Section 12.7 were obtained on Rev. 5 of this document. The only significant changes in this revision, relative to Rev. 5, involved changes to data tables addressing construction staffing requirements and costs.		9. Equip./Component No.: n/a 10. System/Bldg./Facility: n/a
11. Receiver Remarks:		12. Major Assm. Dwg. No.: n/a 13. Permit/Permit Application No.: n/a 14. Required Response Date: n/a

15. DATA TRANSMITTED

(A) Item No.	(B) Document/Drawing No.	(C) Sheet No.	(D) Rev. No.	(E) Title or Description of Data Transmitted	(F) Approval Designator	(G) Reason for Transmittal	(H) Originator Disposition	(I) Receiver Disposition
1	WHC-SD-WM-EV-107		0	Closure Technical Data Package for the Tank Waste Remediation System Environmental Impact Statement	E/S/Q	2	1	1

16. KEY

Approval Designator (F)	Reason for Transmittal (G)	Disposition (H) & (I)
E, S, Q, D or N/A (see WHC-CM-3-5, Sec.12.7)	1. Approval 2. Release 3. Information 4. Review 5. Post-Review 6. Dist. (Receipt Acknow. Required)	1. Approved 2. Approved w/comment 3. Disapproved w/comment 4. Reviewed no/comment 5. Reviewed w/comment 6. Receipt acknowledged

17. SIGNATURE/DISTRIBUTION (See Approval Designator for required signatures)

(G) Reason	(H) Disp.	(J) Name	(K) Signature	(L) Date	(M) MSIN	(J) Name	(K) Signature	(L) Date	(M) MSIN	(G) Reason	(H) Disp.
2	1	Cog.Eng. P. L. Kline									
2	1	Cog. Mgr. J. G. Field		7/15/95							
		QA (approved by J. Weber, on EDT dated 3/6/95 attached)									
		Safety (approved by J. M. Garcia, on EDT dated 3/6/95 attached)									
		Env. (approved by R. H. Engelmann, on EDT attached)									

18.	19.	20.	21. DOE APPROVAL (if required)
P. L. Kline Signature of EDT Originator — Date 7/15/95	L. E. Borneman Authorized Representative for Receiving Organization — Date 7/15/95	J. G. Field Cognizant Manager — Date	Ctrl. No. [ ] Approved [ ] Approved w/comments [ ] Disapproved w/comments [x] Not Required per Waiver WA-557

1	/	Cog.Mgr.	L.E. Bomeman	2/28/95	32-06		
1	/	QA	J. Weber	3/6/95	51-57		
1	/	Safety	J.M. Garold		33-09		
1	/	Env.	R.H. Engelmann		H6-26		
1	/	Disp.Pro.	J.O. Honeyman		57-81		

18.	19.	20.	21. DOE APPROVAL (if required)
P.I. Seaman 2/28/95 Signature of EDT Originator Date	L.E. Bomeman 2/28/95 Authorized Representative for Receiving Organization Date	L.E. Bomeman 3/7/95 Cognizant Manager Date	Ctrl. No. [] Approved [] Approved w/comments [] Disapproved w/comments

SD-7400-172-2 (04/94) GEF097

Table 5-8. Comparison of Alternatives by Process Module: Capital Cost (Millions of 1995 Dollars).[1,2,3,4]

Process Module	In Situ Disposal	Extensive Pretreatment Option A Grout/gravel	Extensive Pretreatment Option B Grout/gravel	No Separations Grout/gravel	Tri-Party Agreement Preferred Alternative Grout/gravel
Barrier construction[5]	$86	$113	$237	$86	$111
Emptied SST closure[6]	n/a	$26.6/$14.6	$26.6/$14.6	$26.6/$14.6	$26.6/$14.6
Emptied DST closure[7]	n/a	$4.4/$2.6	$4.4/$2.6	$4.4/$2.6	$4.4/$2.6
Total	$86	$144/$130	$268/$254	$117/$103	$142/$128

Notes:

SST = single-shell tank
DST = double-shell tank

[1]The cost of gravel was estimated from Appendix A, Cost Barrier Materials and was figured at $22 per cubic meter ($m^3$) for 756,000 m^3 of material, or $16,600,000. There are 16 55,000-gallon tanks that would be stabilized with the same grout mixture used for stabilizing the ancillary equipment. These tanks have a total void volume of 5,324 m^3. The cost of this grout was estimated at $0.14 per kilogram (kg) for Type I/II cement, $0.04/kg for fly ash, and $18.50/$m^3$ for sand from Pit 30. For 106,500 kg of cement, the cost would be $14,900; 958,000 kg of fly ash would cost $38,300; and 5,160,000 kg of sand (3,225 m^3 of sand) would cost $59,700. The total cost of this grout is $112,900. The cost of the water was not calculated. The cost of the air entrainment additive was unknown but assumed to be negligible.

[2]The cost of concrete was estimated at $0.14/kg for Type I/II cement, $0.04/kg for fly ash, and $18.50/$m^3$ for sand from Pit 30. For 15,000,000 kg of cement, the cost would be $2,100,000; 137,000,000 kg of fly ash would cost $5,480,000; 1,260,000,000 kg of sand (1,300,000 m^3 of sand) would cost $23,200,000. The total cost of this grout is $30,780,000. The cost of the water was not calculated. The cost of the air entrainment additive was unknown but assumed to be negligible.

[3]The cost of solidifying the ancillary equipment is based on the same grout formula as in notes 1 and 2. There is 13,700 m^3 of void space in the ancillary equipment for the SSTs and the DSTs. The SST ancillary equipment void space is 10,500 m^3, and the DST ancillary equipment void space is 3,200 m^3. For SST ancillary equipment, 210,000 kg of cement would cost $29,400; 1,890,000 kg of fly ash would cost $75,600; 17,400,000 kg of sand (10,900 m^3 of sand) would cost $201,500. The total cost of stabilizing the ancillary SST equipment would be $306,500. For DST ancillary equipment, 64,000 kg of cement would cost $8,960; 576,000 kg of fly ash would cost $23,000; 5,312,000 kg of sand (3,320 m^3 of sand) would cost $61,400. The total cost of stabilizing the ancillary DST equipment is $93,360. The cost of water was not calculated. The cost of the air entrainment additive was unknown but assumed to be negligible.

[4]The costs for monitoring and maintenance are reflected in Table 5-10 and were not included in these costs.

Table 5-9. Comparison of Alternatives by Capital Cost Component (Millions of 1995 Dollars).

Capital Cost Component	In Situ Disposal	Extensive Pretreatment Option A Grout/gravel	Extensive Pretreatment Option B Grout/gravel	No Separations Grout/gravel	Tri-Party Agreement Preferred Alternative Grout/gravel
Labor[1]	$30.6	$54.1/$57.1	$105/$107.3	$43.9/$46.9	$53.6/$56.6
Materials/supplies[2]	$28.5	$42.9/$37.4	$81.1/$75.6	$34.1/$28.6	$42.5/$37.0
Equipment[3]	n/a	$0.25/$0.35	$0.25/$0.35	$0.25/$0.35	$0.25/$0.35
Local purchases[4]	$57.5	$43.5/$35.1	$130/$121	$82.9/$74.5	$42.5/$34.1
Total	$~~117~~ $116	$141/$130	$316/$304	$161/$150	$139/$128

Notes:

n/a = not applicable

[1]Average wage for an exempt employee at TWRS is $57.11/hour, for a non-exempt employee is $22.35/hour, and for a bargaining unit employee is $41.31/hour (based on overhead, the common support pool and general and administrative rates found in Soft Reporting on November 11, 1994 for organization code 70000). Labor costs were calculated taking the staff hours from Tables 5-2A through 5-2D and multiplying by the average wage. Ancillary equipment stabilization and barrier construction labor costs were included in both grout and gravel stabilization. It was assumed that all design, engineering, and supervisory personnel were exempt, and that all radiation and nonradiation workers were bargaining unit employees.

[2]Materials and supplies include the tank and ancillary equipment stabilization materials and the materials used in barrier construction over the tanks and over the LLW Vaults (in the Extensive Pretreatment and TPA Preferred Alternatives). They include only materials that cannot be bought locally (asphalt, asphalt coating and geotextile fabric for the barrier; fly ash for the grout mix). All other materials for stabilization and barrier construction are listed in local purchases. These numbers were calculated from Appendix A, Barrier Cost by Component. Asphalt would cost $27,800,000 for tank barriers, $45,300,000 for extensive pretreatment grout, $8,500,000 for extensive pretreatment glass, and $8,100,000 for the Tri-Party Agreement glass. Geotextiles would cost $717,000 for tank barriers, $1,700,000 for extensive pretreatment grout, $284,000 for extensive pretreatment glass, and $268,000 for Tri-Party Alternative glass. Fly ash would cost $5,600,000 for the grout stabilization option (both for tanks and ancillary equipment); it would cost $137,000 for the gravel stabilization option (for the 55,000-gallon tanks and for ancillary equipment). The cost of the grout option is listed first, and the cost of the gravel option is listed second.

Table 5-10. Comparison of Alternatives by Monitoring and Maintenance Cost Component (Millions of 1995 Dollars).[1,2]

Monitoring and Maintenance Cost Component	In Situ Disposal	Extensive Pretreatment Option A	Extensive Pretreatment Option B	No Separations	Tri-Party Agreement Preferred Alternative
Labor[3]	0.39	0.40	0.40	0.39	0.40
Materials/supplies[4]	0.011	0.012	0.016	0.011	0.012
Equipment[3,5]	0.030	0.030	0.030	0.030	0.030
Local purchases[4]					
Total	0.43	0.44	0.45	0.43	0.44

Notes:

[1]See Appendix A for details on the calculations.

[2]Monitoring and maintenance applies to all phases of the closure package (tank stabilization, ancillary equipment stabilization, and barrier construction).

[3]The labor rates are based on an average wage of $130,000 per year for supervisors, and $60,000 per year for laborers and a clerk/secretary.

[4]All materials and supplies are local purchases.

[5]Equipment costs are based on one tractor with attachments and three pickup trucks, to be replaced once every five years.

- For additional backup information, see Appendix A, Figures A2, A3, and A4; and Tables A8 and A9.

Table 5-12. Comparison of Alternatives by Unit Process: Sequence of Construction (Calendar Year: Start/Completion Date).[1]

Unit Process	In Situ Disposal[2] Chemical Vitrification	Extensive Pretreatment Option A[3]	Extensive Pretreatment Option B[3]	No Separations	Tri-Party Agreement Preferred Alternative
Barrier construction	2013,2016/ 2030,2033	2024/2060	2024/2030	n/a	2028/2034
Emptied SST closure[4]	n/a	2010/2024	2010/2024	2010/2024	2010/2024
Emptied DST closure[5]	n/a	2019/2023	2019/2023	2018/2022	2023/2027

Notes:

n/a = not applicable
SST = single-shell tank
DST = double-shell tank

[1]Based on WHC-EP-0616, *Tank Waste Technical Options Report*, (Boomer et al. 1993).

[2]The start/completion dates for barrier construction for the in-situ disposal alternative is based on WHC-SD-WM-EV-101 (McConville 1995). In situ chemical stabilization decontamination and decommissioning ends in 2013, and barrier construction over the tanks begins immediately after that task; it ends in 2030. In situ vitrification decontamination and decommissioning ends in 2016, and barrier construction over the tanks begins immediately after that task. It ends in 2033. 2016-2033

[3]The start and completion dates for barrier construction for the extensive pretreatment alternatives and the Tri-Party Agreement preferred alternative are based upon the assumption that no barrier construction over the low-level waste vaults can begin until decontamination and decommissioning activities for the facilities end.

[4]The start and completion dates for emptied SST closure are based on the Tank Farm Retrieval Sequence schedule found in WHC-SD-WM-ER-193. This schedule is reproduced in Appendix A. These figures reflect work occurring sequentially (that is, no parallel operations were used). Tank stabilization and ancillary equipment stabilization begin as soon as Tank Farm retrieval operations end; barrier construction begins as soon as tanks and ancillary equipment are stabilized.

[5]The start and completion dates for emptied DST closure are based upon the assumption that no tank or ancillary equipment stabilization can begin until treatment operations end, and no barrier construction can begin until tanks and ancillary equipment have been stabilized for each tank cluster. This assumption was used because no schedule was generated for the retrieval sequence of the DSTs. These figures reflect work occurring sequentially (that is, no parallel operations were used).

For additional backup information, see Appendix A, Tables A1-A9 and A-11.

Table A11. Barrier Cost by Component (1994 Dollars)
(Backup for Table 5-1, 5-2D, 5-8 and 5-9).

BACKUP FOR BARRIER COST BY COMPONENT
(IN 1994 DOLLARS)

MATERIAL	241-A	241-AX	241-B	241-BX	241-BY	241-C	241-S	241-SX	241-T	241-TX	241-TY	241-U
Dat Design	128,326	98,336	247,428	209,901	212,377	252,130	214,150	250,908	247,428	320,621	129,380	247,785
Eng/Inspect	256,652	196,475	494,856	419,809	424,754	504,860	428,612	513,815	494,856	641,242	259,160	494,571
SRDI Test	59,759	59,759	59,759	59,759	59,759	59,759	59,759	59,759	59,759	59,759	59,759	59,759
ENG SUBTOTAL	444,737	354,472	802,043	689,472	696,890	817,049	703,127	830,482	802,043	1,021,622	448,499	799,615
Site Work	76,577	58,706	172,756	138,295	140,162	177,304	142,070	174,752	172,756	241,598	77,322	167,975
Base Course	43,653	33,757	83,514	71,072	71,897	85,173	72,567	86,743	83,514	107,759	44,274	81,610
Asphalt	1,096,842	844,178	2,088,454	1,777,317	1,797,843	2,179,938	1,815,190	2,169,204	2,088,454	2,694,759	1,107,162	2,045,832
Drain Gravel	81,837	71,480	170,807	146,155	147,801	174,098	148,167	177,408	170,807	216,831	92,660	167,430
Batch	1,202,708	945,832	2,147,732	1,858,531	1,878,404	2,188,453	1,884,407	2,234,904	2,147,732	2,710,535	1,213,411	2,108,115
Gravel Filter	48,851	34,881	109,292	89,737	90,975	111,885	92,061	113,354	109,292	147,461	48,475	106,013
Sand Filter	32,361	22,889	73,108	59,898	60,735	74,859	61,466	75,812	73,108	88,895	32,772	71,298
Geotextile	25,329	17,983	57,166	46,853	47,505	58,556	48,079	59,301	57,166	77,357	25,835	55,770
Lower SA	140,781	87,030	337,488	272,987	276,872	340,007	280,559	349,531	337,488	463,458	142,614	328,634
Upper SA	175,202	122,872	405,196	330,282	334,981	415,123	339,145	420,026	405,196	551,488	177,362	394,934
Road	8,378	7,883	13,600	12,463	12,558	13,759	12,818	14,207	13,600	15,796	8,440	13,444
CON SUBTOTAL	2,943,569	2,257,571	5,659,114	4,803,570	4,859,948	5,773,150	4,907,349	5,875,242	5,659,114	7,327,914	2,872,173	5,541,653
TOTAL	3,388,326	2,612,043	6,461,157	5,493,042	5,556,838	6,590,199	5,610,476	6,705,724	6,461,157	8,349,536	3,420,672	6,326,470

MATERIAL	DST AN	DST AP	DST AW	DST AY	DST AZ	DST SY	EX PAE OPT B	EX PAE OPT A	TPA GLASS	TOTALS
Dat Design	180,130	168,913	134,841	68,730	68,730	100,770	5,158,199	1,038,855	985,231	11,157,585
Eng/Inspect	360,660	337,825	269,683	133,460	133,460	201,540	11,713,798	2,077,709	1,966,867	22,315,184
SRDI Test	59,759	59,759	59,759	59,759	59,759	59,759	59,759	59,759	59,759	1,254,939
ENG SUBTOTAL	601,049	566,497	464,283	259,949	259,949	362,069	17,930,456	3,176,323	3,010,060	34,727,688
Site Work	115,947	101,290	80,757	40,402	40,402	60,224	14,400,406	1,265,455	1,144,322	18,889,696
Base Course	61,239	57,465	48,036	23,178	23,178	34,607	1,610,910	340,763	323,385	3,566,724
Asphalt	1,531,415	1,437,029	1,151,228	579,620	579,620	865,423	45,265,770	8,521,531	8,087,188	89,883,895
Drain Gravel	126,527	118,274	96,224	50,124	50,124	73,174	3,528,842	675,589	641,877	7,140,040
Batch	1,621,323	1,546,069	1,257,185	677,616	677,616	967,401	50,662,065	7,835,675	7,473,781	95,248,595
Gravel Filter	75,003	67,954	52,009	20,118	20,118	38,064	3,145,201	537,900	507,183	5,505,579
Sand Filter	49,874	45,187	34,475	13,090	13,090	23,783	2,136,898	383,657	342,727	3,759,982
Geotextile	39,090	35,330	26,967	10,239	10,239	16,603	1,871,353	284,457	268,060	2,841,104
Lower SA	225,328	200,592	150,681	50,800	50,800	100,731	10,778,043	1,783,667	1,677,545	18,389,664
Upper SA	274,365	248,546	188,919	67,607	67,607	127,293	12,268,398	2,065,082	1,944,652	21,320,393
Road	11,341	11,341	9,574	6,340	6,340	8,007	72,454	29,599	29,064	332,424
CON SUBTOTAL	4,131,552	3,666,957	3,092,133	1,539,194	1,539,194	2,315,310	133,555,045	23,703,635	22,440,040	254,765,049
TOTAL	4,732,601	4,233,454	3,556,416	1,799,143	1,799,143	2,677,379	151,185,501	26,879,958	25,450,100	289,493,335

NOTE. (1) The above design and construction costs are 1993 dollars escalated by a 2.9% inflation factor, and include a 15% contingency.

