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

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.J.P. Nygard 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/ questions.
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 Brown **FROM:** Phil Rogers

**FAX#:** **JOB#:** 8996001-6-0200

**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) 790-1411

| | 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 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.L. Nygard 3/15/96
CHECKED/DATE

CALCULATION & RESULTS
ATTACHED

*JACOBS\FORMS\CALCVR.SHT*

# Facsimile Cover Sheet

**To:** Phil Bramson
**Company:**
**Phone:**
**Fax:**

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

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

**Comments:**

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

Art Palmer

Table 3.1

Radionuclide Source Term

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

Notes:

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

Table 3.7

Estimated Concentrations at Hypothetical Well (pCi/L)

INPUT FOR RWELL1.OUT

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

| Isotope | TRANSS RICH1.OUT (pCi/L) | Dilution Factor | Well Conc. (pCi/L) | Conversion Factor | PRESTO Input (Ci/cu. m) | Status for PRESTO |
|---|---|---|---|---|---|---|
| Am-241 | 7.29E-120 | 0.0004 | 2.9E-123 | 1.00E-09 | 2.9E-132 | Ignore |
| C-14 | 13515.1 | 0.0004 | 5.40604 | 1.00E-09 | 5.41E-09 | Retain |
| Cl-36 | 16.9191 | 0.0004 | 0.006768 | 1.00E-09 | 6.77E-12 | Ignore |
| I-129 | 16.8499 | 0.0004 | 0.00674 | 1.00E-09 | 6.74E-12 | Retain |
| K-40 | 22.7167 | 0.0004 | 0.009087 | 1.00E-09 | 9.09E-12 | Retain |
| Nb-94 | 6.85E-12 | 0.0004 | 2.74E-15 | 1.00E-09 | 2.74E-24 | Retain |
| Ni-59 | 0.211816 | 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#: 8996001-6-0200

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) 790-1411

| | 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 | 0.000078 | 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) | 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 Rule

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

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

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

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

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

| TABLE D.4.6.6 | | | | |
|---|---|---|---|---|
| EMISSIONS | | HAZARD/MEI WKR | | RISK/MEI WKR |
| Carbon Monoxide | | | | |
| Nitrogen Oxide | | | | |
| 1,3-Butadiene | | | | 4.56E-07 |
| 2-Hexanone | | | | |
| 2-Pentanone | | | | |
| Acetone | | 4.73E-03 | | |
| Acetonitrile | | 1.63E-03 | | |
| Benzene | | 6.37E-03 | | 1.08E-07 |
| Heptane | | | | |
| Methyl N-amyl Ketone | | 1.17E-03 | | |
| N-hexane | | 5.10E-04 | | |
| Nonane | | | | |
| Octane | | | | |
| Toluene | | 2.02E-05 | | |
| Ammonia | | 4.80E-02 | | |
| Phosphoric Acid Tributyl Ester | | | | |
| Carbon Tetrachloride | | 3.95E-08 | | 4.08E-13 |
| Ethyl Butyl Ketone | | 3.28E-09 | | |
| Methyl Chloride | | | | 7.17E-15 |
| Tetrahydrofuran | | | | |
| TOTAL | | 6.24E-02 | | 5.64E-07 |
| *TOTAL IN REV. C* | | *7.71E-02* | | |
| | | | | |
| TABLE D.4.6.7 | | | | |
| EMISSIONS | | HAZARD/MEI WKR | | RISK/MEI WKR |
| Carbon Monoxide | | | | |
| Nitrogen Oxide | | | | |
| 1,3-Butadiene | | | | 1.08E-06 |
| 2-Hexanone | | | | |
| 2-Pentanone | | | | |
| Acetone | | 1.42E-02 | | |
| Acetonitrile | | 4.88E-02 | | |
| Benzene | | 1.91E-02 | | 2.55E-07 |
| Heptane | | | | |
| Methyl N-amyl Ketone | | 3.50E-03 | | |
| N-hexane | | 1.53E-03 | | |
| Nonane | | | | |
| Octane | | | | |
| Toluene | | 6.05E-05 | | |
| Ammonia | | 1.44E-01 | | |
| Phosphoric Acid Tributyl Ester | | | | |
| Carbon Tetrachloride | | 1.18E-07 | | 9.69E-13 |
| Ethyl Butyl Ketone | | 9.83E-09 | | |
| Methyl Chloride | | | | 1.70E-14 |
| Tetrahydrofuran | | | | |
| TOTAL | | 2.31E-01 | | 1.34E-06 |

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

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

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

| TABLE D.4.7.6 | | |
|---|---|---|
| EMISSIONS | HAZARD/MEI WKR | RISK/MEI WKR |
| Carbon Monoxide | | |
| Nitrogen Oxide | | |
| 1,3-Butadiene | | 5.71E-07 |
| 2-Hexanone | | |
| 2-Pentanone | | |
| Acetone | 4.73E-03 | |
| Acetonitrile | 1.63E-03 | |
| Benzene | 6.37E-03 | 1.34E-07 |
| Heptane | | |
| Methyl N-amyl Ketone | 1.17E-03 | |
| N-hexane | 5.10E-04 | |
| Nonane | | |
| Octane | | |
| Toluene | 2.02E-05 | |
| Ammonia | 4.80E-02 | |
| Phosphoric Acid Tributyl Ester | | |
| Carbon Tetrachloride | 3.95E-08 | 5.11E-13 |
| Ethyl Butyl Ketone | 3.28E-09 | |
| Methyl Chloride | | 8.97E-15 |
| Tetrahydrofuran | | |
| TOTAL | 6.24E-02 | 7.05E-07 |
| TOTAL SHOWN IN REV C | *7.71E-02* | |
| | | |
| TABLE D.4.7.7 | | |
| EMISSIONS | HAZARD/MEI WKR | RISK/MEI WKR |
| Carbon Monoxide | | |
| Nitrogen Oxide | | |
| 1,3-Butadiene | | 1.31E-06 |
| 2-Hexanone | | |
| 2-Pentanone | | |
| Acetone | 1.42E-02 | |
| Acetonitrile | 4.88E-02 | |
| Benzene | 1.91E-02 | 3.09E-07 |
| Heptane | | |
| Methyl N-amyl Ketone | 3.50E-03 | |
| N-hexane | 1.53E-03 | |
| Nonane | | |
| Octane | | |
| Toluene | 6.05E-05 | |
| Ammonia | 1.44E-01 | |
| Phosphoric Acid Tributyl Ester | | |
| Carbon Tetrachloride | 1.18E-07 | 1.17E-12 |
| Ethyl Butyl Ketone | 9.83E-09 | |
| Methyl Chloride | | 2.06E-14 |
| Tetrahydrofuran | | |
| TOTAL | 2.31E-01 | 1.62E-06 |
| TOTAL SHOWN IN REV C | | |

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

| TABLE D.4.9.6 | | |
|---|---|---|
| EMISSIONS | HAZARD/MEI WKR | RISK/MEI WKR |
| Carbon Monoxide | | |
| Nitrogen Oxide | | |
| 1,3-Butadiene | | 1.90E-07 |
| 2-Hexanone | | |
| 2-Pentanone | | |
| Acetone | 4.73E-03 | |
| Acetonitrile | 1.63E-03 | |
| Benzene | 6.37E-03 | 4.49E-08 |
| Heptane | | |
| Methyl N-amyl Ketone | 1.17E-03 | |
| N-hexane | 5.10E-04 | |
| Nonane | | |
| Octane | | |
| Toluene | 2.02E-05 | |
| Ammonia | 4.80E-02 | |
| Phosphoric Acid Tributyl Ester | | |
| Carbon Tetrachloride | 3.95E-08 | 1.70E-13 |
| Ethyl Butyl Ketone | 3.28E-09 | |
| Methyl Chloride | | 2.99E-15 |
| Tetrahydrofuran | | |
| TOTAL | 6.24E-02 | 2.35E-07 |
| TOTAL SHOWN IN REV C | *7.71E-02* | |
| | | |
| TABLE D.4.9.7 | | |
| EMISSIONS | HAZARD/MEI WKR | RISK/MEI WKR |
| Carbon Monoxide | | |
| Nitrogen Oxide | | |
| 1,3-Butadiene | | 2.26E-07 |
| 2-Hexanone | | |
| 2-Pentanone | | |
| Acetone | 5.61E-03 | |
| Acetonitrile | 1.93E-02 | |
| Benzene | 7.55E-03 | 5.32E-08 |
| Heptane | | |
| Methyl N-amyl Ketone | 1.38E-03 | |
| N-hexane | 6.02E-04 | |
| Nonane | | |
| Octane | | |
| Toluene | 2.38E-05 | |
| Ammonia | 5.73E-04 | |
| Phosphoric Acid Tributyl Ester | | |
| TOTAL | 3.50E-02 | 2.79E-07 |