(2) The costs for EPT Option A, EPT Option B, and TPA Glass do not include the costs for barriers over the tank farms; they are strictly the costs of the barriers over the LLW Vaults.

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

Cost Component	Tri-Party Agreement Preferred Alternative
Capital	3,600[1]
Operating	3,900[2]
Research and development	630[3]
Repository fee	1,750
Other related costs	8,600[4]
Total	$18,500

Notes:

[1]Total capital cost includes 40% contingency. Contingency is excluded from other costs.

[2]Includes start-up, decontamination and decommissioning, and monitoring and maintenance costs.

[3]Pg. 130 of Boomer 1994, which was based on a draft of the *Tank Waste Remediation System Multi-Year Program Plan* (MYPP) (WHC 1994).

[4]Other related costs are costs defined in the MYPP that should be included in the total costs, but are not directly related to operations. These costs are:

Program management	$1,180
Operations and maintenance	4,290
Tank farm safety	440
Tank farm upgrades	1,720
Characterization	933
Total	$8,563

(SIS 4342)

Round to $8,600 million. These costs are taken as total unescalated costs from the MYPP.

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.

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

TWRS EIS
CALCULATION COVER SHEET

DISCIPLINE & TITLE Engineering / Change in interim Storage & LAW VAULT Areas for the Extensive Separations Case

ORIGINATOR Cain Henderson DATE 1/29/96

REVISION NO. 0

OBJECTIVE Calculates the additional Area Required for Extensive Separations based on lower waste loading

METHODOLOGY noted

ASSUMPTIONS noted

(Continue on another sheet if necessary)

JCH Henderson
SIGNATURE

Checked by RAW 2-13-96

CALCULATION & RESULTS ATTACHED

JACOBS\FORMS\CALCVR.SHT

EXTENSIVE SEPARATIONS Change in LAW VAULT AREA AND HLW Storage Pad Required for interim Storage

HLW 1571 CANISTERS OR 393 HMPCs
LAW 83 VAULTS

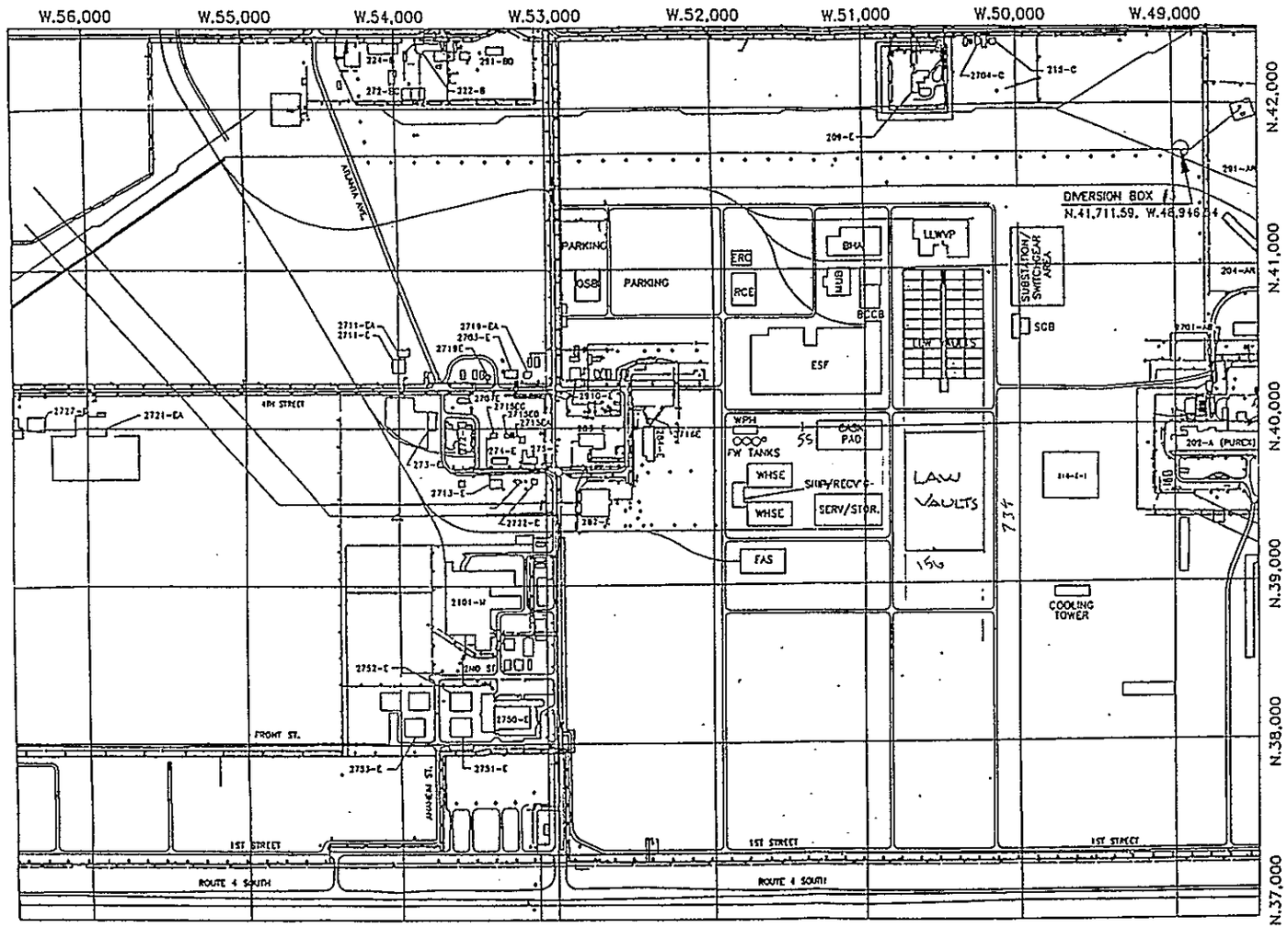
EXISTING (RONO DATA PKG) HLW Storage Pad equals 6800 m^2

Required STORAGE SPACE:
393x (3x3) x 1.10 = 3890
Req for upright stacking.

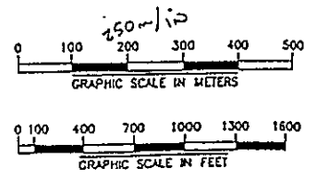
⇒ Existing Pad is sufficient for Interim Storage.

Additional LAW VAULTS = 36500 m^2

Figure 8-1. Site Layout for Extensive Separation Alternative with Low-Level Waste Vitrification.



200 EAST AREA



LEGEND

BCCB	BULK HANDLING & COLD CHEMICAL MAKE-UP BUILDING
BHA	BULK HANDLING AREA
ERC	EMERGENCY RESPONSE CENTER
ESF	EXTENSIVE SEPARATIONS FACILITY/HLWVP
FW TANKS	FIRE WATER TANKS
	HLWVP PROCESS
	HCMA/CANISTER/CASK/HANDLING ANNEX
	HCBB/CONTACT FILTER BUILDING
	ANALYTICAL LAB
	CONDENSATE COLLECTION ANNEX
FAS	FABRICATION & ASSEMBLY SHOP
WPH	WATER PUMPHOUSE
LLWVP	LLW TREATMENT
	LOW SOURCE TERM
MUB	MECHANICAL UTILITY BUILDING
OSB	OPERATIONS SUPPORT BUILDING
RCE	REGULATED TWRS COMPLEX ENTRY
SERV/STOR	SERVICE/STORAGE
SGB	SWITCHGEAR BUILDING/ TRANSFORMER PAD
SHIP/RECV'G	SHIPPING/RECEIVING BUILDING
WHSE	WAREHOUSE

NOTE:

1. 200 ACRES DISTURBED AREA FOR SITE ARRANGEMENT.

U.S.DEPARTMENT OF ENERGY

EXTENSIVE SEPARATIONS ALTERNATIVE WITH LLW GLASS SITE PLAN

1:3000

TWRS EIS
CALCULATION COVER SHEET

DISCIPLINE & TITLE Engineering / Closure - Borrow Site Requirements and Affected Areas - Changes due to Revised Waste loading.

ORIGINATOR C. Henderson DATE 1/30/95

REVISION NO. 0

OBJECTIVE For the Ex Situ Alternatives that involve LAW disposal - Calculate the change in borrow requirements and the new Area disturbed to accommodate the new LAW Vaults

METHODOLOGY Using the revised Vault Areas scale the changes in borrow material for the barriers.

ASSUMPTIONS Noted

(Continue on another sheet if necessary)

SIGNATURE

Checked by PDW 2-13-96

CALCULATION & RESULTS ATTACHED

JACOBS\FORMS\CALCVR.SHT

Table 5-3B. Comparison of Alternatives by Barrier Construction Resource Requirements (Units as Indicated). NEW BASE CASE

Construction Resource	In Situ Disposal	Extensive Pretreatment Option A	Extensive Pretreatment Option B	No Separations	~~Tri-Party Agreement Preferred Alternative~~ INT. SEPARA
Land (ha) surface committed[1]					
Temporarily	20	24	24	20	24
Permanently	17	~~25~~	64	17	25
Water (m^3) [2]	38,000	72000 ~~57,000~~	145,000	38,000	72000 ~~57,000~~
Source of water					
Energy					
Electrical (GWh) [3]	n/a	n/a	n/a	n/a	n/a
Propane (m^3)	n/a	n/a	n/a	n/a	n/a
Diesel fuel (m^3) [4]	45,000	72000 ~~60,000~~	142,000	45,000	72,000 ~~59,000~~ 70200
Gasoline (m^3) [5]	260	420 ~~350~~	830	260	420 ~~350~~
Materials					
Concrete (m^3)	0	0	0	0	0
Steel (t)	0	0	0	0	0
Asphalt (m^3)	62,500	97,000 ~~81,600~~	164,000	62,500	97,000 ~~80,700~~ 25200
Excavation (m^3) [6]	0	0	0	0	0
Soil (m^3) [7]	377,000	645,000 ~~535,000~~	1,320,000	377,000	645,000 ~~526,000~~
Riprap (m^3) [8]	638,000	931,000 ~~809,000~~	1,480,000	638,000	931,000 801,000
Gravel/sand (m^3) [9]	415,000	744,000 ~~615,000~~	2,250,000	415,000	744000 ~~598,000~~
Waste debris	0	0	0	0	0
Waste water	0	0	0	0	0
Sewage	0	0	0	0	0

NOTE THE ORIGINAL BARRIER ESTIMATES for the Intermediate Separations and extensive separations were Based on 46 VAULTS not 40
The new Requirement is for 83 Vaults ⇒ the ratio is 83/46 = 1.8
so the VAULT Related barrier requirements should go up by a factor of 1.8.

NOTE: No SEPARATIONS = Barriers over the tank farms only, TPA & Extensive Pretreat equal Barriers over TANKS + Vaults. Changes due to increases in vault size are Calculated as: INT Sep = No Sep + (INT Sep - No Sep) 1.8

EXT Pretreat = No Sep + (EXT Sep - No Sep) 1.8

Table 5-3B. Comparison of Alternatives by Barrier Construction Resource Requirements (Units as Indicated).

Construction Resource	In Situ Disposal	Extensive Pretreatment Option A	Extensive Pretreatment Option B	No Separations	~~Tri-Party Agreement Preferred Alternative~~ COMBO
Land (ha) surface committed[1]					
Temporarily	20	24	24	20	~~24~~
Permanently	17	25	64	17	~~25~~
Water (m^3) [2]	38,000	57,000	145,000	38,000	55,000 ~~57,000~~
Source of water					
Energy•					
Electrical (GWh) [3]	n/a	n/a	n/a	n/a	n/a
Propane (m^3)	n/a	n/a	n/a	n/a	n/a
Diesel fuel (m^3) [4]	45,000	60,000	142,000	45,000	59,000 ~~59,000~~
Gasoline (m^3) [5]	260	350	830	260	340 ~~350~~
Materials					
Concrete (m^3)	0	0	0	0	0
Steel (t)	0	0	0	0	0
Asphalt (m^3)	62,500	81,600	164,000	62,500	80,000 ~~80,700~~
Excavation (m^3) [6]	0	0	0	0	0
Soil (m^3) [7]	377,000	535,000	1,320,000	377,000	511,000 ~~526,000~~
Riprap (m^3) [8]	638,000	809,000	1,480,000	638,000	785,000 ~~801,000~~
Gravel/sand (m^3) [9]	415,000	615,000	2,250,000	415,000	584,000 ~~598,000~~
Waste debris	0	0	0	0	0
Waste water	0	0	0	0	0
Sewage	0	0	0	0	0

NOTE THE EXSITU INSITU COMBINATION ALTERNATIVE LAW VAULT AREA IS 1/2 OF the Modified OR New Base Case INTERMediate SEPARATIONS alt. The No SEPARATIONS ALT Resources represent Tank farm barriers only & therefore the requirements for the Combo alt = No Sep + 1/2 (INTERMediate Sep − No Sep)

Table 5-3B. Comparison of Alternatives by Barrier Construction Resource Requirements (Units as Indicated).

Construction Resource	In Situ Disposal	Extensive Pretreatment Option A	Extensive Pretreatment Option B	No Separations	~~Tri-Party Agreement Preferred Alternative~~ Phased Imp (Total Alt)
Land (ha) surface committed[1]					
Temporarily	20	24	24	20	24
Permanently	17	25	64	17	25
Water (m^3) [2]	38,000	57,000	145,000	38,000	72000 ~~57,000~~
Source of water					
Energy					
Electrical (GWh) [3]	n/a	n/a	n/a	n/a	n/a
Propane (m^3)	n/a	n/a	n/a	n/a	n/a
Diesel fuel (m^3) [4]	45,000	60,000	142,000	45,000	72000 ~~59,000~~
Gasoline (m^3) [5]	260	350	830	260	420 ~~350~~
Materials					
Concrete (m^3)	0	0	0	0	0
Steel (t)	0	0	0	0	0
Asphalt (m^3)	62,500	81,600	164,000	62,500	97000 ~~80,700~~
Excavation (m^3) [6]	0	0	0	0	0
Soil (m^3) [7]	377,000	535,000	1,320,000	377,000	645000 ~~526,000~~
Riprap (m^3) [8]	638,000	809,000	1,480,000	638,000	931000 ~~801,000~~
Gravel/sand (m^3) [9]	415,000	615,000	2,250,000	415,000	744000 ~~598,000~~
Waste debris	0	0	0	0	0
Waste water	0	0	0	0	0
Sewage	0	0	0	0	0

the BARRIER Requirements for the Phased Implementation Alt are the SAME as the Intermediate Separations Alt

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	317,000 (1.1E+07)	Pit 30
Ex Situ No Separations - Vitrification - Calcination	 Aggregate Aggregate	 123,000 (4.4E+06) 123,000 (4.4E+06)	 Pit 30 Pit 30
Ex Situ Extensive Separations	Aggregate	372,000 (1.3E+07)	Pit 30
Ex Situ/In Situ Combination	Aggregate	410,000 (1.5E+07)	Pit 30
Phased Implementation (Phase 1 only)	Aggregate	12,000 (4.3E+05)	Pit 30
Phased Implementation (Phase 2)	Aggregate	159,000 (5.7E+06)	Pit 30

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	354,000 ~~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 645,000 Riprap 931,000 Aggregate/Sand 744,000	~~530,000~~ (~~1.9E+07~~) 2.3E+07 ~~805,000~~ (~~2.9E+07~~) 3.2 ~~606,000~~ (~~2.2E+07~~) 2.7	McGee Ranch Vernita Quarry Pit 30
Ex Situ/In Situ Combination	Silt 511,000 Riprap 785,000 Aggregate/Sand 580,000	~~436,000~~ (~~1.6E+07~~) 1.9 ~~400,000~~ (~~1.7E+07~~) 2.1 ~~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

2.1E7

700,000

490,000

The change in temporary land impacts at the borrow sites due to the changes in waste loading → bigger LAW VAULTS → Larger Barriers → More Borrow.