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

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

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

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

| TABLE D.4.9.14 | | |
|---|---|---|
| EMISSIONS | HAZARD/MEI WKR | RISK/MEI WKR |
| Carbon Monoxide | | |
| Nitrogen Oxide | | |
| 1,3-Butadiene | | 2.91E-11 |
| 2-Hexanone | | |
| 2-Pentanone | | |
| Acetone | 1.28E-06 | |
| Acetonitrile | 4.39E-06 | |
| Benzene | 1.72E-06 | 6.84E-12 |
| Heptane | | |
| Methyl N-amyl Ketone | 3.15E-07 | |
| N-hexane | 1.37E-07 | |
| Nonane | | |
| Octane | | |
| Toluene | 5.40E-09 | |
| Ammonia | 1.30E-07 | |
| Phosphoric Acid Tributyl Ester | | |
| TOTAL | 7.98E-06 | 3.59E-11 |
| TOTAL SHOWN IN REV C | *7.96E-06* | *3.60E-11* |
| | | |
| TABLE D.4.9.15 | | |
| EMISSIONS | HAZARD/MEI WKR | RISK/MEI WKR |
| Aluminum | | |
| Arsenic | | 9.07E-11 |
| Boron | 5.36E-10 | |
| Barium | 1.59E-10 | |
| Beryllium | | 1.55E-14 |
| Bismuth | | |
| Cadmium | | 7.48E-13 |
| Cerium | | |
| Chromium (+3) | 2.09E-06 | |
| Copper | | |
| Manganese | | |
| Molybdenum | | |
| Nickel | | |
| Lead | | |
| Silver | | |
| Uranium | | |
| Vanadium | | |
| Zinc | | |
| TOTAL | 2.09E-06 | 9.15E-11 |
| TOTAL SHOWN IN REV C | | *9.14E-11* |

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

| TABLE D.4.9.23 | | |
|---|---|---|
| EMISSIONS | HAZARD/MEI WKR | RISK/MEI WKR |
| Carbon Monoxide | | |
| Nitrogen Oxide | | |
| 1,3-Butadiene | | 2.38E-07 |
| 2-Hexanone | | |
| 2-Pentanone | | |
| Acetone | 2.04E-03 | |
| Acetonitrile | 7.03E-03 | |
| Benzene | 2.75E-03 | 5.62E-08 |
| Heptane | | |
| Methyl N-amyl Ketone | 5.05E-04 | |
| N-hexane | 2.20E-04 | |
| Nonane | | |
| Octane | | |
| Toluene | 8.71E-06 | |
| Ammonia | 2.07E-02 | |
| Phosphoric Acid Tributyl Ester | | |
| Carbon Tetrachloride | 1.71E-08 | 2.13E-13 |
| Ethyl Butyl Ketone | 1.42E-09 | |
| Methyl Chloride | | 3.75E-15 |
| Tetrahydrofuran | | |
| TOTAL | 3.33E-02 | 2.94E-07 |
| | | |
| TABLE D.4.9.24 | | |
| EMISSIONS | HAZARD/MEI WKR | RISK/MEI WKR |
| Acetone | 1.13E-06 | |
| Ammonia | 3.65E-06 | |
| n-Butyl Alcohol | 8.48E-06 | |
| 2-Hexanone | | |
| Methyl Isobutyl Ketone | 3.34E-07 | |
| TOTAL | 1.36E-05 | |
| | | |
| | | |
| TABLE D.4.9.25 | | |
| EMISSIONS | HAZARD/MEI WKR | RISK/MEI WKR |
| Carbon Monoxide | | |
| Nitrogen Oxide | | |
| 1,3-Butadiene | | 6.41E-07 |
| 2-Hexanone | | |
| 2-Pentanone | | |
| Acetone | 6.13E-03 | |
| Acetonitrile | 2.11E-02 | |
| Benzene | 8.26E-03 | 1.51E-07 |
| Heptane | | |
| Methyl N-amyl Ketone | 1.51E-03 | |
| N-hexane | 6.61E-04 | |
| Nonane | | |
| Octane | | |
| Toluene | 2.61E-05 | |
| Ammonia | 6.22E-02 | |
| Phosphoric Acid Tributyl Ester | | |
| Carbon Tetrachloride | 5.12E-08 | 5.73E-13 |
| Ethyl Butyl Ketone | 4.25E-09 | |
| Methyl Chloride | | 1.01E-14 |
| Tetrahydrofuran | | |
| TOTAL | 9.99E-02 | 7.92E-07 |
| | | |

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

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

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

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

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

CONFIRMATION OF TOTALS TABLE D.6.4.6

| SOURCE | FISH | CRAWDAD | DUCK-p | DUCK-f | HERON | MUSKRAT |
|---|---|---|---|---|---|---|
| 300 Year Maximum | | | | | | |
| INTERNAL | 3.10E-07 | 3.60E-07 | 2.90E-07 | 8.70E-07 | 5.60E-07 | 2.90E-07 |
| IMMERSION OR SURFACE | 3.60E-10 | 1.80E-10 | 2.00E-10 | 2.00E-10 | 5.40E-11 | 1.10E-10 |
| SEDIMENT | 9.50E-12 | 1.90E-11 | 3.80E-12 | 3.80E-12 | 5.70E-12 | 5.70E-12 |
| TOTAL | 3.10E-07 | 3.60E-07 | 2.90E-07 | 8.70E-07 | 5.60E-07 | 2.90E-07 |

| SOURCE | FISH | CRAWDAD | DUCK-p | DUCK-f | HERON | MUSKRAT |
|---|---|---|---|---|---|---|
| 500 Year Maximum | | | | | | |
| INTERNAL | 4.20E-07 | 4.30E-07 | 4.80E-07 | 1.20E-06 | 7.70E-07 | 4.80E-07 |
| IMMERSION OR SURFACE | 2.60E-13 | 1.30E-13 | 1.40E-13 | 1.40E-13 | 3.90E-14 | 7.90E-14 |
| SEDIMENT | 7.50E-12 | 1.50E-11 | 3.00E-12 | 3.00E-12 | 4.50E-12 | 4.50E-12 |
| TOTAL | 4.20E-07 | 4.30E-07 | 4.80E-07 | 1.20E-06 | 7.70E-07 | 4.80E-07 |

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

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

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

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

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

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

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

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

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

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

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

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

TWRS EIS
CALCULATION COVER SHEET

DISCIPLINE & TITLE 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)

JACOBS ENGINEERING GROUP INC.

DATE 12/7 SUBJECT SHEET NO. 3-15

BY DLS CHKD. JOB NO.