IN SITU Alternatives = No Change.

EX SITU INT. SEPARATIONS. + EXTENSIVE SEP + PRESENT IMP.

McGEE Area = $\frac{645000\ m^3}{3m\ depth} = 2.15E5\ m^2 \times \frac{1\ ha}{10{,}000\ m^2} = 22\ ha.$

McGee Area = 22 ha total

Old McGee = 18 ha the increase = 4 ha.

Pit 30 = $\frac{744000\ m^3}{3\ m} \times \frac{1}{10000} = 25\ ha.$

OLD Pit30 Reqmt = 20 ha ⇒ Increase = 5 ha.

Vernita Area = $\frac{931000\ m^3}{3} \times \frac{1}{10000} = 31\ ha$

Old Vernita Area = 27 ha. ⇒ Increase = 4 ha

COMBINATION ALT.

McGee = $\frac{511{,}000}{3} \times \frac{1}{10^4} = 17\ ha$ OLD = 15 ⇒ Increase = 2

Vernita = $\frac{785000}{3} \times \frac{1}{10^4} = 26\ ha$ OLD = 16 ha ⇒ Increase = 10 ha

Pit 30 = $\frac{580000}{3} \times \frac{1}{10^4} = 19\ ha$ OLD = 23 Increase = −4 ha.

TWRS EIS
CALCULATION COVER SHEET

DISCIPLINE & TITLE Engineering / Change in interim Storage AND DISPOSAL Vault Areas for the Intermediate Separations Alt.

ORIGINATOR Colin Henderson DATE 1/29/96

REVISION NO. 0

OBJECTIVE Calculate the additional Area Required For Intermediate Separations based on lower Waste loading and smaller Canister size

METHODOLOGY noted

ASSUMPTIONS noted

(Continue on another sheet if necessary)

J Col Hend
SIGNATURE

Checked by ADW 2-13-96

CALCULATION & RESULTS ATTACHED

JACOBS\FORMS\CALCVR.SHT

Based on the Revised Waste loading and higher Volumes of HLW AND LAW the two areas of HLW interim Storage and LAW disposal VAULT AREA WILL INCREASE.

For The INTERMEDIATE SEPARATIONS Alternative the New Volumes are:

HLW = 33386 CANISTERS / 8350 HMPC's

LAW = 83 disposal VAULTS @ 5300 m^3 each.

The additional LAW vaults require an additional 69160 m^2 of Area

INTERIM HLW STORAGE REQUIRES ~ 2.5m x 2.5m per shielded HMPC.

CURRENT LAYOUT HAS 64800 m^2 storage Space

REQUIRED STORAGE SPACE IS:

Space = 8350 HMPCs x 6.25 m^2 x 110%

= 57400 m^2

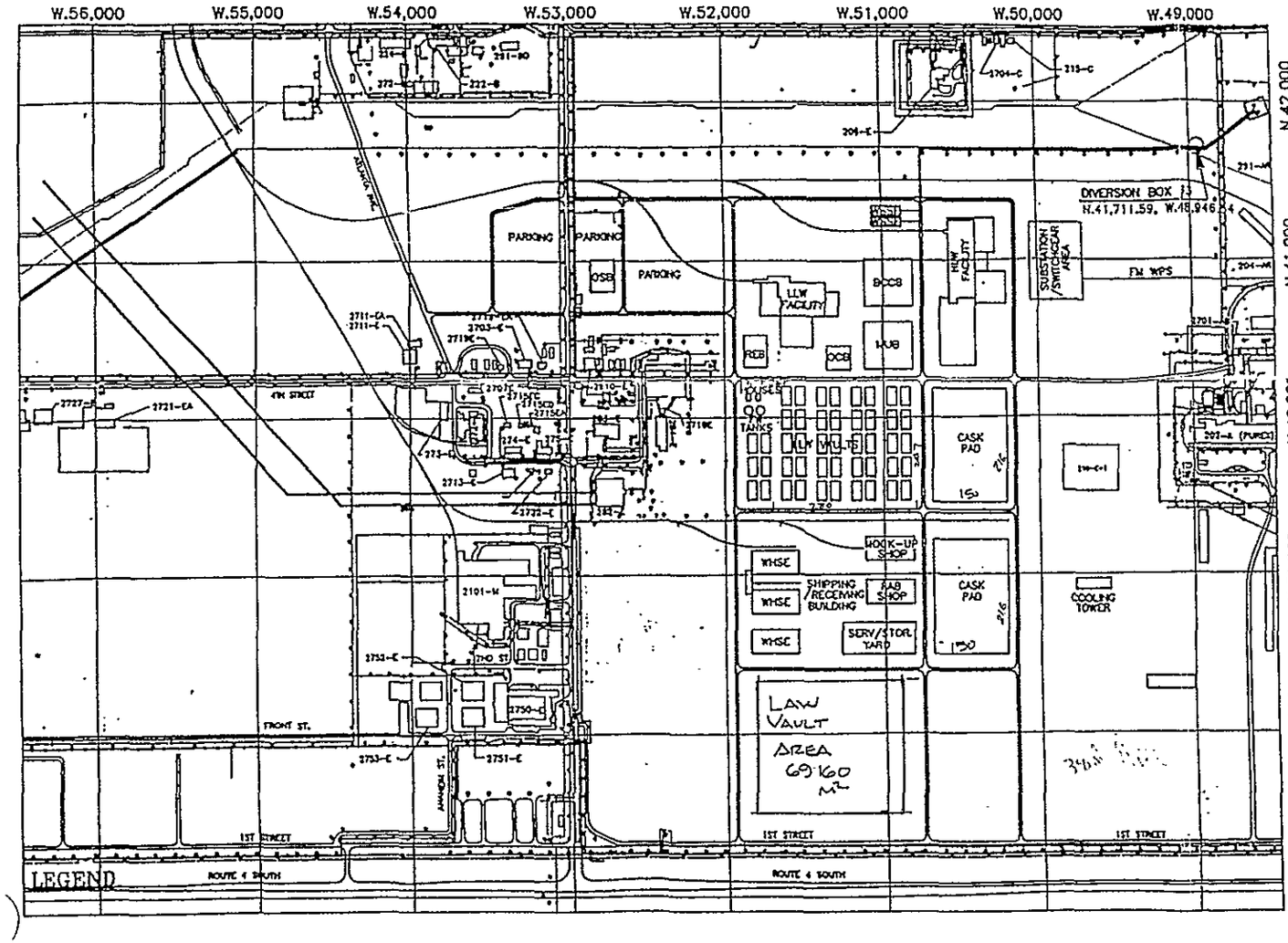
⇒ EXISTING PAD AREA IS ADEQUATE FOR INTERIM STORAGE of HLW

Note the existing (Rev 0 data pkg) Provides

64800 m^2 / 1700 HMPC ≐ 38 m^2 / HMPC

which is sufficient to ALLOW storage of the HMPCs on their side. With the higher number of canisters the HMPC's would have to be placed on the pad with the canister in an upright orientation. (Similar to Assumption made for No SEPARATIONS)

Figure 8-1. Site Plan.



200 EAST AREA

LEGEND

BOCB	BULK HANDLING & COLD CHEMICAL MAKE-UP BUILDING
FAB	FABRICATION
FW	FIREWATER
HLW	HIGH LEVEL WASTE VITRIFICATION
LLW	LOW LEVEL WASTE VITRIFICATION
MUB	MECHANICAL UTILITIES BUILDING
OCB	OPERATIONS CONTROL BUILDING
OSB	OPERATIONS SUPPORT BUILDING
REB	REGULATED ENTRANCE BUILDING
WSSF	WASTE STAGING AND SAMPLING FACILITY
SERV/STOR	SERVICE/STORAGE
WHSE	WAREHOUSE

CASE 8A EIS

247 m/in.

U.S. DEPARTMENT OF ENERGY

FLUOR DANIEL INC. ADVANCED TECHNOLOGY DIVISION

EIS
TPA PREFERRED ALTERNATIVE
SITE PLAN

ES-ALT8A-03 | 2

8-3/8-4

TWRS EIS
CALCULATION COVER SHEET

DISCIPLINE & TITLE Engineering / Change in Interim Storage for HLW & LAW Vault Areas for the Ex Situ/In Situ Combination alt & Phased Imp. Alt

ORIGINATOR Colin Henderson DATE 1/30/96

REVISION NO. 0

OBJECTIVE Calculate the additional Area required for the Combination and Phased Imp. Alternatives based on Lower waste loading

METHODOLOGY noted

ASSUMPTIONS noted.

(Continue on another sheet if necessary)

Checked by FGW 2-13-96

SIGNATURE

CALCULATION & RESULTS ATTACHED

JACOBS\FORMS\CALCVR.SHT

The Additional Area required for Interim HLW Storage and LAW disposal vaults for the Ex Situ/In Situ Combination alternative.

Based on the Calc for the Intermediate Separations Alternative the Interim storage Pad provided would be sufficient providing the HMPC's are stored onend. Thus no change in HLW interim storage pad.

The number of LAW disposal Vaults will go from 20 to 42 due to the revised waste loading and the 1.25 blending factor.

This would require an additional

69160 x 1/2 = 35000 m^2 of Area.

(from Int Sep Calc)

Phased Imp.

The Area required for interim HLW storage for the Phased Implementation Phase I would not change from current projections.

The ~~total~~ Phased Implementation alternative would have the same Area requirements as the Intermediate Separations alternative.

Interim HLW Storage Area of 64800 m^2
Low Vault Area = 147,000 m^2

TWRS EIS
CALCULATION COVER SHEET

DISCIPLINE & TITLE Engineering / Change in interim Storage Requirements for No Separations With Revised Waste Loadings & 0.62 m³ Canisters

ORIGINATOR Colin Henderson DATE 1/29/96

REVISION NO. 0

OBJECTIVE Calculate the new Area required for interim HLW Storage and Layout Required Area On site plan

METHODOLOGY Calc New Area Using the revised quantities of HMPCs.

ASSUMPTIONS No Separations would use the 0.62 m³ Canisters, and place 4 Canisters in an HMPC for onsite Storage.

(Continue on another sheet if necessary)

J.C. Henderson
SIGNATURE

Checked by R. Dickson 2-13-96

CALCULATION & RESULTS ATTACHED

JACOBS\FORMS\CALCVR.SHT

Based on the New Waste Loading AND Higher Volumes of HLW and LAW the two Areas that will affect the temporary and permanent land use Commitments will be the interim onsite Storage requirements for HLW, the increase in number of LAW VAULTS, and the additional SURFACE Area of LAW DISPOSAL that will require A Hanford barrier.

1) NO SEPARATIONS VITRIFICATION:

OLD CASE 3 INTERIM STORAGE PADS.

2@ 139m x 525m

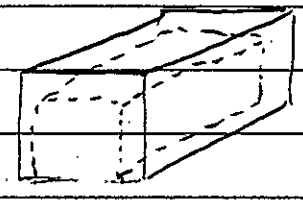
1@ 139m x 292m

HMPC 5m long x 2m dia.

The Concrete Shielding Casks are 90.7 mt/cask (No Sep. Pg 6-8 Fig 9)

$\rho_{concrete} \approx 2.3$ mt/m³

Volume Concrete / Shielding Cask $= \frac{90.7}{2.3}$ m³ $= 39.4$ m³.



Add .3m to HMPC for Clearance

INSIDE of BOX is then 5.3m x 2.3m

let t = wall thickness in m

then Volume $= 3 \times [(5.3+2t) \times (2.3+t) \times t]$
$+ [(2.3+2t) \times (2.3+t) \times t] \times 2$

$= 3 [(12.2 + 5.3t + 4.6t + 2t^2) t]$
$+ [(5.29 + 2.3t + 5.29t + 2t^2) t] 2$

$= 36.6t + 15.9t^2 + 13.8t^2 + 6t^3 + 10.58t + 4.6t^2 + 10.58t^2 + 4t^3$

$= 47.18t + 44.88t^2 + 10t^3 = 39.4 m^3$

$\Rightarrow 10t^3 + 44.88t^2 + 47.18t - 39.4 = 0$

t is $\approx 0.5 m$

foot print of a shielding Cask is then $\approx$ 3m x 3m with the casks standing on end.

x check Old Numbers 21,400 Canisters x $9 m^2$ = $192600 m^2$

Area of pads scaled from dwg = 187000

The New Requirement for No Separations will then be 146856 HMPC's

Assume that a thinner walled shielding cask would be used such that the footprint was 2.5m x 2.5m then the Area Req for interim storage is:

146900 HMPC x 2.5^2 = $920,000 m^2$

Add 10% to allow some spacing

No Sep. Vit. Area Required = $1.012 \times 10^6 m^2$

Increased New Area = $875,400 m^2$ FOR VITRIFICATION

CALCINATION. 38687 HMPC x $(2.5m)^2$ = $241,800 m^2$ x 1.1 = 266,000

OLD Requirement was $\approx$ ½ No Sep Vit = ½(186,600) = $93300 m^2$

$\Rightarrow$ Increase = $172,700 m^2$ for CALCINATION

The Interim Storage Requirement for No Separations is then:

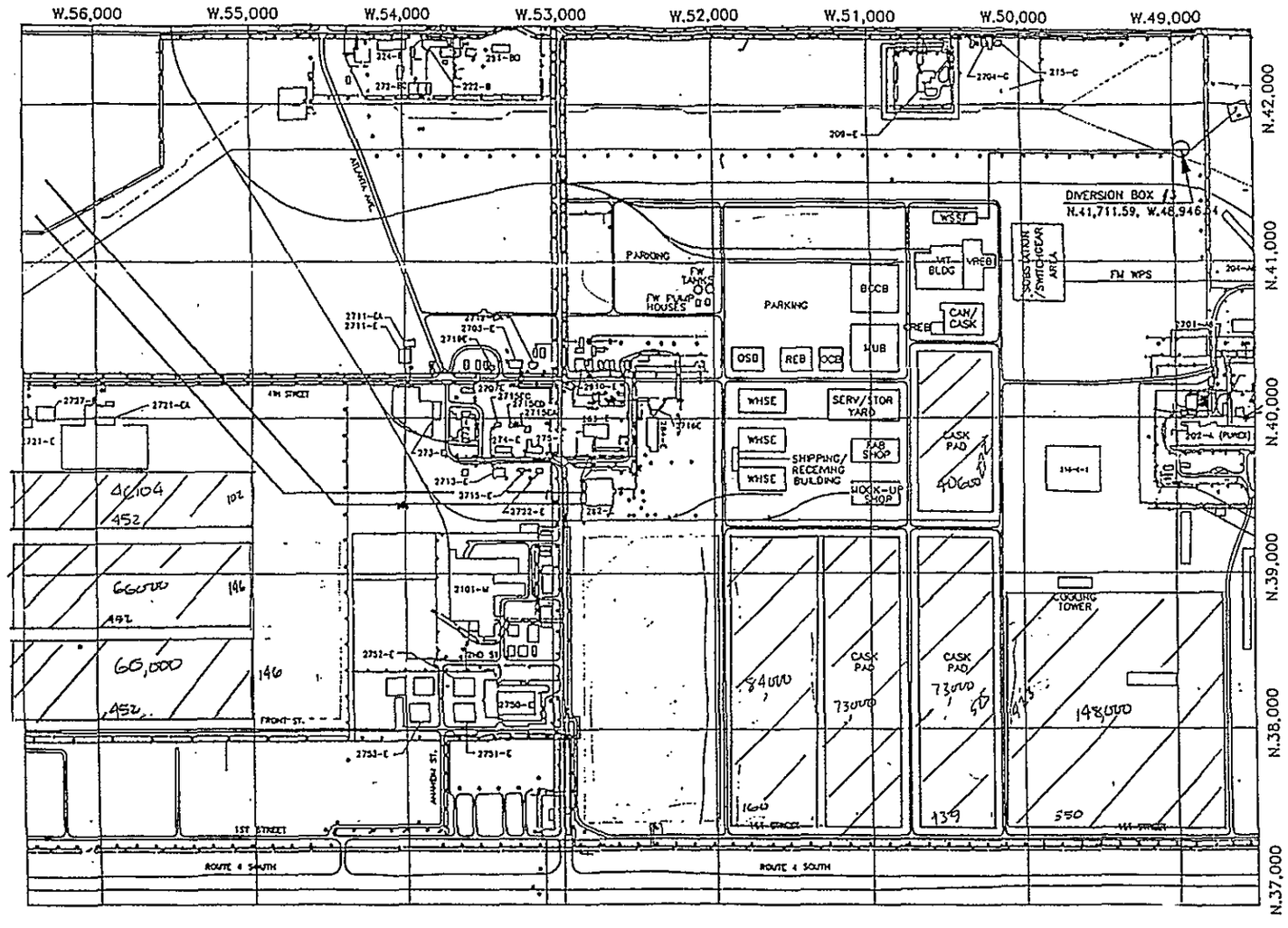
Vitrification = 1.012×10^6 m^2
this is an increase of 825400 m^2.
83 ha

Calcination = 266,000 m^2
this is an increase of 172,700 m^2
17.27 → 18 ha

The total delta between No Sep Vit & No Sep Calcination is

$1.012 \times 10^6 - 266{,}000 = 746000$
$= \underline{75 \text{ ha}}$

Figure 5-2. Site Plan.