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

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

FORM 91-000-1 (4/61)

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 B 10 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 01-005-1 (4/87)

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 91-005-1 (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% estimate 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

$\frac{\text{Capital phase I}}{\text{Capital ext. retrieval}} \times \text{Closure cost ext. ret} = \frac{1424}{5880} \times 170$

= $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 labor
about

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 (4/81)

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

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

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

④ HLW vitrification would be approximately 1/2 that of HLW 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 × (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 con. | 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 = $1.133 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 will process same waste and product same products as inter. sep. $1,493 million *

Total Phase 2 Large plants op cost $4611 million

* Δ HLW $140 million
Δ LAW 175 million
Δ other op cost 1,178 million
(vaults, canisters etc)
$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 | 10 944 |
| Repository Fee | — | 6500 | 6500 |
| Total | 7866 million | 25 342 million | $33 208 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: _____

MISC34-006W (8/94)

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 81-006-1 (4/81)

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)

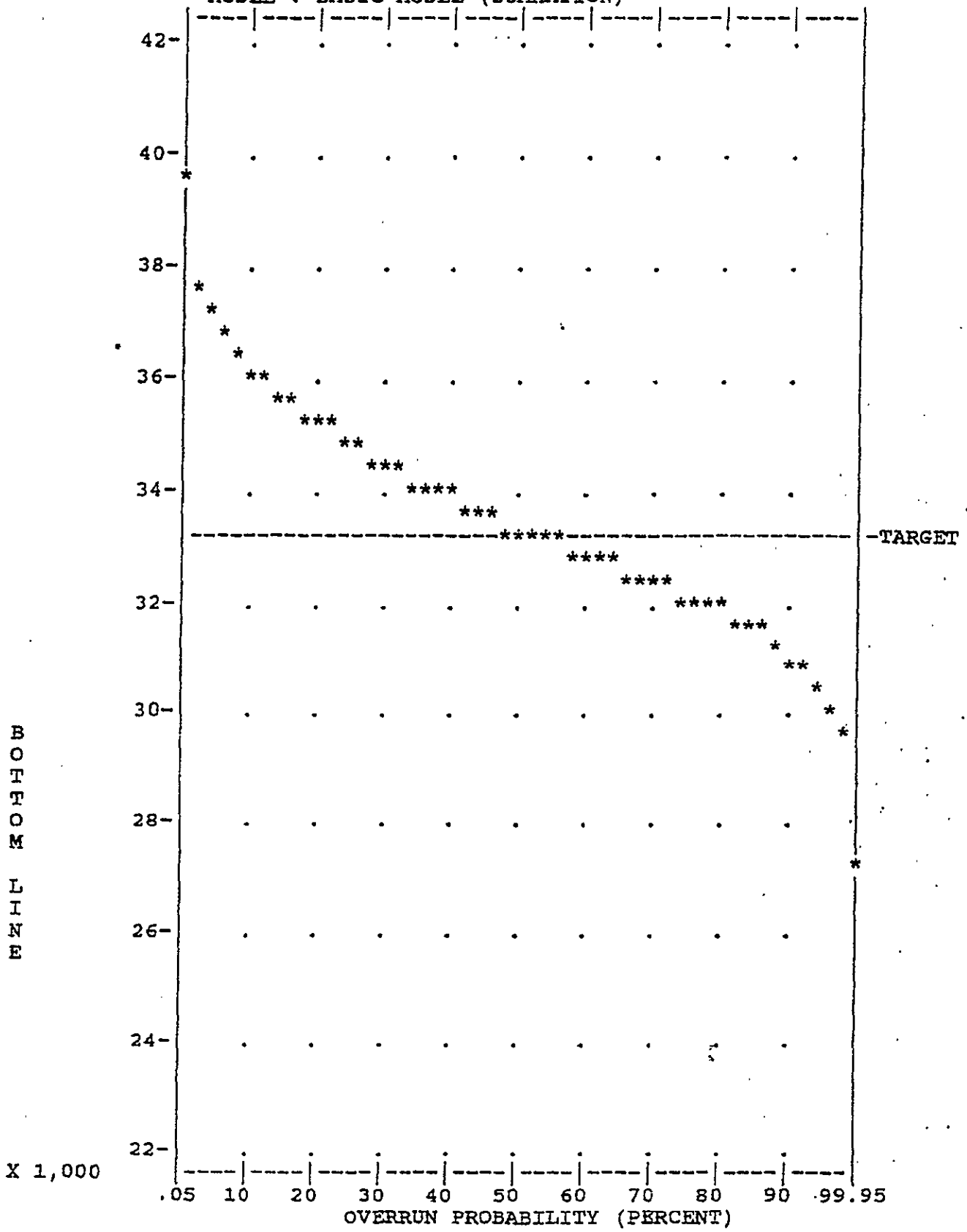
| NUM | ELEMENT | UNIT | TARGET | PROB+ | LOW | HIGH |
|---|---|---|---|---|---|---|
| 1 | Current Operations | | 8600 | 50 | 6880 | 10320 |
| 2 | R&D Waste Ret. & Transfer | | 190.00 | | 190.00 | 190.00 |
| 3 | R&D Treatment | | 0 | | 0 | 0 |
| 4 | Capital Waste Ret. & Transfer | | 2280 | 50 | 1824 | 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

*JACOBS\FORMS\CALCLCF.212*

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| | | | 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-06 | 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 WSTLOAD2.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 | 8.00E+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)

---

[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.

---

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 | | |
|---|---|---|---|
| [redacted] | 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<br>1.6E+04 | 2E-05<br>6E-09 | 2<br>8 |
| | HLW vitrified w/o Cs and Sr | 3.2E+02<br>3.3E+03 | 1E-04<br>3E-08 | None (0.2)<br>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<br>1.5E+02 | 4E-07<br>7E-08 | None (2E-04)<br>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.

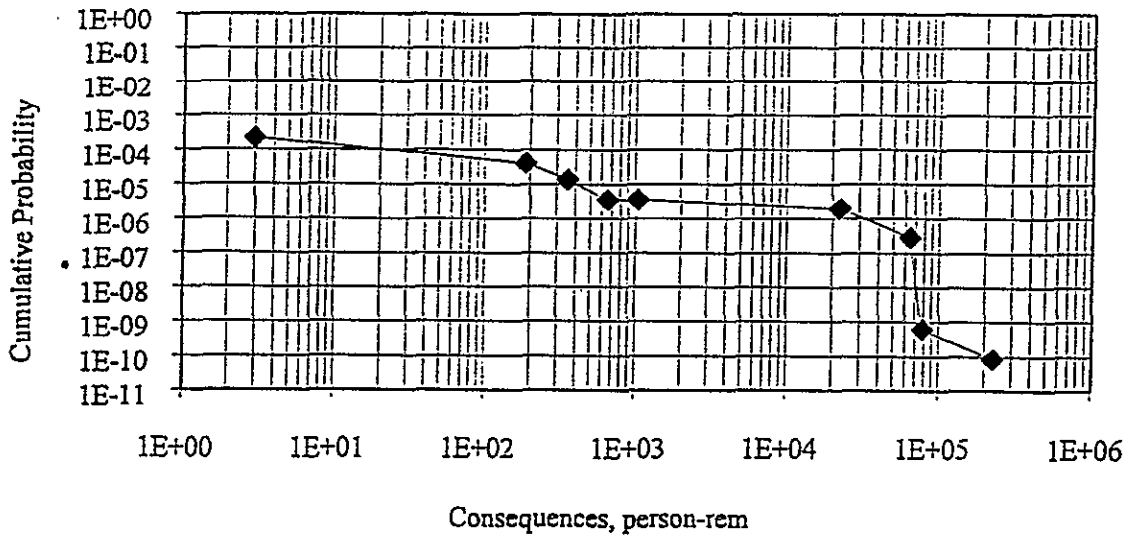



**Figure 1.** Cumulative Distribution Function for Treated Tank Waste Shipments in the Extensive Separations Alternative

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 $6.0 \times 10^{-4}$ 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 Bronson

Conversion of Groundwater Concentration to Risk + Dose.

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

The calculation is as the following.

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

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 (4/91)

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 BDW CHKD. JOB NO. 01K47/01

Items calculated within this calculation


| | Page |
|---|---|
| 1 Table B.10.0.3 | |
| A. Ex Situ no Separations alternative - vitrification | 02 |
| B. Ex Situ Extensive Separations alternative | 07 |
| C. Ex Situ Intermediate Separations alternative | 10 |
| D. Ex Situ/In Situ Combination alternative | 15 |
| E. Ex Situ no Separations alternative - calcination | 19 |
| F. Phased Implementation alternative - Phase II | 22 |
| 2. Comparative boxes 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. Insitu Fill and Cap alternative | 39 |
| 3 Insitu 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 Insitu Combination alternative | 42 |
| 10 Phased Implementation - Phase II | 42 |
| 4 Table 5.1.1 | |
| J. Table 5.1.1 Key Geology and Soil Input Parameters all alternatives | 43 |
| 5 Tables in Chapter 3 and Appendix B | |
| K. Tables - data calculation | 46 |
| 1. Tables 3.6.1 and B.6.2.1 | 46 |
| 2. Tables 3.6.2 and B.6.2.2 | 47 |
| 3. Tables 3.6.3 and B.6.2.3 | 47 |
| 6. Data for Table 5.16.1 was taken from the revised data of table B.10.0.3. | 48 |


FORM 91 006 1 (4/84)

Because of required changes in the $Fe_2O_3$ 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 its increased throughput of materials for the increased output of glass product for disposal.

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

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

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

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

Number of Canisters 587000 / 21400 = 27.4 ratio

Number of HMPCs 147,000 / 21400 = 6.87 ratio

Number of shielding units = 147,000 / 21400 = 6.87 ratio

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

= 13.72

∴ Diesel usage increase = (13.72)(1.02 E+03) m³

= 140 E+4

total Diesel usage = (3.50 E+03) + (5.22 E+04) + (1.19 E+04) = 6.76 E+04 m³

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

∴ Increased usage = (Kerosene usually)(Ratio increase)

= (5.64 E+04)(1.97) m³

= 1.06 E+05 m³

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

= (# Casks)(90.7 Mg each)

= (125,600)(90.7 Mg Each) = 11391920 Mg

b. Concrete for storage pad increase

= (125,600)(6.6) = 828960 m²

(147,000)(6.6)

= 970200 m²

= 73,563 m²

4 (452)(146) = 65992

5 (452)(146) = 65992

6 (452)(102) = 46104

1 (423)(350) = 148050

2 (255)(325) = 133875

3 (160)(525) = 84000

Σ = 365925

Σ+Σ = 544013 m²

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)

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

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

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

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

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

$\times 1m = 53160$

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

$\Sigma = 846.58\ m^3$

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

$\Sigma_T$ $853.1\ m^3$

$\rho = 7\ Mg/m^3$ $(853.1)(7) = 5971.7$ 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. OK 47101

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

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

2. Raw water usage for operational 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 = 2.561 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) = 8.48 E+05 m³

FORM 91-005-1 (4/81)

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 $m^3$/vault)(60 vaults)
= 2.58 E+05 $m^3$
added to item for shield plugs etc = (2.58E+05) + (1.5E+05) + (8.1E+03)
= 4.16 E+05 $m^3$

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 $m^3$ at 7 Mg/$m^3$

Number of boxes = (79 vaults)(1613 boxes/vault) = 125037
Steel = (125037)(0.144)(7) = 126037.29 Mg. = 1.26 E+05 M Tons

additional Rebar for storage pad of 1000 $m^2$ (20 x 50 m)

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

$A = \pi \frac{d^2}{4} = 0.0001227\ m^2$ for assumed rebar.

= 0.6135 $m^3$ + 0.6135 $m^3$
= (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

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

Kerosene ratio = 2.5 Oxygen for $H_2$ separation = 1.85E+05

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

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

12. Calculate the increase in materials for the Sulfur cement 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

JE JACOBS ENGINEERING GROUP INC.

DATE 2-15-96 SUBJECT SHEET NO. 12 of 48

BY RDW CHKD. JOB NO. 01K47101

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

5. The gasoline usage for construction of extra vaults.

(60)(240)(3.788) ÷ $10^3$ = 5.46 E+01 $m^3$

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

additional Cannisters
additional HMPCs
additional Shielding casks.
additional Vaults.

vaults = (60)(25530)(3.788) ÷ $10^3$
= 5.8 E+03 $m^3$

handling of extra Cannisters, boxes and shielding equipment.

(1.7)(1.02 E+03) = 1.734 E+03 $m^3$

ops Diesel = (5.8 E+03 $m^3$) + (1.734 E+03 $m^3$)
= 7.53 E+03 $m^3$

total Diesel = (6.62 E+04) + (7.53 E+03) + (2.1 E+04)
= 9.47 E+04 $m^3$

7. Calculate the increased kerosene usage

(Ratio)(original value)
= (1.7)(5.8 E+04) $m^3$
= 9.86 E+04 $m^3$

8. Calculate additional concrete requirements

60 new vaults = (60)(4300 $m^3$) = 2.58 E+05 $m^3$ (44/60) =

new scheld casks = total# − old# = (8350) − (1705)
= (6645)(90.7) = 6.03 E+05 Mg
= (6.03 E+05) ÷ (1.6 Mg/$m^3$) = 3.77 E+05 $m^3$
= 3.77 E+05 $m^3$

storage pad increase

new area = (6.6)(8350) = 55,110 $m^2$
old area = (6.6)(1705) = 11,253 $m^2$
additional area = 43857 $m^2$ = 400 m × 110 m = 44000 $m^2$

assumed Concrete 0.2 meters thick.

Volume = (44 000)(0.2) = 8.9 E+03 $m^3$

operations Concrete = (2.58 E+05 $m^3$) + (3.77 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) = 1.2 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

JACOBS ENGINEERING GROUP INC.

DATE 2-15-95 SUBJECT SHEET NO. 14 of 48

BY RDW CHKD. JOB NO. OIK 47101

Carbon Steel total.

$= (1.07E+05) + (5.16E+04) + (1.9E+04)$

$= 1.78E+05$ mTons.

10. Calculate Stainless steel requirements for operations Connections.

Number of Connections $= 3.34E+04$ @ $0.62\ m^3$

amount of Stainless Steel $= (3.3400)(0.75) = 25050$ Mg

$= 2.51E+04$ mTons.

Stainless steel total $= (2.51E+04) + (1.9E+04)$

$= 4.41E+04$ mTons.

11. Calculate increase in Glass formers due to changes in loading which increase amount of glass required.

(ratio) (glass formers originally required)

$= (1.7)(2.94E+05)$

$= 5.0E+05$ mTons.

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

$= 3.25E+05$ mTons

Process Chemicals $= (3.25E+05) + (1.90E+05)$

$= 5.15E+05$ MTons.

13. Change in the sulfur cement materials

Sulfur $= (1.30E+05\ mTons)(1.7) = 2.21E+05$ mTons.

DCP $(3.4E+03\ mTons)(1.7) = 5.78E+03$ mTons

Oligomer $(3.4E+03\ mTons)(1.7) = 5.78E+03$ mTons

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

FORM 31-005-1 (4/81)

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. Conditions for Intermediate Separations and extension Separations are equal 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: Ex Situ / In Situ 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 91.0051 (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 91-005A (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 costs; 4175 - 853 = 3322

(3322) (90.7 Mg) = 301305.4

$\rho$ = 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

$V = (22{,}000)(0.2) = 4400\ m^3$

$= 4.4E+03\ m^3$

operation Concrete $= (8.5E+04) + (9.46E+04) + (1.88E+05)$

$= 3.68E+05\ m^3$

Construction Concrete $= (4.4E+03\ m^3) + (2.7E+05)$

$= 2.74E+05\ m^3$

total Concrete $= (2.74E+05) + (3.68E+05) + (1.9E+04)$

$= 6.61E+05\ m^3$

9. Calculate the operations and Construction increase for Carbon Steel requirements.

vaults $= (22)(500\ Mg) = 11000\ Mg$

$= 1.1E+04$ mtons.