LEGEND

BCCB	BULK HANDLING & COLD CHEMICAL MAKE-UP BUILDING
CAN/CASK	CASK/CANISTER FACILITY
CREB	CASK/CANISTER REGULATED ENTRANCE BUILDING
FAB	FABRICATION
FW	FIREWATER
MUB	MECHANICAL UTILITIES BUILDING
OCB	OPERATIONS CONTROL BUILDING
OSB	OPERATIONS SUPPORT BUILDING
RCB	REGULATED ENTRANCE BUILDING
WSSF	WASTE STAGING AND SAMPLING FACILITY
SERV/STOR	SERVICE/STORAGE
VIT BLDG	VITRIFICATION BUILDING
VRCB	VITRIFICATION REGULATED ENTRANCE BUILDING
WHSE	WAREHOUSE

200 EAST AREA

(730,704 m²)

INTERIM HLW Storage.

233.5 m/in

CASE 8A EIS

U.S.DEPARTMENT OF ENERGY

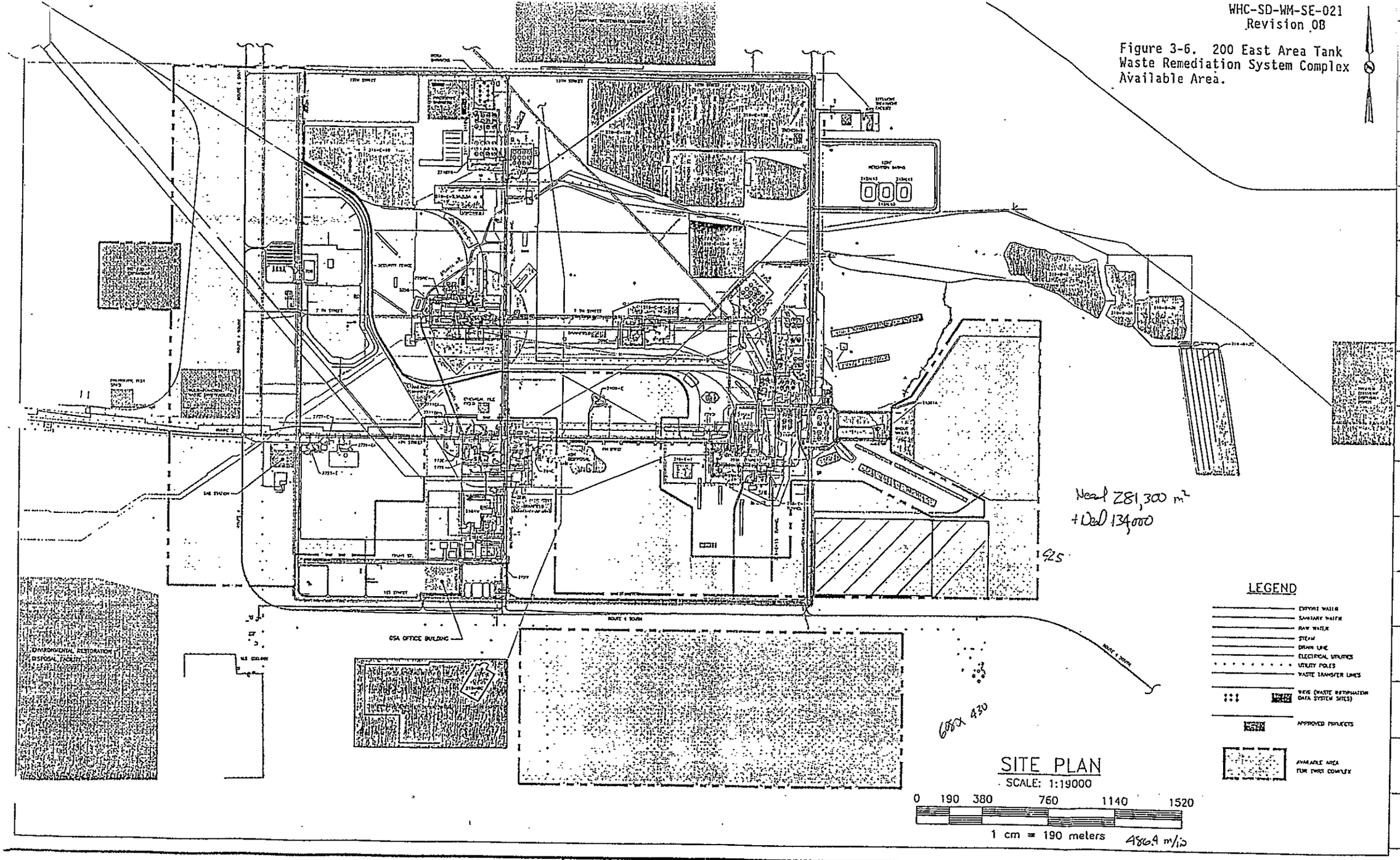
FLUOR DANIEL INC. ADVANCED TECHNOLOGY DIVISION

EIS
NO PRETREATMENT
SITE PLAN

ES-ALT8A-03

5-5/5-6

Figure 3-6. 200 East Area Tank Waste Remediation System Complex Available Area.



NOTE: THIS MAP IS FOR REFERENCE ONLY. DO NOT USE FOR CONSTRUCTION OR ENGINEERING PURPOSES.

ICF KAISER HANFORD COMPANY
MAPPING SERVICES

CADFILE: ZRBT0343	CUSTOMER: AL SHORD	TITLE: 200 EAST TWRS COMPLEX AVAILABLE AREA	3-11/3-12
DATE: 1-3-95	DRAWN BY: RAFAEL TORRES		

TWRS EIS
CALCULATION COVER SHEET

DISCIPLINE & TITLE ENGINEERING / UTILIZATION of the CROSS-SITE TRANSFER line during waste Retrieval

ORIGINATOR Colin Henderson DATE 2/10/96

REVISION NO. 0

OBJECTIVE Calculate the Average number of hours that the XSITE, TRANSFER LINE would be used

METHODOLOGY Noted

ASSUMPTIONS Noted

(Continue on another sheet if necessary)

SIGNATURE

checked by PGW 2-13-96

CALCULATION & RESULTS ATTACHED

JACOBS\FORMS\CALCVR.SHT

JACOBS ENGINEERING GROUP INC.

DATE 2/8/96 SUBJECT SHEET NO.

BY CH. CHKD. JOB NO.

WASTE RETRIEVAL & TRANSFER ACTIVITIES.

OPS. FOR INTERMEDIATE SEPARATIONS RETRIEVAL = 2001/2024 = 23 yrs.

200 WEST TANK FARMS

DSTs = SY

SSTs = T, TX, TY, U, S, SX

SY = 870 + 1738 = 2608 ← DST

T = 43 + 1986 = 2029 SST

TX = 5 + 7004 = 7009 ↓

TY = 3 + 635 = 638

U = 168 + 3382 = 3550

S = 58 + 5452 = 5510

SX = 63 + 4362 = 4425

25569 Kgal (FROM HANLON 1995 TABLE E-4)

AT a 3:1 DILUTION THE VOLUME TO BE TRANSFERRED ACROSS SITE = 25569 x 4 = 102,276 kgal

at a 4:1 DILUTION VOLUME = 5 x 25569 = 127845 kgal.

LINE IS 3 in ϕ

TRANSFER Velocity = 4.5 - 6 ft/sec

FROM CRANE Q = 100 - 138 GPM.

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	LOW TIME	HIGH TIME
Volume	102276 kgal	127845 kgal
Q	138 GPM	100 GPM
No. Months	276	276
Minutes/Month	2685	4632
Hours/Month	45 hrs.	77 hrs. ←

JACOBS ENGINEERING GROUP INC.

DATE _____ SUBJECT _____ SHEET NO. _____

BY _____ CHKD. _____ JOB NO. _____

The Replacement Crossite Transfer Line Design Parameter Assumptions

Line size 3" dia.

Solids Transfer Capability 0 - 33% Vol %

Design Velocity 4.5 - 6 ft/sec (Suitable for Solids Transfer)

Design Pressure 1200 psi (Max Pressure 1500 psi)

Particle size: up to 4000 micron

In 200 West there would be:

2 Waste transfer annexes with

1 Waste Staging and Sampling facility with 6-100,000 gal tanks

- Wastes would be batched thru the X site transfer line in ~~as large~~ batches as large as possible to minimize secondary waste generation.

- Assumptions included:
  a) Waste Staging and Sampling Facility would condition the retrieved waste to achieve the required solids size and concentration.
  b) Design Parameters used for the RCSTS would provide the capability to transfer SST & DST wastes including solids slurry.

FORM 01.005.1 (4/81)

FAX COVER SHEET

Date: February 29, 1996

Page 1 of 3 Pages (Coversheet included)

Fax Number To:	Fax Number From:
736-7504	373-6594
Name:	**Name:**
Colin Henderson	John Guberski
Phone Number/Location:	**Phone Number/Location:**
736-0616	376-5084/2750/A-123
Organization:	**Organization:**
Jacobs Engineering	TFTP Environmental Compliance

Message

Here are details on W-058, Cross site transfer.

A-5000-865 (01/92) WEF189

3.3 RANGE OF OPERATION

~~The primary and secondary containment piping and all system components shall be designed to transfer tank wastes with the following characteristics:~~

RCS equipment shall be designed such that the following velocities can be achieved for wastes with the corresponding parameters shown below. Actual transfer velocity will be determined by the cognizant engineer before each transfer, based on waste characterization.

	Design parameters	
Achievable design velocity	4.5 ft/s	6.0 ft/s
Specific gravity	1.5	1.25
Viscosity	30.0 cP	10 cP
Solid content	30.0 displacement vol%	20.0 displacement vol%
Miller number	<100	<100
Minimum pH (Harris 1992)		
Transfers/flushes	11.0	11.0
Temperature		
Transfers/flushes	35 to 200 °F	35 to 200 °F
Insulation	Required	Required
Particle size*	0.5 to 4,000 μm	0.5 to 4,000 μm
Friction factor	0.0404 (non-Newtonian)	Newtonian flow

ΔP for Booster 1200 or 1500 depending on Sp Gr.

3.4 PIPING

The pipeline system shall consist of pipe-in-pipe transfer lines in a routing configuration as shown in Figure 1-2. The pipe-in-pipe transfer lines shall comply with the secondary containment requirements in WAC 173-303-400; WAC 173-303-640; and DOE Order 6430.1A, *General Design Criteria* (DOE 1989).

The primary piping shall be 304L stainless steel and the encasement piping shall be carbon steel (Parsons 1994). The piping components shall be chemically compatible with the alkaline radioactive mixed liquid waste listed in Appendix A. The system also shall be designed with a 230 psi relief valve to prevent overpressurization of the existing connecting transfer line network. Pump 102-SY will be capable of supplying 140 gal/min and 20 ft of net positive suction head to the suction of the Project W-058 booster pump(s).

All pipe and pipe fittings outside the diversion boxes and other boxes are to (1) be joined with welds, (2) be provided with the capability for periodic pressure tests, and (3) have water flush capabilities. Piping within the boxes may be joined via jumpers, welds, or mechanical means, ~~except national pipe thread connections~~ as required for transfer flexibility and ease of maintenance. ~~However, National Pipe Thread connections shall not be used~~

*0- to 50-μm particles will comprise approximately 95% of total.
50- to 500-μm particles will comprise <5% of total.
500- to 4,000-μm particles will comprise <1% of total.

3-2

Post-it® Fax Note 7671
To Colin Henderson
Co./Dept.
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Fax #

3.4 PIPING

The pipeline system shall consist of pipe-in-pipe transfer lines in a routing configuration as shown in Figure 1-2. The pipe-in-pipe transfer lines shall comply with the secondary containment requirements in WAC 173-303-400; WAC 173-303-640; and DOE Order 6430.1A, *General Design Criteria* (DOE 1989).

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The system shall be designed and constructed to minimize the settling of solids in the pipes, pipe fittings, or other piping components during and after the batch transfers. The system also shall be designed such that the

Table 3-1. Design Parameters.

Achievable design velocity*	4.5 ft/s	6.0 ft/s
Specific gravity (mixture)	1.5	1.25
Viscosity	30.0 cP	10 cP
Solid content	30% solids volume fraction	20% solids volume fraction
Miller number		
Minimum pH (Harris 1992)	<100	<100
Transfers/flushes		
Temperature	11.0	11.0
Transfers/flushes		
Insulation	35 to 200 °F	35 to 200 °F
Particle size**	Required	Required
Friction factor	0.5 to 4,000 μm 0.0404 (non-Newtonian)	0.5 to 4,000 μm Newtonian flow

*Achievable design velocity is the theoretical velocity at which the pumped materials with the characteristics shown in this table can be transferred. It is not intended or implied that these velocities are the optimal transfer velocities for waste with the given characteristics.

**0- to 50-μm particles will comprise approximately 95% of total.
50- to 500-μm particles will comprise <5% of total.
500- to 4,000-μm particles will comprise <1% of total.

ΔP = 740-1220 for booster

TWRS EIS
CALCULATION COVER SHEET

DISCIPLINE & TITLE Engineering - Selective Retrieval Costs

ORIGINATOR D. Murray DATE 5/25/95

REVISION NO. Ø 1 C.#.

OBJECTIVE Develop Costs for Selective Retrieval

METHODOLOGY Proportion Costs from Engineering Data Packages

ASSUMPTIONS Attached (on 1/19)
Revised for November DEIS.

(Continue on another sheet if necessary)

David J. Murray
SIGNATURE

CALCULATION & RESULTS ATTACHED

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JACOBS ENGINEERING GROUP INC.

DATE 5/24 SUBJECT Sective Retrieval Costs SHEET NO. 1/19

BY MM CHKD. JOB NO. 01K47101

Objective: Use the data from the WHC packages to develope costs for selective retrieval

From Selective Retrieval paper

Tank Type	# Retrieved	# In Situ
SST	60	89
DST	10	18

So for SSTs, 40% Retrieved, 60% In Situ

and for DST's 35% Retrieved 65% In Situ

Now look at cost components for Retrieval & Transfer, TPA, and Grave Fill

A. Retrieval & Transfer

References Tables 5-13, 5-14 & Backup to 5-13

Assumption: Overall schedule doesn't change, but operating rate is slower (capacity less) This won't affect transfer, since it is governed by hydraulic considerations. Staffing will be less to operate a plant with lesser capacity.

1. SST's

Retrieval, build 40% of arms, sluicing and confinement. Transfer, cap cost unchanged, op cost, unchanged. R&D cost unchanged, barriers - omit

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DATE 5/24/95 SUBJECT Selective Retrieval Costs SHEET NO. 2/19

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

SST Cost $millions

Retrieval	Cap	Op	R+D	Total
Arms	113	428	57	598
Sluicing	232	197	29	458
Confinement	235	350	29	614
Transfer	408	1528	20	1956
Total:	988	2503	135	3626

2 DST's

Retrieval, build 35% of mixer pumps & sluicing transfer, costs unchanged, R+D unchanged

DST Cost $millions

Retrieval	Cap	Op	R+D	Total
Mixer Pumps	321	88	46	455
Sluicing	17	15	2	34
Transfer	0	458	0	458
Total	338	561	48	947

3 MUST's - No Change

Retrieval	Cap	Op	R+D	Total
Sluicing	39	33	2	74
Transfer	23	69	1	93
Total	62	102	3	167

Overall Total	1388	3166	186	4740

JACOBS ENGINEERING GROUP INC.