Pad 220 x 110 m Area

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

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

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

$= (29.7)(7) = 2.08E+02$ Mtons.

ops Carbon Steel $= (9.6E+03) + (1.1E+04)$

$= 2.06E+04$ metric tons

Const Carbon Steel $= (5.34E+04) + (2.08E+02)$

$= 5.36E+04$ mtons

total Carbon Steel $= (5.36E+04) + (206E+04)$

$= 7.42E+04$ 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: Ex Situ no Separations alternative - Calcination.

The number of canisters increased to 108388 at 0.62 $m^3$ (1.66 E+05)

new number HMPCs = 27097 (41500)

new number Shielding Casks = 27097 (41500)

old number HMPCs = 10300

old number shielding Casks = 10300

JACOBS ENGINEERING GROUP INC.

DATE 2-15-96 SUBJECT SHEET NO. 20 of 48

BY RDW CHKD. JOB NO. 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.

$\Delta$ HMPCs = 16797 + 16797 shields (31200)
= 33594 (62400)

Ratio = 33594 / 20600 = 1.63 (3.03)

Diesel increase = (1.02 E+02) + (1.02 E+02)(1.63) (3.1 E+02
= (1.02 E+02) + (1.66 E+02)
= 2.68 E+02 $m^3$ (4.12 E+02 $m^3$)

total Diesel usage = (2.68 E+02) + (5.22 E+04) + (1.19 E+04)
= 6.44 E+04 $m^3$ (1.124 E+05 $m^3$)

3. Kerosene usage will not change.

4. Calculate the concrete storage for additional shielding casks and the additional storage pad needed.

(2829840) 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 $m^3$ [(525)(393) 206325 $m^2$]
(41265 $m^3$)

FORM 91.005.1 (4/81)

JACOBS ENGINEERING GROUP INC.

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

BY RDW CHKD. JOB NO. 01R47101

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 ton

(525 1965 886 mt)
(393 886 mt)
(1772 m tons)

= (525)(1060)(0.0001227)(7) = 478 metric tons.

= (212)(2625)(0.0001227)(7) = 478 metric tons

(1.77 E+03 m tons)

Σ = 9.56 E+02 m tons.

Construction = (9.56 E+02) + (6.12 E+04)
(6.3 E+04) = 6.22 E+04 m tons.

Total = (7.04 E+04) + (6.22 E+04)
(1.334 E+05 m tons) = 1.33 E+05 metric tons.

6. Calculate Stainless steel required for the new cannisters as an operational expense.

Cannisters = 0.62 m³ factor = 0.75 Mg/cannister.
Number of Cannisters = 108388

Stainless steel = (108388)(0.75) = 81291 metric tons
= 8.13 E+04 metric tons.

(1.25 E+05 m tons)

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 0.67 m³ = 33400
New number of HMPCs = 8350
New number of Shielding Casks = 8350

old mass of glass = 2.47E+04 metric tons
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

LAW: new mass of Glass = 8.07 E+05 m tons.
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 m tons.
old volume of Glass = 1.83 E+05 $m^3$
Old number of Canisters (4.2) $m^3$ = 39

HLW ratio = 5.45 E+04 / 2.47 E+04 = 2.2

LAW ratio = 8.07 E+05 / 4.83 E+05 = 1.67

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

$$= \frac{8.62\,E+05}{5.08\,E+05} = 1.7$$

$$= 1.7$$

sanitary water increase = (1.7)(2.77 E+06)
= 4.71 E+06 $m^3$

total sanitary water = (6.03 E+04) + (4.71 E+06) + (2.54 E+05) $m^3$
= 5.02 E+06 $m^3$

3. Calculate raw water usage increase for the increased glass product because of reduced waste oxide loading and blending factor.

Raw water = (1.7)(7.7 E+06) = 1.31 E+07 $m^3$

total raw water = (1.31 E+07) + (N/R) + (N/R)
= 1.31 E+07 $m^3$

total water usage = (1.31 E+07 $m^3$) + (5.02 E+06 $m^3$)

= 1.81 E+07 $m^3$

4. Calculate the increased Energy usage for this alternative.

Kwh = (1.7) (6.1E+03) = 1.04E+04 Kwh

Total = (1.04E+04) + (3.73E+01) = 1.044E+04 Kwh

5. Calculate Gasoline requirements for storage vault construction. Vault construction is considered an operational item.

240 gallons of Gasoline per vault.

(83) (240) (3.788) = 75457 Liters

@ $10^3$ Liters/$m^3$ = 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 (4/91)

JACOBS ENGINEERING GROUP INC.

DATE 2-15-96 SUBJECT SHEET NO. 26 of 48

BY RDW CHKD. JOB NO. 01K4701

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 ←

FORM 91-005-1 (4/81)

JACOBS ENGINEERING GROUP INC.

DATE 2-15-96 SUBJECT SHEET NO. 27 of 48

BY R.Jw CHKD. JOB NO. 01K4701

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)

JACOBS ENGINEERING GROUP INC.

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 Recovery will be determined so that a comparison for number of trips for trucks can be determined to compare to the already calculated data.

| | | |
|---|---|---|
| HLW: | New mass of glass | = 7.26E+04 MTons |
| | new volume of glass | = 2.76E+04 $m^3$ |
| | new number of Canisters 0.62 $m^3$ | = 4.45E+04 |
| | New number of HNPCs | = 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 HNPCs | = 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) / (5.79E+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.

DATE 2-15-96 SUBJECT SHEET NO. 29 of 48

BY RDW CHKD. JOB NO. 01K47101

1. It was assumed at this point that the following areas 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
   $= (2.78E+07)(7.16\ E+06)$
   $= 3.5\ E+07\ m^3$

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.

DATE 2-15-96 SUBJECT SHEET NO. 30 of 48

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.

(Cont. 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)

9 Calculate the increased concrete requirements for the additional vaults, additional shielding covers, and additional storage pad for interim HLW storage.

additional storage pad requirement

additional HNPC 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 HNPC 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.

10. continued

Steel for storage pad (500 m) (125 m)

used 0.2 center (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 $m^3$/box)(7 mg/$m^3$) = 157865 m tons

= 1.58 E+05 M Tons.

Construction Steel = (268.4 m tons) + (1.07 E+05)

= 1.07 E+05 M tons

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

= 2.01 E+05 metric tons.

total Carbon Steel = (2.01 E+05) + (1.07 E+05) + (1.9 E+04)

= 3.27 E+05 m tons

11. Calculate the stainless steel requirement for the 0.62 $m^3$ canisters required for the HLW glass

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

0.62 $m^3$ Canister = 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 m tons.

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

= 5.97 E+05 m tons

Note

to add $O_2$ to the original case

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

= 3.81 E+05 m tons.

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

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

Dicyclopentadiene = (3.4 E+03)(2.13 = 7.24 E+03 m tons. ←

Oligomer = (3.4 E+03)(2.13) = 7.24 E+03 m tons. ←

14. 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

JACOBS ENGINEERING GROUP INC.

DATE 2-15-96 SUBJECT SHEET NO. 34 of 48

BY MDW CHKD. JOB NO. 01K47101

for trucks and rail cars can be determined, including the number of on-site trips, to compare to the already calculated data.

1. It was assumed at this point that the following entries would remain unchanged.
   a. Land permanently committed
   b. Land temporarily committed
   c. Borrow pit disturbed area

2. Calculate the process ratio change.

HLW - new mass of glass = 2.72 E+04 Mtons
- new volume of glass = 1.03 E+04 $m^3$
new number of canisters (0.62 $m^3$) = 1.67 E+04
new number of HMPCs = 4175
new number of shielding covers = 4175

$\rho = 2.63 Ms/m^3$

old mass of glass = 2.47 E+04 Mtons
old volume of glass = 9.4 E+03 $m^3$
old number of canisters (1.26 $m^3$) = 6.82 E+03
old number of HMPCs = 1705
old number of shielding covers = 1705

LAW - new mass of glass = 4.84 E+05 Mtons
new volume of glass = 2.63 E+E+05 $m^3$
new number of vaults = 50

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

$\rho = 1.84 Ms/m^3$

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

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

= 1.24

FORM 91-005-1 (4/81)

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 HMPC2 = 2470

Δ Shield Covers = 2470

ops diesel fuel increase = (1.24)(1.02E+03)

= 1.27 E+03

total ops diesel = (1.27 E+03) + (9.67 E+02)

= 2.24 E+03

total Diesel fuel = (2.24 E+03) + (6.62 E+04) + (2.1 E+04)

= 8.94 E+04 $m^3$

8. Calculate the increased Kerosene usage to account for the increase in the waste glass produced.

(Conc Ratio)(Kerosene value)

= (1.24)(5.8 E+04)

= 7.2 E+04 $m^3$

JACOBS ENGINEERING GROUP INC.

DATE 2-15-96 SUBJECT SHEET NO. 37 of 48

BY RDW CHKD. JOB NO. OIK 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

FORM 91-005-1 (4/81)

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
= (1.67 E+04)(0.75) = 1.2525E+04 Mg.
operations SS = 1.3 E+04 m Tons.

total SS = (1.3 E+04) + (1.9 E+04)
= 3.2 E+04 m Tons.

12. Calculate the increased requirement for the glass formers for this revised alternative.
(1.24)(2.94 E+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: cont + ops - 17; closure 8
   b. land incrementally committed: no change

3. In situ vitrification alternative
   a. Land permanently committed: cont + ops - 17; closure 8

4. In situ intermediate separations alternative
   a. Land permanently committed: total - 49; ops + cont - 37; closure - 12
   b. Land temporarily committed: total - 115; ops + cont - 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

JACOBS ENGINEERING GROUP INC.

DATE 2-15-96 SUBJECT SHEET NO. 40 of 48

BY RDW CHKD. JOB NO. 01K47101

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 $m^3$

JACOBS ENGINEERING GROUP INC.

DATE 2-15-96 SUBJECT SHEET NO. 41 of 48

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 Extensive Separations alternative
a. Land committed permanently: total - 46; ops & const - 34; closure 72
b. Land temporarily committed: total - 112, ops & const - 88; closure —
c. Borrow pit disturbed: McGee Ranch - 25, pit 30 - 68;
Vernita quarry - 31.
d. Borrow pit Silt - 6.45E+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 & ops - 32
b. Borrow pit Disturbed: McGee Ranch - 1, pit 30 - 1

JACOBS ENGINEERING GROUP INC.

DATE 2-15-96 SUBJECT SHEET NO. 42 of 48

BY PDW CHKD. JOB NO. 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 $m^3$

FORM 91-005-1 (4/81)

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)
= 26.81 E+05 = 2.7 E+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

JACOBS ENGINEERING GROUP INC.

DATE 2-15-96 SUBJECT SHEET NO. 44 of 48

BY RDW CHKD. JOB NO. OIK 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

FORM 91-005-1 (4/81)

JACOBS ENGINEERING GROUP INC.

DATE 2-15-96 SUBJECT SHEET NO. 45 of 48

BY RJW CHKD. JOB NO. 01K47101

7 Ex Situ no Separations - calcination alternative

a. Remediation

Sand and gravel = 2.1E+06 $m^3$ = 2.75E+06 $yds^3$

Silt = not required

Rip Rap = not required

b. total alternative

Sand and gravel = 3.24E+06 $m^3$ = 4.24E+06 $yds^3$

Silt = 377000 $m^3$ = 500000 $yds^3$

Rip Rap = 638000 $m^3$ = 840,000 $yds^3$

8. Ex Situ Extensive Separations alternative

a. Remediation

Sand and gravel = 9.04E+05 $m^3$ = 1.18E+06 $yds^3$

Silt = not required

Rip Rap = not required

b. Total alternative

Sand and gravel = 2.4E+06 $m^3$ = 3.14E+06 $yds^3$

Silt = 6.45E+05 $m^3$ = 8.45E+05 $yds^3$

Rip Rap = 9.31E+05 $m^3$ = 1.22E+06 $yds^3$

9. Ex Situ In Situ Combination alternative

a. Remediation

Sand and gravel = 9.81E+05 $m^3$ = 1.29E+06 $yds^3$

Silt = not required

Rip Rap = not required

b. Total alternative

Sand and gravel = 1.92E+06 $m^3$ = 2.52E+06 $yds^3$

Silt = 5.11E+05 $m^3$ = 6.7E+05 $yds^3$

Rip Rap = 7.85E+05 $m^3$ = 1.03E+06 $yds^3$

10. Phased Implementation Phase I alternative

a. Remediation — No change except Sand and gravel = 1.2E+04 $m^3$

b. total alternative — No change except Sand and gravel = 1.2E+04 $m^3$

= 1.57E+04 $yds^3$

JACOBS ENGINEERING GROUP INC.

DATE 2-15-96 SUBJECT SHEET NO. 46 of 48

BY RDW CHKD. JOB NO. 01K47101

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 = 2.7 E+06 $m^3$ = 3.54 E+06 $yds^3$

Silt = 6.45 E+05 $m^3$ = 8.45 E+05 $yds^3$

Rip Rap = 9.31 E+05 $m^3$ = 1.22 E+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)

= [(1.67 E+06) ÷ (7.20 E+05)] (317,000) $m^3$

= 726,187 $m^3$ = 2.57 E+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 $ft^3$

= 1.8 E+07 $ft^3$

FORM 91-005-1 (4/81)

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) = 17 06280 $ft^3$

= 1.71E+06 $ft^3$

e. Ex Situ/In Situ Combination

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

= 724625.63 = 725 000 $m^3$

= (725000)(35.4) = 25665000 $ft^3$

= 2.57E+07 $ft^3$

f. Phased Implementation - phase 2

quantity = (64.0/6.5)(159000) $m^3$

= 1565538.4 = 1,570,000 $m^3$

= (1570000)(35.4) = 55578000 $ft^3$

= 5.56E+07 $ft^3$

2 Tables 3.6.2 and B.6.2.2

a. Ex Situ In Situ Combination

value calculated by Colin Henderson in calc dated

1-30-96 = 384000 $m^3$

= (384000)(35.4) = 13593600 $ft^3$

= 1.36E+07 $ft^3$

3 Tables 3.6.3 and B.6.2.3

a. Item 2 - Ex Situ Intermediate Separations, Ex Situ Extensive Separations, or phased Implementation (phase 2)

Silt = 645,000 (2.3E+07)

Riprap = 931,000 (3.3E+07)

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

Numbers from Colin Henderson Calc 1-30-96

JACOBS ENGINEERING GROUP INC.

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

BY RDW CHKD. JOB NO. 01K4701

b. Ex situ / Insitu Combination

| | | | |
|---|---|---|---|
| Silt | = | 511,000 | = 1.8E+07 |
| Riprap | = | 785,000 | = 6.8E+07 |
| aggregate/Sand | = | 580,000 | = 2.1E+07 |
| | = | 490,000 | = 1.7E+07 |
| | = | 700,000 | = 2.5E+07 |

The data for Table 5.16.1 was taken from Table B.10.0.3 as it was revised.