DATE 5/24/95 SUBJECT Selective Retrieval Costs SHEET NO. 3/19

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

B. TPA

References: Table 9-17 & F.11

Capital: Overall retrieval is 70 tanks out of 177, or 40%. Using 6/10's rule

Cap $ = $(0.4)^{0.6} \times 3{,}640 = 2{,}100$

Operating = $0.4 \times 3880 = 1550$

R&D (unchanged) = 630

Repository = $0.4 \times 1750 = 700$

Total 4980

C. Gravel Fill

Capital = $0.6 \times 148.25 = 89$

Operating = $0.6 \times 471 = 283$

R&D (unchanged) = 10

Total 382

D. Closure Activities

TPA: Tank & Equip Stab; (Gravel Fill) Barrier Const, Tank & Vault Mon; (Grout Fill)

In Situ Barrier Const, Monit

JACOBS ENGINEERING GROUP INC.

DATE 5/25/95 SUBJECT Selective Retrieval Costs SHEET NO. 4/19

BY [illegible] CHKD. _____ JOB NO. 01K4701

Reference Table 5-9 (Replacement)

1. For TPA w/ gravel tank fill, the total capital cost is 0.4 × 169.4 = 67.8

2. For In Situ Dry & Fill, the total capital cost is 0.6 × 115.5 = 69.3

3. Total = 137.1

For M&M, round the numbers from Table 5-10 of data pkg to 1 million

Summary Table
$ Millions 1995

Cost Component Continued Ops	R&T	TPA	In Situ	Closure	Total 8600
Capital ①	1388	2100	89	137	3714
Operating ②	3166	1550	283	0	4999
M&M	0	Note 2	Note 2	1	1
D&D	0	Note 2	Note 2	0	Note 2
R&D	186	~~630~~ 670	~~70~~ 0	0	~~826~~ 856
Repository Fee	0	~~700~~ 3706	0	0	~~700~~ 3706
Total	4740	4980	382	138	~~10,240~~ 21,876

① Includes 30-40% contingency
② Includes start-up, D&D, and M&M

Table 5-13. Comparison of Alternatives by Process Module for Retrieval and Transfer: (Millions of 1995 Dollars)[1].

Process Module	No Disposal Action	In Situ Disposal	Extensive Pretreatment	No Separations	TPA Preferred Alternative
SST retrieval	$0	$0	$2,508	$2,508	$2,508
SST confinement	$0	$0	$1,492	$1,492	$1,492
SST waste transfers	$0	$0	$1,956	$1,956	$1,956
SST subsurface barriers	$0	$0	$768	$768	$768
DST retrieval	$2,198	$0	$1,306	$1,213	$1,306
DST waste transfers	$272	$0	$458	$344	$458
MUST retrieval	$0	$0	$74	$74	$74
MUST waste transfers	$0	$0	$93	$93	$93
Total	$2,470	$0	$8,657	$8,466	$8,657

Note:

DST = double-shell tank
MUST = miscellaneous underground storage tanks
SST = single-shell tank
TPA = Tri-Party Agreement

[1]For basis of estimate, see Appendix A, Backup to Table 5-13, Overall Retrieval Costs for no action alternative.

5/19

Table 5-14. Comparison of Alternatives by Overall Cost Component for Retrieval and Transfer (Millions of 1995 Dollars).

Cost Component	No Disposal Action	In Situ Disposal	Extensive Pretreatment	No Separations	TPA Preferred Alternative
Capital[1]	$1,930	$0	$3,270	$3,270	$3,270
Operating[2]	$440	$0	$5,180	$4,990	$5,180
Research and Development[3]	$100	$0	$210	$210	$210
Total	$2,470	$0	$8,660	$8,470	$8,660

Notes:

TPA = Tri-Party Agreement

[1]For basis of capital cost estimate, see Table 5-15.

[2]For basis of operating cost estimate, see Table 5-16.

[3]Research and development cost is estimated as 5 percent of capital cost.

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Backup to Table 5-13. Overall Retrieval Costs for Tri-Party Agreement and Extensive Separations Alternatives (2 sheets).

Tanks	Cap Cost Millions	Operating Staff Hours	Op. Cost Millions	M&M Cost Millions	R&D Cost Millions	Total Cost Millions
SSTs						
Retrieval						
Arm-based	$283	13,514,932	$1,069	$0	$57	$1,408
Sluicing	$579	6,224,163	$492	$0	$29	$1,100
Confinement						
Arm-based	$587	11,080,075	$876	$0	$29	$1,492
Sluicing	$0	0	$0	$0	$0	$0
Barriers	~~$390~~	~~4,540,061~~	~~$359~~	~~$0~~	~~$20~~	~~$768~~
Transfer						
Pipeline	$408	19,329,408	$1,528	$0	$20	$1,956
Container	$0	0	$0	$0	$0	$0
SST Total =	$2,247	54,688,639	$4,324	$0	$155	~~$6,725~~ 5956
DSTs						
Retrieval						
Mixer pumps	$916	3,172,608	$251	$0	$46	$1,213
Sluicing	$48	541,987	$43	$0	$2	$93
Transfer						
Pipeline	$0	5,798,822	$458	$0	$0	$458
DST Total =	$964	9,513,418	$752	$0	$48	$1,764
MUSTs						
Retrieval						
Sluicing	$39	421,546	$33	$0	$2	$74

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Backup to Table 5-13. Overall Retrieval Costs for Tri-Party Agreement and Extensive Separations Alternatives (2 sheets).

Transfer Container	$23	870,998	$69	$0	$1	$93
MUST Total =	$62	1,292,544	$102	$0	$3	$167
Retrieval =	$3,273	65,494,600	$5,177	$0	$207	$8,657

Notes:

DST = double-shell tank
MUST = miscellaneous underground storage tank
SST = single-shell tank

As indicated in Section 5.0, the values in these tables are imported from spreadsheet calculations. The number of significant figures shown does not imply level of accuracy or degree of confidence in the estimated values.

See Notes to Backup Table 5-6 Construction Staff Hours for capital cost basis.

See Table 5-1 and Table 5-16 for operating cost staff hours and basis.

D&D cost basis is included in operating cost, and is based on entombment in place, per the Hanford Mission Plan, DOE/RL-93-102.

Operating cost includes startup cost.

Retrieval R&D cost is assumed to be 5 percent of retrieval capital cost, except R&D cost for arm-based SST retrieval includes additional $43 million for SST retrieval test facility.

Boomer, K. D., et al., 1993, *Tank Waste Technical Options Report*, WHC-EP-0616, Rev. 0, Westinghouse Hanford Company, Richland, Washington.

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

Cost Component	Tri-Party Agreement Preferred Alternative
Capital	3,600[1]
Operating	3,900[2] 7,500
Research and development	630[3]
Repository fee	1,750
~~Other related costs~~	~~8,600[4]~~
Total	~~$18,500~~ 9880

Notes:

[1]Total capital cost includes 40% contingency. Contingency is excluded from other costs.

[2]Includes start-up, decontamination and decommissioning, and monitoring and maintenance costs.

[3]Pg. 130 of Boomer 1994, which was based on a draft of the *Tank Waste Remediation System Multi-Year Program Plan* (MYPP) (WHC 1994).

[4]Other related costs are costs defined in the MYPP that should be included in the total costs, but are not directly related to operations. These costs are:

Program management	$1,180
Operations and maintenance	4,290
Tank farm safety	440
Tank farm upgrades	1,720
Characterization	933
Total	$8,563

Round to $8,600 million. These costs are taken as total unescalated costs from the MYPP.

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.

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

F.11 Backup for Table 9-16

Table F-36. Total Cost by Unit Operation.

	Construction	Labor	Equipment	Materials and Supplies			Low-Level Vaults	HLW Canisters	Research and Development	Repository Fee	Totals
				Start-up	D,and,D	Operations					
Sludge wash	$43	$129	$6	$2	$12	$6			$9		$207
Cesium removal	$380	$276	$54	$21	$105	$56			$83		$975
Centralized facilities	$520										$520
LLW vitrification	$1,300	$624	$170	$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		$24									$24
HLW disposal								$239		$1,750	$1,989
Total	$3,643	$1,708	$308	$173	$850	$373	$225	$239	$630	$1,750	$9,900

3640

Notes:

Table values are in millions of 1995 dollars.

3880

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.Table 7-17. Comparison of Alternatives by Overall Cost Component (Millions of 1994 Dollars).

Cost Component	In Situ Chemical Stabilization	Drying and Gravel Fill	In Situ Vitrification
Capital[1]	4,300	~~150~~ 148	4,700
Operating[2]	4,200	~~3,000~~ 471	4,800
Monitoring/maintenance (after closure)[3]	n/a	n/a	n/a
Research and development[4]	--	10	67
Total	8,500	~~3,200~~ 629	9,600

Notes:

[1]Capital cost - See Table 7-18

[2]Operating cost - See Table 7-19

[3]Monitoring and maintenance costs are provided in the *Closure Technical Data Package for the Tank Waste Remediation System Environmental Impact Statement* (Scanlon et al. 1995).

[4]Radio frequency drying will require two years of research and development at $5 million per year, based on engineering judgement.

The in situ vitrification option will require seven years of research and development at a total cost of $67 million. This is an escalated Pacific Northwest Laboratory estimate shown in PNL-7499 (Koegler 1990).

Koegler, S. L., 1990, *Underground Tank Vitrification Project Plan*, PNL-7499, Pacific Northwest Laboratory, Richland, Washington.

Scanlon, P. L., H. Hampt, W. A. Skelly, 1995, *Closure Technical Data Pakcage for the Tank Waste Remediation System*, Draft, Westinghouse Hanford Company, Richland, Washington.

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Table 7-18. Comparison of Alternatives by Capital Cost Component (Millions of 1994 Dollars).

Capital Cost Component	In Situ Chemical Stabilization[1]	Drying and Gravel Fill[2]	In Situ Vitrification[3]
Labor	2,600	~~1~~ 5	2,800
Materials/Supplies	1,450	~~11~~ 13	1,550
Equipment	20	~~110~~ 111	50
Local Purchases	260	~~21~~ 19	280
Total	4,300	~~150~~ 148	4,700

Notes:

[1]Tables M4-5 (Stabilization by Grout Capital Cost) and F7-7 (Tank Farm Confinement Capital Cost) of the *Tank Waste Technical Options Report* (Boomer et al. 1993) were used as a basis.

In Situ Chem Stab:

242-A Evaporator

Capital cost = 0

Tank Farm Confinement Facility

Labor	= $2,600 million
M/S	= $1,700 million
Equipment	= $0
{Local purchases	= 0.15(M/S + Equipment)}
Total	= $4,300 million

Grout mixing

Labor	= $ 5.6 million
M/S	= $13 million
Equipment	= $21.5 million
{Local purchases	= 0.15 (M/S + Equipment)}
Total	= $40 million

[2]SD-WM-TI-111 Rev 1 (Higley 1985), was used as a basis for one radio frequency drying system. Forty-five systems are used. Table M5-5 (Stabilization by Gravel Capital Cost Estimate) of the *Tank Waste Technical Options Report* was used as a basis for the Gravel Fill estimate.

242-A Evaporator

Capital cost = 0

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Table 7-18. Comparison of Alternatives by Capital Cost Component (Millions of 1994 Dollars).

Notes: (Continued)

Drying & Gravel Fill

Radio Frequency Drying

Labor	= $0
M/S	= $0
Equipment	= ~~$121~~ 105 million
{Local purchases	= 0.15(M/S + Equipment)} = 16
Total	= $121 million[3]

M/S + Eq + .15(M/S+Eq) = 121

~~M/S~~ + Eq = 121/1.15 = 105

Eq = 105

Gravel Fill

Labor	= $ 5.4 million
M/S	= $13 million ? typo?
Equipment	= $ 6.4 million
{Local purchases	= 0.15 (M/S + Equipment)} = 3
Total	= $25 million[3]

[3]Tables M9-4 (In Situ Vitrification Capital Cost Summary modified to include sand excavation) and F7-7 (Tank Farm Confinement Capital Cost) of the *Tank Waste Technical Options Report* were used as a basis.

ISV:

242-A Evaporator

Capital cost	= 0

TFCF

Labor	= $2,600 million
M/S	= $1,700 million
Equipment	= $0
{Local purchases	= 0.15 (M/S + Equipment)}
Total	= $4,300 million

In Situ Vitrification

Labor	= $163 million
M/S	= $123 million
Equipment	= $ 64 million
{Local purchases	= 0.15 (M/S + Equipment)}
Total	= $350 million

Boomer, K. D., S. K. Baker, A. L. Boldt, J. D. Galbraith, J. S. Garfield, C. E. Golberg, B. A. Higley, L. J. Johnson, M. J. Kupfer, R. M. Marusich, R. J. Parazin, A. N. Praga, G. W. Reddick, E. J. Slaathaug, L. M. Swanson, T. L. Waldo, C. E. Worcester, 1993, *Tank Waste Technical Options Report*, WHC-EP-0616, Westinghouse Hanford Company, Richland, Washington.

Higley, B. A., 1985, *Hanford Defense Waste environmental Impact Statement Working Papers - Existing Tank Waste*, SD-WM-TI-111 Rev. 1, Rockwell Hanford Operations, Richland, Washington.

14/19

Table 7-19. Comparison of Alternatives by Operating Cost Component (Millions of 1994 Dollars). (5 sheets)

Operating Cost Component	In Situ Chemical Stabilization[1]	Drying and Gravel Fill[2]	In Situ Vitrification[3]
Labor	2,100	~~2,700~~ 186	2,600
Materials/Supplies	10	~~28~~ 34	100
Equipment	110	~~33~~ 39	24
Local purchases	20	~~10~~ 11	22
Startup	370	92	430
Decontamination and decommissioning	1,600	~~110~~ 109	1,600
Total	4,200	~~3,000~~ 471	4,800

Notes:

[1]In situ chemical stabilization
242-A Evaporator = 5-year operating life
Total operating cost = $127 million
Annual operating cost = $15 million

Following numbers based on previous operation of 242-A Evaporator:
Labor = 59 Exempt x 130,000 per year = $8 million per year x 5 years = $40 million
60 Nonexempt x 50,000 per year = $3 million per year x 5 years = $15 million
Materials/Supplies = $1 million per year x 5 years = $ 5 million
Equipment (Upgrade cost = $13 million) = $3 million per year x 5 years = $15 million
{Local purchases = 15% of (Materials/Supplies + Equipment)}
Total = $15 million per year = $75 million
Startup = 2 years operating cost
= 2 ($15 million)
= $30 million

Decontamination and decommissioning = 2 years operating labor + 0.3 (capital cost)
= 2 ($11 million) + 0.3(0)
= $22 million

Tank Farm Confinement Facility (TFCF) (Grout) = 2-year operating life
Total operating cost = $2100 million
Annual operating cost = $153 million

Table 7-19. Comparison of Alternatives by Operating Cost Component (Millions of 1994 Dollars). (5 sheets)

Notes: (Continued)

Following numbers based on Tables F7-8 and F7-9 of the *Tank Waste Technical Options Report* (Boomer et al. 1993), modified to include 15-m (48-ft)-dia. dome penetration.

1005
Labor = 239 Exempt x 130,000 per year = $31 million per year x 2 yr = $ 62 million
83 Nonexempt x 50,000 per year = $ 4 million per year x 2 yr = $ 8 million
683 Bargaining units x 90,000 per year = $62 million per year x 2 yr = $124 million
Labor Total = $97 million per year x 2 yr = $194 million

Materials/Supplies
Electricity = 4 E4 kwh x $0.025/kwh = $1,000 per year x 2 yr = $2,000
Equipment = $53 million (1993) x 1.05 = $55.7 million per year x 2yr = $111 million
{Local purchases = 15% of (Materials/Supplies + Equipment)}
TFCF Total = $153 million per year = $305 million

Startup = 2($153 million) = $306 million
Decontamination and decommissioning = 2($97 million) + 0.3($4,300 million) = $1,484 million

Grout Mixing = 2-year operating life
Total operating cost = $100 million
Annual operating cost = $16.5 million

Following numbers based on Tables M4-6 and M4-7 of the *Tank Waste Technical Options Report*, modified to include mixing systems.