FORM 01.005.1 (4/94)

Page A-1
RDW 2-15-96

Table B.10.0.3 Resource Summary, Tank Waste Alternatives

| Resource | Phase | No Action Alternative | Long-Term Management | In Situ Fill and Cap Alternative | In Situ Vitrification Alternative | Ex Situ Intermediate Separations Alternative |
|---|---|---|---|---|---|---|
| Land, permanently committed (hectares) (Long-term commitment of radiologically contaminated area) | Total | 17 | 25 | 25 | 25 | 40 |
| | Construction/ Operation | 0 | N/A | N/A | N/A | 7 |
| | Closure | 17 | 25 | 25 | 25 | 33 |
| Land, incremental temporarily committed (hectares) (area disturbed during construction and operations) | Total | 0 | 42 | 21 | 111 | 108 |
| | Construction/ Operation | 0 | 42 | 1 | 91 | 84 |
| | Closure | 0 | N/A | 20 | 20 | 24 |
| Borrow Pit Disturbed Area (hectares) based on an excavation depth of 3 meters | McGee Ranch | N/A | N/A | 16 | 16 | 21 |
| | Pit 30 | N/A | N/R | 39 | 34 | 57 |
| | Vernita Quarry | N/A | N/A | 21 | 21 | 27 |
| Water, Total (cubic meters) | Sanitary plus Raw Water | 1.52E+06 | 1.52E+06 | 2.43E+06 | 1.71E+08 | ~~1.47E~~ 2.40+07 |
| Water, Sanitary (cubic meters) | Total | N/R | N/R | 2.43E+06 | 1.71E+08 | ~~3.6E~~ 5.83+06 |
| | Construction | N/R | N/R | 5.9E+05 | 1.7E+08 | 5.0E+05 |
| | Operation | N/R | N/R | 1.8E+06 | 1.2E+06 | ~~3.1E~~ 5.27+06 |
| | Closure | N/R | N/A | 4.13E+04 | 3.8E+04 | 6.0E+04 |
| Water, Raw (cubic meters) | Total | 1.5E+06 | 1.52E+06 | N/R | N/R | ~~1.07E~~ 1.82+07 |
| | Construction | N/A | 1.7E+04 | N/R | N/R | N/R |
| | Operation | 1.5E+06 | 1.5E+06 | N/R | N/R | ~~1.07E~~ 1.82+07 |
| | Closure | N/A | N/A | N/R | N/R | N/R |
| Energy Electricity (Gwh) | Total | 1.1E+03 | 1.1E+03 | 1.8E+00 | 4.46E+03 | ~~9.07E+03~~ 1.56E+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~~ 9.46E+01 |
| | Closure | N/A | N/A | 3.0E+02 | 3.0E+02 | 3.9E+02 |

Page A-2
RGW 2-15-96

Table B.10.0.3 Resource Summary, Tank Waste Alternatives (cont'd)

| Resource | Phase | No Action Alternative | Long-Term Management | In Situ Fill and Cap Alternative | In Situ Vitrification Alternative | Ex Situ Intermediate Separations Alternative |
|---|---|---|---|---|---|---|
| Diesel (cubic meters) | Total | 2.2E+04 | 8.5E+04 | 5.96E+04 | 7.1E+04 | 9.47 ~~8.82~~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 ~~5.8~~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 | ~~1.75E+06~~ ~~1.7E+05~~ |
| | Closure | N/A | N/A | 1.9E+04 | N/R | 1.9E+04 |
| Carbon Steel (metric tons) | Total | 1E+03 | 1.33E+04 | N/R | 2.6E+05 | 1.78 ~~1.64~~E+05 |
| | Construction | N/A | 1.23E+04 | N/R | 2.6E+05 | 1.07E+05 |
| | Operation | 1E+03 | 1.0E+03 | N/R | 2.6E+05 | ~~N/R~~ 5.14 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<br>sulfur (mt)<br>dicyclopentadine (mt)<br>oligomer (mt) | Operation | N/A | N/A | N/A | N/A<br><br>5.78<br>5.78 | 2.21<br>~~1.30~~E+05<br>~~3.4~~E+03<br>~~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

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~~ ~~4.93~~ 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 ~~3.2E+06~~ | 5.24 ~~3.08E06~~ | 2.2E+05 | 4.97 ~~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 ~~5.5E+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 |



Page H-3
RDN 8-15-96

Table B.10.0.3 Resource Summary, Tank Waste Alternatives (cont'd)

| Resource | Phase | Ex Situ No Separations Alternative (Vitrification) | Ex Situ No Separations Alternative (Calcination) | Ex Situ Extensive Separations Alternative | Ex Situ/ In Situ Combination Alternative | Phased Implementation Alternative (Phase 1) | Phased Implementation Alternative (Phase 2) |
|---|---|---|---|---|---|---|---|
| Energy Electricity (Gwh) | Total | 8.8 ~~4.72E+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~~ 5.46 E+01 | ~~N/R~~ 2.0E+01 | N/R | ~~N/R~~ 7.55E+01 |
| | Closure | 3.01E+02 | 3.01E+02 | 3.91E+02 | 3.36E+02 | 3.3E+02 | 3.91E+02 |
| Diesel (cubic meters) | Total | ~~6.46~~ 7.81E+04 ~~6.54E+04~~ | 6.44 ~~6.4E+04~~ | 1.2E+05 ~~9.72E+04~~ | 5.21 ~~5.16E+05~~ | 3.6E+04 | 3.7 ~~3.2E+04~~ |
| | Construction | 1.19E+04 | 1.19E+04 | 2.9E+04 | 4.54E+05 | 1.8E+04 | 1.3E+04 |
| | Operation | ~~3.50~~ 1.4E+04 ~~1.02E+03~~ | 2.68 ~~1.02E+02~~ | 2.4E+04 ~~1.02E+03~~ | 9.22 ~~4.17E+03~~ | 2.0E+02 | 6.0 ~~1.22E+03~~ |
| | Closure | 5.22E+04 | 5.22E+04 | 6.72E+04 | 5.8E+04 | 1.8E+04 | 1.8E+04 |
| Kerosene (cubic meters) | Operation | ~~5.64E+04~~ 1.06E+05 | 8.05E+04 1.05E+04 | ~~9.36E+04~~ 2.34E+05 | ~~2.9E+04~~ 4.93 | 9.8E+02 | 3.0E+04 5.1 |
| Materials: Concrete (cubic meters) | Total | 9.62 ~~2.33E+06~~ | 2.22 ~~1.27E+06~~ | ~~8.48~~ 9.35 ~~6.69E+05~~ 8.66 | 6.67 ~~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 | ~~2.43~~ 9.17 ~~2.04E+06~~ | 1.93E+06 ~~9.8E+05~~ | ~~1.58~~ 4.76 ~~1.5E+05~~ 3.47 | 3.68E+05 ~~8.5E+04~~ | 4.4E+02 | ~~1.7E+04~~ 5.93E+05 |
| | Closure | 1.9E+04 | 1.9E+04 | 1.9E+04 | 1.9E+04 | 0 | 1.9E+04 |



Page 4-4
8-15-96

Table B.10.0.3 Resource Summary, Tank Waste Alternatives (cont'd)