Labor
141
36 Exempt x 130,000 per year = $4.7 million per year x 2 yr = $9 million
15 Nonexempt x 50,000 per year = $0.8 million per year x 2 yr = $2 million
90 Bargaining units x 90,000 per year = $8.1 million per year x 2 yr = $16 million
Labor Total = $14 million per year x 2 yr = $28 million

Materials/Supplies
Water (includes potable water for all in situ chemical stabilization personnel) - 1146 people
= 1.2 E6 m³ x $3/m³ = $3,500,000 = 600,000 m³/yr = 523 m³/person·yr
Electricity = 1.6 E6 kwh x $0.025/kwh = $ 40,000
Cement = 7.1 E6 kg x $0.09/kg = $640,000
Flyash = 71.2 E6 kg x $0.04/kg = $2,850,000
M/S Total = $3.5 million per year x 2yr = $7.0 million
Equipment = $643,500 (1993) x 1.05 = $680,000 per year x 2yr = $1.4 million
{Local purchases = 15% of (Materials/Supplies + Equipment)}

Startup = 2($18 million) = $36 million
Decontamination and decommissioning = 2($14 million) + 0.3($40 million) = $40 million

Out

Additional Staffing (includes Program Management, Operations and Maintenance, Tank Safety, Tank Upgrades, and Characterization)
Exempt = 6.1 E3 staff-yrs x $130,000/staff-yr = $790 million
Nonexempt = 1.2 E3 staff-yrs x $50,000/staff-yr = $ 61 million
Bargaining units = 1.0 E4 staff-yrs x $90,000/staff-yr = $940 million
Total = $1,800 million

16/19

Table 7-19. Comparison of Alternatives by Operating Cost Component (Millions of 1994 Dollars). (5 sheets)

Notes: (Continued)

[2]Drying and Gravel Fill

242-A Evaporator = 5-year operating life
Total operating cost = $127 million
~~Annual operating cost = $15 million~~

Following numbers based on previous operation of 242-A Evaporator:
Labor = 59 exempt x 130,000 per year = $8 million per year x 5 yr = $40 million
60 nonexempt x 50,000 per year = $3 million per year x 5 yr = $15 million } 55
Materials/Supplies = $1 million per year x 5 yr = $ 5 million
Equipment (Upgrade cost = $13 million) = $3 million per year x 5 yr = $15 million
~~(Local purchases = 15% of (Materials/Supplies + Equipment))~~
Total = $15 million per year = $75 million 75/5 = 15

Startup = 2 years operating cost
= 2 ($15 million)
= $30 million

Decontamination and decommissioning = 2 years operating labor + 0.3(capital cost)
= 2 ($11 million) + 0.3(0)
= $22 million

Radio Frequency Drying = 9-year operating life
Total operating cost = ~~$183 million~~ 186
~~Annual operating cost = $12 million~~

93 Labor 13 Exempt x 130,000 per year = $1.7 million per year x 9 yr = $15 million
3 Nonexempt x 50,000 per year = $0.2 million per year x 9 yr = $ 2 million
77 Bargaining units x 90,000 per year = $6.9 million per year x 9 yr = $62 million } 79
Total Labor = $9 million per year = ~~$80 million~~ 79

Materials/Supplies = 29
Electricity = 1.1E8 kwh x $0.025/kwh = $2.8 million per year x 9 yr = ~~$25 million~~ 26
Water (includes potable water for all drying and gravel fill staff) = 224 people
= 1.1 E6 m^3 x $3/$m^3$ = $370,000 per year x ~~9 yr~~ = $ 3 million
$3/$m^3$ = $0.01/gal (1¢/gal)
Equipment = 0
~~(Local purchases = 15% of (Materials/Supplies + Equipment))~~
Total = $12 million = $108 million
Startup = 2($12 million) = $24 million
Decontamination and decommissioning = 2($9 million) + 0.3($121 million) = $54 million

Gravel Fill = 4-year operating life
Total operating cost = $147 million
Annual operating cost = $19 million

$224 \text{ people} \times 9 \text{ yrs} \times \frac{523 m^3}{\text{person} \cdot \text{yr}} = 1.05 \times 10^6 m^3$
$\times \$3/m^3 = \$3$ million - checks

17/19

Table 7-19. Comparison of Alternatives by Operating Cost Component (Millions of 1994 Dollars). (5 sheets)

Notes: (Continued)

131 Labor 47 exempt x 130,000 per year = $6.1 million per year x 4 yr = $24 million
14 nonexempt x 50,000 per year = $0.7 million per year x 4 yr = $ 3 million
70 Bargaining units x 90,000 per year = $6.3 million per year x 4 yr = $25 million
Total Labor = $13 million per year = $52 million 52

Materials/Supplies = 0
Electricity = 5E4 kwh x $0.025/kwh = $1250 per year x 4 yr = $ 0 million
Equipment = $6 million per year x 4 yr = $24 million
{Local purchases = 15% of (Materials/Supplies + Equipment)}
Total = $19 million = $76 million

Startup = 2 ($19 million) = $38 million
Decontamination and decommissioing = 2($13 million) + 0.3($24 million) = $33 million

Continuing Opns - Don't Include

Additional Staffing (includes Program Management, Operations and Maintenance, Tank Safety, Tank Upgrades, and Characterization)

Exempt = 8.8 E3 staff years x $130,000/staff years = $1,100 million
Nonexempt = 1.8 E3 staff years x $50,000/staff years = $ 88 million
Bargaining units = 1.5 E4 staff years x $90,000/staff years = $1,100 million
Total = $2,500 million

[3]In Situ Vitrification
242-A Evaporator = 5-year operating life
Total operating cost = $127 million
Annual operating cost = $15 million

Following numbers based on previous operation of 242-A Evaporator:
Labor = 59 exempt x 130,000 per year = $8 million per year x 5 yr = $40 million
60 nonexempt x 50,000 per year = $3 million per year x 5 yr = $15 million
Materials/Supplies = $1 million per year x 5 yr = $ 5 million
Equipment (Upgrade cost = $13 million) = $3 million per year x 5 yr = $15 million
{Local purchases = 15% of (millionaterials/Supplies + Equipment)}
Total = $15 million per year = $75 million

Startup = 2 years operating cost
= 2 ($15 million)
= $30 million

Decontamination and decommissioning = 2 years operating labor + 0.3(capital cost)
= 2 ($11 million) + 0.3(0)
= $22 million

Vitrification = 5-year operating life
Total operating cost = $2400 million
Annual operating cost = $110 million per year

Table 7-19. Comparison of Alternatives by Operating Cost Component (Millions of 1994 Dollars). (5 sheets)

Notes: (Continued)

Following numbers based on Tables M9-5 and M9-6 of the *Tank Waste Technical Options Report*.
Labor 292 exempt x 130,000/year = $38 million per year x 5 yr = $190 million
131 nonexempt x 50,000/year = $ 7 million per year x 5 yr = $ 35 million
437 Bargaining units x 90,000/year = $39 million per year x 5 yr = $195 million
Labor Total = $84 million per year = $420 million

Materials/Supplies
Water (includes potable water for all in situ vitrification staff)
= 1.2 E6 m^3 x $3/$m^3$ = $3.6 million

Electricity	= 4.4 E9 kwh x $0.025/kwh = $110 million
Limestone	= 1.1 E7 kg x $0.09/kg = $990,000
Propane	= 1.1 E7 kg x $0.02/kg = $220,000
Ammonia	= 6.8 E5 kg x $0.38/kg = $260,000
M/S Total	= $23 million per year x 5yr = $115 million
Equipment	= $2.4 million (1993) x 1.05 = $2.5 million per year x 5yr = $ 12.5 million
Total	= $110 million per year = $545 million

Startup = 2($110 million) = $220 million
Decontamination and decommissioning = 2($84 million) + 0.3($4650 million) = $1563 million

Additional Staffing (includes Program Management, Operations and Maintenance. Tank Safety, Tank Upgrades, and Characterization)

Exempt	= 7.2 E3 staff years x $130,000/staff years = $ 930 million
Nonexempt	= 1.4 E3 staff years x $50,000/staff years = $ 72 million
Bargaining units	= 1.3 E4 staff years x $90,000/staff years = $1,100 million
Total	= $2,100 million

Boomer, K. D., S. K. Baker, A. L. Boldt, J. D. Galbraith, J. S. Garfield, C. E. Golberg, B. A. Higley, L. J. Johnson, M. J. Kupfer, R. M. Marusich, R. J. Parazin, A. N. Praga, G. W. Reddick, E. J. Slaathaug, L. M. Swanson, T. L. Waldo, C. E. Worcester. 1993. *Tank Waste Technical Options Report*, WHC-EP-0616, Westinghouse Hanford Company, Richland, Washington.

Table 5-9 Comparison of Alternatives by Capital Cost Component ($millions, 1995) 19/19

Capital Cost Component	In Situ Disposal	Extensive Pretreatment Option A Grout/Gravel	Extensive Pretreatment Option B Grout/Gravel	No Separations Grout/Gravel	Tri-Party Agreement Preferred Alternative Grout/Gravel
Labor	$29.5	$52.1/$58.1	$97.9/$104	$42.7/$48.7	$51.6/$57.6
Materials & Supplies	$28.5	$42.9/$37.4	$81.1/$75.6	$34.1/$28.6	$42.5/$37.0
Equipment	n/a	$0.25/$0.35	$0.25/$0.35	$0.25/$0.35	$0.25/$0.35
Local Purchases	$57.5	(3) ~~$43.5/$35.1~~	$130/$121	(1) $82.9/$74.5	(2) ~~$42.5/$34.1~~ 123.3/114.
TOTAL	$115.5	~~$139/$131~~ 178.1/170.3	$309/$301	$160/$152	~~$137/$129~~ ~~[illegible]~~ 177.2/169.4

122.3/113.9

Replacement Table.

Notes

(1) Minimum Cost for Ex-Situ Alt

(2) Costs cant go down for TPA. It appears that 40.4 was subtracted instead of added. So add 40.4 to ~~TPA~~ No Sepns local purchases, making them 123.3/114.9 for TPA

(3) Same must be done for Ext Spns, Option A. $\Delta = 39.4$ in this case.

TWRS EIS
CALCULATION COVER SHEET

DISCIPLINE & TITLE ENGINEERING - Calculation of DATA Revisions FOR DRAFT TWR-ETS

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

JE JACOBS ENGINEERING GROUP INC.

DATE 2-15-96 SUBJECT SHEET NO. 7 of 37

BY PDW 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. 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

B Table II - Number trips or Cars from above 05

2. Calculate trip combinations for Mike Harker's tables.

A. ExSitu Intermediate Separations alternative 07
B. ExSitu No Separations alternative - Vitrification 08
C. ExSitu No Separations alternative - Calcination 10
D. ExSitu Extensive Separations alternative 11
E. ExSitu / 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. ExSitu Intermediate Separations 25
B. ExSitu No Separations - Vitrification 26
C. ExSitu No Separations - Calcination 27

JACOBS ENGINEERING GROUP INC.

DATE 2-15-96 SUBJECT SHEET NO. 2 of 37

BY RDU 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

FORM 91.006.1 (6/83)

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
(yd^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 (yd^3)	3.5E+05	2.18E+05	2.92E+04	3.38E+05	1.297E+05	2.59E+05
4c Gravel (yd^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 (mT)	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 (mT)	1.26E+05	NA	NA	1.26E+05	5.35E+04	1.66E+05
Prefab Shapes (Tons)	1.4E+05	NA	NA	1.39E+05	5.89E+04	1.17E+05
8 Stainless Steel (mT)	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 Forms (mT)	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 (yd³) Sand (0.816) (0.1837)	2.244E+05	2.334E+05	NA	5.712E+05	1.102E+05	2.1E+05
9b (tons) other material	42435	44088	NA	108383	20814	40414
5* Concrete (yd³)	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	3.31E+05	6.64E+05
5b Sand (yd³)	4.94E+05	9.58E+06	1.21E+06	1.06E+04	2.46E+05	4.94E+05
5c Gravel (yd³)	4.94E+05	9.58E+06	1.21E+06	1.06E+04	2.46E+05	4.94E+05

FORM 01.005 (4/84)

JACOBS ENGINEERING GROUP INC.

DATE 2-15-96 SUBJECT SHEET NO. 4 of 37

BY RDW CHKD. JOB NO. 014470101

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. Oligomer, (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. 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.

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 01.005.1 (4/89)

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	20 Tons/load TRUCK	SEATTLE Portland.	18 800	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 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	502 000	67 200	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 $4.2 m^3$ Prefab shapes bottle	20 ton TRUCK	Seattle Portland	7000	NA	NA	6950
8.	Stainless steel Prefab $0.62 m^3$ cylinder	20 ton truck	Seattle Portland	2425	24200	4470	66
9.	Glass former	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 TANKCAR	Seattle PORTLAND	59	NA	NA	165
c.	Oligomer	20 ton TRUCK	SEATTLE PORTLAND	131	NA	NA	371

FORM 01 205 2 (1/89)

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 (4/91)

JACOBS ENGINEERING GROUP INC.

DATE 2-15-96 SUBJECT SHEET NO. 7 of 37

BY PDW CHKD. JOB NO. 01K4701

Calculate the number of various trips 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 prefab 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 = 2425

Σ = 12150 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

Sosolan = 3

Diesel fuel = 186

Kerosene = 2144

Σ = 2333 Trips/yr = 2333/14 = 123

Σ for Table entry = 5200 + 123

= 5.3 E+03 trips/yr

FORM 91-005-1 (4/91)

JACOBS ENGINEERING GROUP INC.

DATE 2-15-96 SUBJECT SHEET NO. 8 of 37

BY RAW CHKD. JOB NO. 01K47101

5 Processing offsite truck trips / yr. period = 19 years.

Glassformer/chemicals = 2122

Sulfur = 4449

oxygen = 14320

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) + (5200)

= 5.3 E+03

7. offsite rail glassformer chemicals

DCPD = 59

trips/yr = 59/19 = 4

Σ for Table entry = (260) + (4) = 264

= 2.64 E+02

8. Trips to yucca mountain = 8.35 E+02

B. Ex Situ No Separations alternative - vitrification

1. on site Borrow trips

Sand = 36334

gravel = 36334

total = 72668

Σ for Table entry = (7.27 + E04) + (2.02 E+04)

= 9.29 E+04

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JE 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 Materials = 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

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JACOBS ENGINEERING GROUP INC.

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BY RDW CHKD. JOB NO. 01K47101

C Ex Site no separations alternative - Calculation

1. onsite truck Borrow Site Trips

Sand = 4867

Gravel = 4867

total = 9734

E for Table entry = (9734) + (20200)

= 29934

= 3.0 E+04

2. offsite truck Trip cities

Concrete prefab Shapes = 16797

Diesel fuel = 3200

total = 19997 = 2.0 E+04

E 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

E 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

E for Table entry = (779) + (50)

= 8.29 E+02

5. offsite rail - no change.

6. offsite Rail - Yucca mountain = 2.71E+03

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BY RDW CHKD. JOB NO. 01K 47101

D. Ex Situ Extensive separations alternative

1. onsite truck Borrow site Trips

load = 56334
travel = 56334
total = 112668

Σ for Table entry = (1.13 E+05) + (6.10 E+04)
= 1.74 E+05

2. offsite truck tri cities trips

gasoline = 3
diesel fuel = 1214
Concrete prefab shapes = 143
Reagents = 7420
total = 8780

Σ for Table entry = (8780) + (27000)
= 35780
= 3.58 E+04

3 offsite truck portland/Saddle 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 glass formers/chemicals

oxygen = 20400
other materials = 5420 Trip/year period = 19
sulfur = 12489
DAP = 371
total = 38680 trips/year = 2036

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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 Soil

Dcpd = 165

Trips/yr = 165/19 = 9

E for table entry = (9) + (637)
= 6.46 E+02

7. offsite Soil - 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 Prof. Shapes = 3222

total = 10182

E for Table entry = (10182) + (14500)
= 2.47E+04

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BY RDW CHKD. JOB NO. 01K47101

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.

glass former / Chemicals

oxygen = 7160 period = 19

other materials = 1041

Sulfur = 2267

oligomer = 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

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BY RDW CHKD. JOB NO. 01K47101

7. offsite Rail glass former chunks

DCOD = 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 I - 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

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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

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JACOBS ENGINEERING GROUP INC.

DATE 2-15-96 SUBJECT SHEET NO. 16 of 37

BY RDW. CHKD. JOB NO. 01K47/01

To provide information on the sensitivity of the processes 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 pages 2 and 3 above have been computed and are tabulated in the following Table, Table III for the sensitivity evaluation using the three cases numbered and defined above on page 16.

JACOBS ENGINEERING GROUP INC.

DATE 2-15-96 SUBJECT

BY RDW CHKD.

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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 H base formers	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 (0.1837)	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	3.25E+05	4.07E+05
	Tons	260700	357500	447700

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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 cases 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.

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JACOBS ENGINEERING GROUP INC.

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BY RAW CHKD.

SHEET NO. 19 of 37

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 TON/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 mobile crane 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	—	20075	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	5052	6325
10. Process chemicals	20 ton/Load + truck	Seattle Portland	23485	28325	32835
a Oxygen (Liquid	20 ton truck	Seattle Portland	10428	14300	17908
11 Sulfur Cement					
a Sulfur	45,000 Liter tank truck	Seattle Portland	7872	12805	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

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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 hazard 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

Σ for table entry = (20234) + (52000)
= 72234 = 7.22 E+04

2. off site concrete truck

Portland cement = 3260
Concrete prefab shapes = 2470
Total = 5730

Σ for table entry = (5730) + (29000)
= 34730
= 3.47 E+04

3 off site truck steel

Carbon steel rebar = 277
Carbon steel shapes = 3505
Stainless steel shapes = 715
total = 4497

Σ for Table entry = (4497) + (9500)
= 13997
= 1.4 E+04

4 off site miscellaneous Truckal materials.

Gasoline = 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

tank = 24386

= 1284 trips/year

Σ for table entry = (1284) + (5200)

= 6484 = 6.5E+03

7 offsite rail glassformers/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 = 416

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BY RDW CHKD. JOB NO. 01K 47101

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

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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 glassformers 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

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BY RDW CHKD. JOB NO. 01K 47101

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 Hazardous Chemicals trips/yr.

Other materials = 6325

oxygen = 17908

Sulfur = 13543

oligomer = 399

Total = 38175 trips/yr = 2010

Σ for Table entry = (2010) + (23)

= 2033 = 2.03E+03

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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)(8.10E+02) Km S/P = 8.00E+02 Km

= 47200 TC = 1.40E+02 Km

b. Yucca portland (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

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BY RDW CHKD. JOB NO. 01K 47101

Closure Sand and Gravel = (1.5 − 1.36) E+06 m³
= 0.14 E+06 m³
= (1.4 E+05) (1.31) = 1.834 E+05 yds³

6 cu yd Dump Truck = 30567 Trips

Borrow Site Silt = (6.45 − 5.26) E+05) = 1.19 E+05 m³
= (1.19 E+05)(1.31) = 1.56 yds³ E+05
= 156000
= 26000 trips

Borrow Site Basalt = (9.31 E+05) − (8.05 E+05) = 1.26 E+05 m³
= (1.26 E+05)(1.31) = 165060 yds³
= 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. Exhibit 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

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BY RDW CHKD. JOB NO. 01K47101

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 Tons Cost on Site cost off site = 53654

Tri cities = 146528 Tons 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 In 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

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BY RDW CHKD. JOB NO. 01K47101

Σ for Table entry = (- - - - -) + (5.93E+06)

Cost on Site = 1.01E+07 Km

Cost off Site = 6.03E+06 Km

b. Off site

Tri cities = 19997 Cost off site Cost on site = 3200

Seattle Portland = 84975 Cost on site Cost off site = 17775

Cons Cost on site – Seattle Portland = (84975)(800) = 6.8E+07 Km

Cons 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. Critical Extension Separations alternative

1. Rail Transport Distance, Km

a. Off site

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

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Borrow Site Silt = (6.45 - 5.35) = 1.10 E+05 m^3
= 1.44 E+05 yd^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. Exhibit/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 cu yd truck = 18559 trips

Borrow site silt = 5.11 − 4.36 = 7.5 E+04 m^3
= 9.825 E+04 yds^3
6 cu yd truck = 16375 trips

Σ of trips = 160168 trips (= 78168)
at 10 Km/trip = 1601680 Km (= 781680) Km
= 1.60 E+06 Km covers cast on site (= 7.82 E+05 Km) covers 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 (covers 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 = 3.0 E+07 — Cast off site = 1.74 E+07

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Σ for Table entry = (2.77E+07) + (----)

cost on Site = 5.77E+07 Km ; Cost off Site = 41.51E+07 Km

Σ 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

Cover cost on Site	Cover cost off Site
Sand = 43167	Sand = 43167
gravel = 43167	gravel = 43167
Sand = 82334	
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 Cover = (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 Onsite = 8.01E+06 Km Offsite

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b. off site truck distance km.

Tri cities = 21136 trips (-6645 if shape coil on site)

Seattle Portland =

Cement = 13960 trips (+26560 if shape cast on site)

Steel = 8462 trips

Glass other = 2021 trips

oxygen = 14320 trips

sulfur = 4107 trips

oligomer = 131 trips

	cast on site	cast 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
	= 5.77E+07 Km	= 3.74E+07 Km

Σ for table Entry = (2.98 E+07) + (- - - - -)

= 8.75E+07 Km = 6.72E+07 Km

d. Compare these values in table B.10.0.7 to the values obtained from the transportation mileage accident analyses sheets.

1. Ex site intermediate separations alternative.

a. offsite rail transport, Km

Table cast on site	Table cast 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	1.50E+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 site no separations alternative - vitrification

a. offsite rail transport, Km

4.5 E+07	4.5 E+07	6.4 E+07

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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 extraction separations alternative

a. offsite rail transport km

8.55 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 combination 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

4.75 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

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Develop verification for number of rail cars per trip etc for better defense of rail transport mileage analysis.

Glass formers	WCH data Package		
B_2O_3	5.75E+04 Mg		
Fe_2O_3	1.4E+01 Mg		
Li_2O_3	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 AN/LAN	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
FESA	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		

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Hydroxylamine nitrate	9.5E+1 mg		
SPW glass,			
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 SPW 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)

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Based on calculational estimate above there are two rail trips per month for a total of 48 Trips year

add the construction number of 10 Trips per year

a total would equal 58 Trips 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.

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The Westinghouse Document Table 9-7 for the extensive separations alternative lists 637 Trains per year in support of processing. Each train consists of 20 cars.

Cars per year = (20)(637) = 12740 Cars/year

Incremental material = DCPD = (1.12E+04) − (4.46E+03) in tons
= 6.74E+03 in tons = 7.41E+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.

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Sheet B-1
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	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	5.45E+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	~~9.546~~	~~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	~~3.334~~	5.20E+03	1.40E+02	1.95E+01	1.42E+07		
		~~6.7E+03~~	5.3E+03				Total	1.46E+07
Offsite Rail		~~3.22E+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
			7.64E+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
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			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	~~1.46E+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+04	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
		~~3.00E+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
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			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		~~3.97~~ E+04	trips	km/trip		total		
	borrow	~~[illegible]~~	2.02E+04	1.00E+01		2.02E+05	Total	2.02E+05
Offsite Truck		33	trips	km/trip		total		
	Try Cities	34E+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		
	~~1.06E+04~~ 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
			2.10E+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
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		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		1.10E+04	8.00E+02		8.80E+06		
	3.78E+04	7E+04	trips/yr	km/trip	yr			
	miscellaneous		5.20E+03	1.40E+02	9.00E+00	6.55E+06	Total	1.91E+07
Processing								
2.47 E+03 Offsite Truck		2.55 E+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		

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			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		~~2.60E+03~~	1.40E+02	1.00E+01	3.64E+06	Total	9.47E+06
			~~3.15E+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		~~2.60E+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						
		cu → 418						
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?

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	PHASE 1 IMPLEMENTATION SUB-ALTERNATIVE							
	→	no. Changes						
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

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	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	~~1.41E+05~~	~~2.80E+04~~	1.00E+01		2.80E+05	Total	2.80E+05
Offsite Truck		3.63	trips	km/trip		total		
	concrete	~~2.61E+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		

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	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					

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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								

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	INJUR	5.91E+03						
	FATAL	2.63E+01						

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			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	~~1.96E+4~~	~~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	~~[illegible]~~	~~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	~~[illegible]~~	~~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
Connected 20 Trips
8.47E+05 trips
steel
7.3E+03
SS
5.2E+03
2710

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	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				

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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						

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		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	~~1.10~~E+04	8.00E+02		8.80E+06		
			trips/yr	km/trip	yr			
	miscellaneous	6.2	~~5.20~~E+03	1.40E+02	9.00E+00	6.55E+06	Total	1.91E+07
Processing								
Offsite Truck			trips/yr	km/trip	yr	total		
3.2E+04	glassformer/chem		~~5.13E+02~~	8.00E+02	1.60E+01	6.57E+06		
	miscellaneous	6.2	~~5.20~~E+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		

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	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					

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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								

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	INJUR	6.19E+03					
	FATAL	2.54E+01					

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			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 7.30	8.4E+04	~~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		~~1.24E+04~~						
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 2.62		~~1.30E+02~~	8.00E+02	~~1.95E+01~~	2.03E+06	Total	2.03E+06
VITRIFIED HLW TRANSPORT								
Offsite Rail			trips	km/trip		total		
4.18E+04	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		

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	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					

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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								

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	INJUR	3.66E+03						
	FATAL	1.61E+01						

No Change?

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	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

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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					

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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								

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	INJUR	1.55E+03						
	FATAL	5.68E+00						

	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	~~1.57E+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		

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	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					

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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								

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	INJUR	6.01E+03						
	FATAL	2.64E+01						

	1	2	3	4	5	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	19984.8 gallons
Diesel (m^3)	3.51E+03 ~~m^3~~	1.4E+04	6.044E+04	2.3E+04	~~9.22~~ 5.05 E+03	4.78E+03
(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 ~~m^3~~	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+06
Concrete (m^3) (yds^3)	2.67E+05	1.66E+05 ~~2.12E+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	1.59E+05
onsite sand (m^3) (Ton)	4.7E+05	2.92E+05	3.93E+04	4.54E+05	1.74E+05	3.49E+05
onsite 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	2.51E+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	[illegible] 26050	24480		Sand [illegible] 71400	13770	26214
Mg oxide	4.24E4	4.4E4		1.08E5	2.08E4	3.96 ~~5.19~~ E4
Boron 0.1837						
Process oxygen } (MT)	1.34 ~~3.28~~ 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 = (m tons)(1.1) Concrete = 1.6 mg/m^3 (1.1) = Tons

tons = (m^3)(1.76) (1.3)(27)

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Items for Trucking/Railcar

~~Inventory~~

Gasoline
Diesel fuel
Kerosene
Concrete: Cement (tons)
(cubic yds) Sand
(cubic 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

Sulfur
dicyclopentadiene
Oligomer

$$\text{Tons} = m^3 \left(\frac{mg}{m^3}\right)\left(\frac{mT}{mg}\right)\left(\frac{1.1\ \text{Ton}}{mT}\right)$$

$$\text{Tons} = (m^3)(1.6)(1.1) = m^3(1.76)$$

alternatives

1 Ex Situ Intermediate Seps.
2 Ex Situ no Seps vitrif.
3 Ex Situ no Seps Calcine
4 Ex Situ Extensive Seps.
5 Ex Situ/In Situ Combo.
6 phase 2 Implementation phase 2

ITEM	FROM / 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

BAW 25%, 1.25 HLW 40%, 1.5
Sheet B-34
RBW 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	7.21E+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		

Sheet1 LAW - 15%, 1.25; HLW - 20%, 1.5
Sheet B-3
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Sensitivity Case 2

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

 LAW - 10%, 1.25; HLW - 15%, 1.5
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Sensitivity Case 3

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

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	EX SITU INTERMEDIATE SEPARATIONS ALTERNATIVE							
RETRIEVAL								
Waste Transport						total		
Onsite Truck						1.25E+04		
							Total	1.25E+04
Construction								
Offsite Truck			trips/yr	km/trip	yr	total		
	concrete		4.80E+02	1.40E+02	2.00E+01	1.34E+06		
	raw material		4.50E+01	8.00E+02	2.00E+01	7.20E+05		
	equipment		2.50E+01	1.00E+04	2.00E+01	5.00E+06		
	miscellaneous		5.20E+03	1.40E+02	2.00E+01	1.46E+07		
	steel W-314		5.30E+01	8.00E+02		4.24E+04		
	cement W-314		1.00E+02	1.40E+02		1.40E+04	Total	2.17E+07
Offsite Rail			trips/yr	km/trip	yr	total		
	raw material		1.00E+01	8.00E+02	2.00E+01	1.60E+05	Total	1.60E+05
Onsite Truck								
	borrow W-314		1.38E+03	1.00E+01		1.38E+04	Total	1.38E+04
VITRIFICATION								
Construction								
Onsite Truck			trips	km/trip		total		
	borrow	1.17E+05	~~5.20E+04~~	1.00E+01		5.20E+05		
							Total	5.20E+05
Offsite Truck			trips	km/trip		total		
	concrete	5.45E+04	2.90E+04	1.40E+02		4.06E+06		
	steel	1.51E+04	9.50E+03	8.00E+02		7.60E+06		
			trips/yr	km/trip	yr			
	miscellaneous	7.54E0	~~5.20E~~+03	1.40E+02	1.00E+01	7.28E+06		
							Total	1.89E+07
Processing								
2.2E+04 Offsite Truck			trips/yr	km/trip	yr	total		
~~3.11E+04~~	glassformer/chem		~~2.38E+01~~	8.00E+02	1.95E+01	3.59E+05		
	miscellaneous	~~3.33E+04~~	5.20E+03	1.40E+02	1.95E+01	1.42E+07		
		6.7E+03					Total	1.46E+07
Offsite Rail		~~5.22E+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
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		

Number of trips by truck/Rail Sheet 3-38 RDW 2-15-96

Gasoline 5000 gallon truck/tricities (operations)	1	3	5
Diesel 5000 gallon truck/tricities (operations)	118	398	734
Kerosene 5000 gallon truck/tricities (operations)	3802	5,207	5,703
Concrete 6 cu yds/Truck Load.			
Total	199,775	364,617	358,067
Const	118,555	119,865	120,739
operations	77,072	242,350	233,617
closure	4,149	4,149	4149
Carbon steel Truck - 20 Tons/load			
Total	10,725	14960	17,985
Const	5885	5885	5885
operations	3779	8030	11055
Stainless steel 20 Tons/truck load (operations)	715	1381	1837
Glass Formers			
sand 16 yds/Truck/tricities (0.816)	24386	33405	41824
other materials 20 TONS/TRUCK (0.1837)	3688	5052	6325
process Chemicals 20 Tons/truck.	23485	28325	32835
Liquid oxygen at 20 Tons/truck.	13035	17875	22385
Sulfur Cement			
Sulfur 45,000 Lbs/Tank Truck.	7872	10805	13543
DCPD - Dicyclopentadiene 45 Ton/rail tank car	104	142	177
DCP - Oligomer 20 Tons/TRUCK	233	318	399
	LAW - 25% Na_2O Loading	LAW - 15% Na_2O Loading	LAW - 10% Na_2O Loading
NOTE BASED ON TOTAL quantities.	HLW - 40% waste oxide Loading	HLW - 20% waste oxide Loading	HLW - 15% waste oxide Loading

Trips (1) RJW 8-15-96 Sheet B-39

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

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

(2) based on Casting shield Covers on Site.

(3) based on Casting Shield covers off site.

LAW - 25%	LAW - 15%	LAW - 10%
MgO Loading	MgO loading	Loading Mg
HLW - 40%	HLW - 20%	HLW - 15%
Waste oxide	waste oxide	waste oxide
Loading.	Loading.	Loading

Sheet B-40
RDW 2-15-96

Table B.10.0.3 Resourc

Resource	Phase	No Actio Alternati	u tion tive	Ex Situ Intermediate Separations Alternative	Relin 1.7 LAW-15% loading Blend 1.25 HLW-20% loading Blend 1.5	Relin 2.13 LAW-10% Na2O loading Blend 1.25 HLW-15% loading Blend 1.6	R=1.25 LAW-25% Na2O Loading Blend 1.25 HLW-40% loading Blend 1.5
Land, permanently committed (hectares) (Long-term commitment of radiologically contaminated area)	Total	17		40			
	Construction/ Operation	0		7			
	Closure	17		33			
Land, incremental temporarily committed (hectares) (area disturbed during construction and operations)	Total	0		108			
	Construction/ Operation	0		84			
	Closure	0		24			
Borrow Pit Disturbed Area (hectares) based on an excavation depth of 3 meters	McGee Ranch	N/A		21			
	Pit 30	N/A		57			
	Vernita Quarry	N/A		27			
Water, Total (cubic meters)	Sanitary plus Raw Water	1.52E+06		1.47E+07	2.40 E+07	3.5 E+07	1.77 E+07
Water, Sanitary (cubic meters)	Total	N/R		3.6E+06	5.83 E+06	7.16 E+06	4.4 E+06
	Construction	N/R		5.0E+05			
	Operation	N/R		3.1E+06	5.27 E+06	6.60 E+06	3.84 E+06
	Closure	N/R		6.0E+04			
Water, Raw (cubic meters)	Total	1.5E+06		1.07E+07	1.82 E+07	2.78 E+07	1.33 E+07
	Construction	N/A		N/R			
	Operation	1.5E+06		1.07E+07	1.82 E+07	2.78 E+07	1.33 E+07
	Closure	N/A		N/R			
Energy Electricity (Gwh)	Total	1.1E+03		9.07E+03	1.56 E+04	1.93 E+04	1.13 E+04
	Construction	N/A		7.4E+01			
	Operation	1.1E+03		9.0E+03	1.55 E+04	1.92 E+04	1.12 E+04
	Closure	N/A		N/R			
Gasoline (cubic meters)	Total	N/A		8.0E+03	8.0 E+03	8.07 E+03	8.00 E+03
	Construction	N/A		7.6E+03			
	Operation	N/R		N/R	5.46 E+01	77.3 E+00	9.1 E+00
	Closure	N/A		3.9E+02			

Sheet B-41
RDW 2-15-96

Table B.10.0.3 Resource Su

Resource	Phase	No Actio Alternati	Ex Situ Intermediate Separations Alternative	Ratio 1.7	Ratio 2.13	R = 1.25
Diesel (cubic meters)	Total	2.2E+04	8.32E+04	9.49E+04	1.01E+05	8.9E+04
	Construction	N/A	2.1E+04			
	Operation	2.2E+04	1.02E+03	7.53E+03	1.39E+04	2.24E+03
	Closure	N/A	6.62E+04			
Kerosene (cubic meters)	Operation	N/A	5.8E+04	9.86E+04	1.08E+05	7.2E+04
Materials: Concrete (cubic meters)	Total	N/A	7.29E+05	1.67E+06	1.64E+06	9.15E+05
	Construction	N/A	5.4E+05	6.49E+05	5.53E+05	6.43E+05
	Operation	N/A	1.7E+05	~~1.46E+ 1.11E+06 3.06E+05~~	1.09E+06	3.53E+05
	Closure	N/A	1.9E+04			
Carbon Steel (metric tons)	Total	1E+03	1.64E+05	1.78E+05	3.27E+05	1.95E+05
	Construction	N/A	1.07E+05	1.07E+05	1.07E+05	1.07E+05
	Operation	1E+03	N/R	5.16E+04	2.01E+05	6.87E+04
	Closure	N/R	1.9E+04 ??	??	??	?? 3.2E+04
Stainless Steel (mt) TOTAL	Construction	N/A	~~1.4E+04 1.9E+04~~ NR	~~4.41E+04 11.4E+04 2.51E+04~~	~~5.24E+04 1.9E+04 3.74E+04~~	~~1.9E+04 1.3E+04~~
Hastelloy/Inconel (mt)	Construction	N/R	2.3E+03			
Glass Formers (mt)	Operation	N/A	2.94E+05	5.0E+05	6.26E+05	3.65E+05
Process Chemicals (mt)	Operation	N/A	3.81E+05 1.90E+05 *	5.15E+05	5.97E+05	4.27E+05
Bulk sulfur cement	Operation	N/A				
sulfur (mt)			1.30E+05	2.21E+05	2.77E+05	1.61E+05
dicyclopentadine (mt)			3.4E+03	5.78E+03	7.24E+03	4.22E+03
oligomer (mt)			3.4E+03	5.78E+03	7.24E+03	4.22E+03
Ion exchange media (cubic meters)	Operation	N/A	2.2E+02			
Borrow Site Silt (cubic meters)	Closure	N/A	5.26E+05			
Borrow Site Sand and Gravel (cubic meters)	Total	N/A	1.68E+06			
	Construction	N/A	3.17E+05			
	Operation	N/A	N/A			
	Closure	N/A	1.36E+06			
Borrow Site Basalt (cubic meters)	Closure	N/A	8.05E+05			
Asphalt (cubic meters)	Closure	N/A	8.07E+04			

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* Includes Oxygen for Kerosene burning.

Totals this table

		R= 1.0	R= 1.7	R=2.13
		RDS 2-15-96	Sheet B-42	
Gasoline (m^3)	9.1E0 (2402)	NR	54.6	77.3
	gallons		~~26454~~ ~~26455~~ 14414	20407.3
Diesel (m^3)	2.23E3 588720	1.02E+03	7.53E+03	1.39E+04
		269280	1987920	3619600
Kerosene (m^3)	7.2E4 19008000	5.8E+04	9.86E+04	1.08E+05
		15312000	~~60~~ 26030400	28512000
Concrete (m^3)	915E5 ~~7.2E4~~ 1198650 TOTAL	yd^3 → 7.29E+05	1.67E+06	1.64E+06
		954990	2187700	2148400
~~Cement~~	5.43E5 711330 Const.	→ 5.4E+05	5.49E+05	5.53E+05
~~Sand~~	353E5 462430 operations	→ 707400 1.7E+05	719190 1.11E+06	724430 1.07E+06
~~Gravel~~	1.9E4 24890 closure	→ 222700 1.9E+04	1454100 1.9E+04	1401700 1.9E+04
		24890	24890	24890
Concrete Prefab Shapes (m^3)		NA	NA	NA
Carbon Steel ~~rebar~~ (m Tons)	1.95E+05 214500 TOTAL	180400 1.64E+05	2.72E+05 ~~195800~~ ~~1.78E+05~~	359700 3.27E+05
	1.07E05 Const 117700	117700 1.07E+05	117700 1.07E+05	117700 1.07E+05
Carbon Steel ~~prefab Shapes~~ (m Tons)	ops 6.87E4 75570	NR	67760 ~~5.16E+04~~ 1.46E+05	221100 2.01E+05
Stainless Steel Prefab Shapes (m Tons)	1.3E+04 14300	NR	27610 2.51E+04	36740 3.34E+04
Glass Formers (mT)	3.65E+05 478150 (yd^3)	385140 2.94E+05	655000 5.0E+05	820060 6.26E+05
Sand				
CaO				
MgO				
Boron oxide				
etc.	401500 (Tons)	323400	550000	688600
Process oxygen (mT)	260700 (2.37E+05)	210100 (1.91E+05)	357500 (3.25E+05)	447700 (4.07E+05)
Process Chemicals	4.27E+05 469700	3.81E+05 419100	5.15E+05 566500	5.97E+05 656700
Sulfur Cement				
Sulfur (mT)	177100 1.61E+05	143000 1.3E+05	243100 2.21E+05	304700 2.77E+05
dicyclopentadiene (mT)	(DCPD) 4.22E+03	3.4E+03	5.78E+03	7.24E+03
Oligomer (mT)	(DCP) 4.22E+03 4642	3.4E+03 3740	5.78E+03 6358	7.24E+03 7964

Sheet B-43	R=1.~~0~~ 2.5	R=1.7	R=2.13
Concrete (storage pad) (m^3) RDW 8-15-96			
Cement	3.27E+03	8.8E+03	1.25E+04
Sand			
gravel.			
Concrete vaults (m3)			
Cement	4.3E+04	1.89E+05	3.66E+05
Sand			
gravel			
Concrete Prefab-Shapes. (m^3)	1.4E+05	3.77E+05	6.34E+05
~~Cement~~			
~~Sand.~~			
~~Gravel.~~			
Carbon Steel (storage pad)			
Rebar (mT)	32.2	378	536.8
Carbon Steel (vaults)	5.0E+02	2.2E+04	4.25E+04
rebar (mT)			
Carbon Steel prefab shapes (boxes) 4.2 m^3 (mT)	6.37E+04	1.25E+05	1.58E+05

Number of trips by truck/Rail	R=1.0	R=1.7	R=2.13
	APW 2-15-96	Sheet	B-44
Gasoline 5000 gallon truck/tricities (operations)	NR	3	5
Diesel 5000 gallon truck/tricities (operations)	54	398	734
Kerosene 5000 gallon truck/tricities (operations)	3,063	5,207	5,703
Concrete 6 cuyds/truck load.			
Total	159,165	364,617	358,067
Const	117,900	119,865	120,739
operations	37,117	242,350	233,617
closure	4,149	4,149	4149
Carbon steel truck - 20 tons/load			
Total	9,020	9,790	17,985
Const	5885	5885	5885
operations	NR	3388	11055
Stainless steel 20 tons/truck load (operations)	NR	1381	1837
Glass Formers			
sand ~~[illegible]~~ 16 yds/truck/tricities (0.816)	19643	33405	41824
other materials 20 tons/truck (0.1887)	2971	5052	6325
process chemicals 20 tons/truck	20955	28325	32835
Liquid oxygen at 20 tons/truck.	10505	17875	22385
Sulfur Cement			
Sulfur 45,000 lbs/tank truck.	6356	10805	13543
DCPD - Dicyclopentadiene 45 ton/rail tank car	84	142	177
DCP - Oligomer 20 tons/truck	187	318	399

NOTE BASED ON TOTAL quantities.

Concrete Covers Cost off site

Table B.10.0.7 Transportation Summary by Tank Waste Alternative

Alternative	Rail Transport, Distance (km)		Truck Transport, Distance (km)		Employee Vehicle Distance (km)
	Onsite	Offsite	Onsite	Offsite	
No Action	N/A	N/A	N/A	N/A	2.81E+09
Long-Term Management	0	0	3.24E+05	2.28E+07	2.91E+09
In Situ Fill and Cap	0	0	5.63E+06	1.29E+05	7.05E+08
In Situ Vitrification	N/A	2.10E+05	6.83E+06	2.27E+07	1.32E+09
Ex Situ Intermediate Separations	N/A	~~4.71E+06~~ 6.72E+06	~~7.79E+06~~ 1.50E+07 (1)	~~5.52E+07~~ 9.83E+07 (1)	2.31E+09
Ex Situ No Separations (Vitrification)	N/A	~~7.58E+06~~ 4.5E+07	~~5.93E+06~~ 6.66E+06 (1)	~~4.23E+07~~ 1.06E+08 (1)	1.06E+09
Ex Situ No Separations (Calcination)	N/A	~~4.33E+06~~ 9.25E+06	~~5.93E+06~~ 6.63E+06 (1)	4.23E+07 5.93E+07 (1)	1.06E+09
Ex Situ Extensive Separations	N/A	~~8.34E+06~~ 8.56E+06	~~7.88E+06~~ 9.83E+06 (1)	~~5.91E+07~~ 1.18E+08 (1)	2.19E+09
Ex Situ/In Situ Combination	N/A	~~2.36E+06~~ 3.36E+06	~~6.55E+06~~ 7.33E+06 (1)	~~2.77E+07~~ 5.41E+07 (1)	1.44E+09
Phased Implementation (Phase 1)	N/A	1.74E+05	1.05E+06	1.71E+07	4.76E+08
Phased Implementation (Phase 2)	N/A	~~2.74E+06~~ 4.74E+06	~~6.30E+06~~ 8.01E+06 (1)	~~2.98E+07~~ 6.72E+07 (1)	1.72E+09

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

Sheet B-45
RW 2-15-96

Cost on site

Table B.10.0.7 Transportation Summary by Tank Waste Alternative

Alternative	Rail Transport, Distance (km)		Truck Transport, Distance (km)		Employee Vehicle Distance (km)
	Onsite	Offsite	Onsite	Offsite	
No Action	N/A	N/A	N/A	N/A	2.81E+09
Long-Term Management	0	0	3.24E+05	2.28E+07	2.91E+09
In Situ Fill and Cap	0	0	5.63E+06	1.29E+05	7.05E+08
In Situ Vitrification	N/A	2.10E+05	6.83E+06	2.27E+07	1.32E+09
Ex Situ Intermediate Separations	N/A	~~4.71E+06~~ 6.72E+06	~~7.79E+06~~ 1.14E+07 (1)	~~5.52E+07~~ 1.20E+08 (1)	2.31E+09
Ex Situ No Separations (Vitrification)	N/A	~~7.58E+06~~ 4.5E+07	~~5.93E+06~~ 3.86E+07 (1)	~~4.23E+07~~ ~~5.08~~E+08 (1) 4.90	1.06E+09
Ex Situ No Separations (Calcination)	N/A	~~4.33E+06~~ 9.25E+06	~~5.93E+06~~ 1.01E+07 (1)	~~4.23E+07~~ 1.13E+08 (1)	1.06E+09
Ex Situ Extensive Separations	N/A	~~8.34E+06~~ 8.56E+06	~~7.88E+06~~ 9.86E+06 (1)	~~5.91E+07~~ ~~1.13E+08~~ 1.13E+08 (1)	2.19E+09
Ex Situ/In Situ Combination	N/A	~~2.36E+06~~ 3.36E+06	~~6.55E+06~~ 8.15E+06 (1)	~~2.77E+07~~ ~~5.79E+07~~ 5.77E+07 (1)	1.44E+09
Phased Implementation (Phase 1)	N/A	1.74E+05	1.05E+06	1.71E+07	4.76E+08
Phased Implementation (Phase 2)	N/A	~~2.74E+06~~ 4.74E+06	~~6.30E+06~~ 9.65E+06 (1)	~~2.98E+07~~ 8.75E+07 (1)	1.72E+09

Notes:
N/A = Not Applicable

(1) Concrete shielding covers cost on site.

Sheet B-46
R DW 2-15-96

3035
3350
14

Insert T-1 p.2

Table 5.10.2 Rail Traffic Volumes

Alternative	Construction/Operations Phases[1] Average Trips/Year	Construction/Operations Phases[1] Time Frame	HLW Shipments to Repository[2] Average Trips/Year	HLW Shipments to Repository[2] Time Frame
Tank Waste				
No Action	0	—	0	—
Long Term Management	0	—	0	—
In Situ Fill and Cap	0	—	0	—
In Situ Vitrification	12 ~~16~~	1997-2016	0	—
Ex Situ Intermediate Separations	284 ~~200~~ 284	1997-2024	84	2019-2029
Ex Situ No Separations (Vitrification)	113 ~~80~~ 113	1997-2019	735	2017-2037
Ex Situ No Separations (Calcination)	113 ~~80~~ 113	1997-2019	271	2017-2027
Ex Situ Extensive Separations	687 ~~485~~ 687	1997-2024	40	2020-2029
Ex Situ/In Situ Combination	142 ~~100~~	1997-2024	42	2019-2029
Phased Implementation (Phase I)	~~20~~ 218	1997-2012	0	—
Phased Implementation (Total)	321 ~~108~~	1997-2028	83	2019-2029
Capsules				
Capsules No Action	0	—	0	—
Capsules On-Site Disposal	0	—	0	—
Capsules Overpack and Ship	0	2002-2028	6	2028-2029
Capsules Vitrify with Tank Waste	[illegible]	[illegible]	[illegible]	—

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

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Rev 8-15-96

JACOBS ENGINEERING GROUP INC.
JE
DATE
BY
SUBJECT
CHKD
SHEET NO.
JOB NO.
FORM 91-005-1 (4/81)

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

5.10.3 Rail Traffic

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

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

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

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

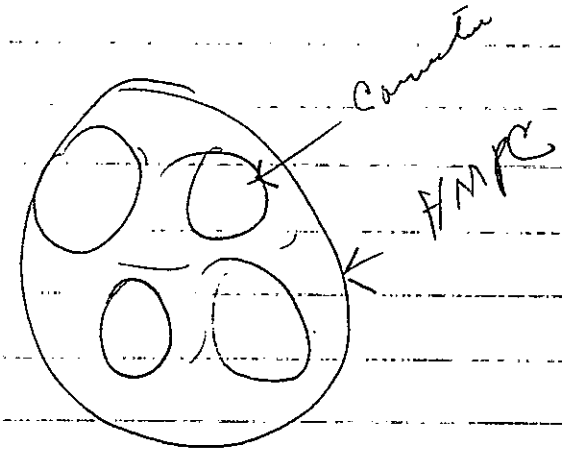
Phased Implementation (Phase I) would involve 20 rail shipments per year to bring materials onto the Site, but no offsite shipments of HLW. The total Phased Implementation alternative would require 108 rail shipments per year during construction and operations, 83 rail shipments per year to the HLW repository,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

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

#

Sheet B-47
BDI 2-15-96

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



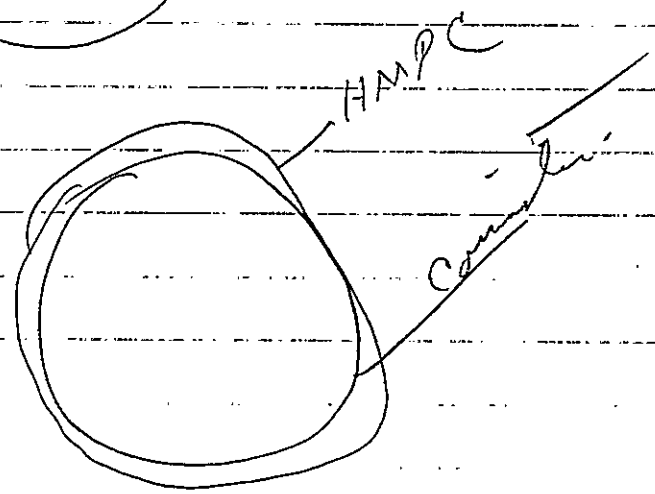


Table 9-7. Transportation in Support of Processing (Units as Indicated).

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

Notes:

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

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

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

Information provided by Hanford Railroad - Transportation.

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

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

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

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