| Resource | Phase | Ex Situ No Separations Alternative (Vitrification) | Ex Situ No Separations Alternative (Calcination) | Ex Situ Extensive Separations Alternative | Ex Situ/ In Situ Combination Alternative | Phased Implementation Alternative (Phase 1) | Phased Implementation Alternative (Phase 2) |
|---|---|---|---|---|---|---|---|
| Carbon Steel (metric tons) | Total | ~~2.32E+05~~ 2.06E+05 | 1.33 ~~1.32E+05~~ | 3.18 2.84 ~~1.98E+05~~ | ~~7.34E+04~~ ~~8.21E+04~~ 1.28E+05 | 8.3E+04 | ~~7.85E+04~~ 2.07E+05 |
| | Construction | 6.72E+04 ~~6.12E+04~~ | 6.22 ~~6.12E+04~~ | 1.4E+05 | 5.36E+04 ~~5.35E+04~~ | 8.3E+04 | 5.89 ~~5.85E+04~~ |
| | Operation | OK ~~1.46E+05~~ 1.46E+05 NK | 7.04E+04 | ~~1.72E+05~~ ~~1.62E+04~~ 1.44 | ~~2.06E+04~~ ~~9.61E+03~~ 7.4E+04 | 2.9E+02 | 1.48E+05 ~~2.0E+04~~ |
| | Closure | N/A | N/A | N/A 2.22E+04 ~~[illegible]~~ | N/A | N/A | N/A 3.66E+04 |
| Stainless Steel (mt) | TOTAL Construction | 4.53E+05 1.26E+04 | 9.39E+04 1.26E+04 | 2.1E+04 | 3.2E+04 9.5E+03 | 1.5E+04 | 1.15E+04 |
| Hastelloy/Inconel (mt) | OPERATION Construction | 4.4E+05 1.51E+03 | 8.13E+04 1.51E+03 | 1.2E+03 1.80E+03 | 1.25E+04 1.15E+03 | 2.6E+03 | 2.37E+04 1.15E+04 |
| Glass Formers (mt) | Operation | 4.66 ~~2.5E+05~~ | N/A | 8.88 ~~3.55E+05~~ | 2.50 ~~1.47E+05~~ | 1.3E+05 | 4.76 ~~2.8E+05~~ |
| 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 sulfur (mt) | Operation | N/A | N/A | 4.35 ~~1.7E+05~~ | 1.11E+05 ~~6.5E+04~~ | 1.43E+04 3.74E+02 ~~5.2E+04~~ | ~~1.2E+05~~ 3.04E+05 |
| dicyclopentadine (mt) | | N/A | N/A 1.12E+04 | ~~4.46E+03~~ | 2.83 ~~2.65E+03~~ | ~~7.4E+02~~ ~~1.36E+03~~ | ~~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~~ ~~1.46E+03~~ 3.74E+02 | ~~2.4E+03~~ 5.78E+03 |
| Ion exchange media (cubic meters) | Operation | N/A | N/A | 4.9E+03 | 1.1E+02 | 1.4E+01 | 1.4E+02 |
| Borrow Site Silt (cubic meters) | Closure | 3.77E+05 | 3.77E+05 | 5.35E+05 | 4.36E+05 | 0 | 5.26E+05 |
| Borrow Site Sand and Gravel (cubic meters) | Total | 1.38E+07 ~~1.29E+06~~ | ~~3.62~~ ~~1.33~~ ~~1.29E+06~~ 3.84 | 2.4 ~~1.73E+06~~ | 1.92 ~~1.34E+06~~ | 1.2E+04 | 2.2 ~~1.5E+06~~ |
| | Construction | ~~3.42E+05~~ ~~1.23E+05~~ 5.55 | 1.68 ~~1.23E+05~~ | 8.88 ~~3.72E+05~~ | 6.05 ~~4.11E+05~~ | 1.2E+04 | 5.67 ~~1.71E+05~~ |
| | 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~~ 7.54 ~~7.44E+05~~ |
| | Closure | 1.17E+06 | 1.17E+06 | 1.36E+06 | 9.4E+05 | N/A | 1.36E+06 |
| Borrow Site Basalt (cubic meters) [1] | Closure | 6.38E+05 | 6.38E+05 | 8.05E+05 | 7.0E+05 | N/A | 8.05E+05 |

add a block for Total

add a block for operations under Stainless steel

page A-5 PBW 8-15-96

Table B.10.0.3 Resource Summary, Tank Waste Alternatives (cont'd)

| Resource | Phase | Ex Situ No Separations Alternative (Vitrification) | Ex Situ No Separations Alternative (Calcination) | Ex Situ Extensive Separations Alternative | Ex Situ/ In Situ Combination Alternative | Phased Implementation Alternative (Phase 1) | Phased Implementation Alternative (Phase 2) |
|---|---|---|---|---|---|---|---|
| Asphalt (cubic meters) | Closure | 6.25E+04 | 6.25E+04 | 8.16E+04 | 6.98E+04 | N/A | 8.07E+04 |

Notes:
[1] Silt and Basalt Borrow materials are used only for barrier construction during closure.
N/A = Not Applicable
N/R = Not Reported



Page A-6
RDW 2-15-96

Page A-7
RDW 2-15-96

Table 3.6.1 Borrow Site Summary - Materials Used During Construction and Operations

| Alternative | Borrow Type | Amount ($m^3$ [$ft^3$]) | Location |
|---|---|---|---|
| No Action (Tank Waste) | N/A | N/A | N/A |
| Long-Term Management | N/A | N/A | N/A |
| In Situ Fill and Cap | Aggregate | 690,000 (2.5E+07) | Pit 30 |
| In Situ Vitrification | Sand | 540,000 (1.9E+07) | Pit 30 |
| Ex Situ Intermediate Separations | Aggregate 16.7 ~~17.4~~ / 7.29 → | 317,000 (1.1E+07) | Pit 30 |
| Ex Situ No Separations<br>- Vitrification<br>- Calcination 1.29 / 1.27 1.02 | Aggregate 4.32 / 2.66 →<br>Aggregate | 200 000 (7.2 E+06)<br>123,000 (4.4E+06)<br>123,000 (4.4E+06) | Pit 30<br>Pit 30 |
| Ex Situ Extensive Separations | Aggregate 8.66 ~~9.55~~ / 6.69 | 481543 (1.68)<br>372,000 (1.3E+07) | Pit 30 |
| Ex Situ/In Situ Combination | Aggregate 4.73 / 3.74 | 518 650 (1.9)<br>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<br>Riprap<br>Aggregate/Sand | 377,000 (1.3E+07)<br>638,000 (2.3E+07)<br>415,000 (1.5E+07) | McGee Ranch<br>Vernita Quarry<br>Pit 30 |
| Ex Situ Intermediate Separations, Extensive Separations, or Phased Implementation (Phase 2) [2] | Silt<br>Riprap<br>Aggregate/Sand | 530,000 (1.9E+07)<br>805,000 (2.9E+07)<br>606,000 (2.2E+07) | McGee Ranch<br>Vernita Quarry<br>Pit 30 |
| Ex Situ/In Situ Combination | Silt<br>Riprap<br>Aggregate/Sand | 436,000 (1.6E+07)<br>490,000 (1.7E+07)<br>700,000 (2.5E+07) | McGee Ranch<br>Vernita Quarry<br>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 |

Page A-9
RJW 2-15-96

Table B.10.0.3 Resource Summary, Tank Waste Alternatives (cont'd)

| Resource | Phase | No Action Alternative | Long-Term Management | In Situ Fill and Cap Alternative | In Situ Vitrification Alternative | Ex Situ Intermediate Separations Alternative |
|---|---|---|---|---|---|---|
| Diesel (cubic meters) | Total | 2.2E+04 | 8.5E+04 | 5.96E+04 | 7.1E+04 | 8.82E+04 |
| | Construction | N/A | 6.3E+04 | 1.3E+03 | 1.5E+04 | 2.1E+04 |
| | Operation | 2.2E+04 | 2.2E+04 | 6.1E+03 | 6.1E+03 | 1.02E+03 |
| | Closure | N/A | N/A | 5.22E+04 | 4.5E+04 | 6.62E+04 |
| Kerosene (cubic meters) | Operation | N/A | N/A | N/A | N/A | 5.8E+04 |
| Materials:• Concrete (cubic meters) | Total | N/A | 3.5E+05 | 1.9E+04 | 1.3E+05 | 7.29E+05 |
| | Construction | N/A | 3.5E+05 | N/R | 1.3E+05 | 5.4E+05 |
| | Operation | N/A | N/A | N/R | N/R | 1.7E+05 |
| | Closure | N/A | N/A | 1.9E+04 | N/R | 1.9E+04 |
| Carbon Steel (metric tons) | Total | 1E+03 | 1.33E+04 | N/R | 2.6E+05 | 1.64E+05 |
| | Construction | N/A | 1.23E+04 | N/R | 2.6E+05 | 1.07E+05 |
| | Operation | 1E+03 | 1.0E+03 | N/R | 2.6E+05 | N/R |
| | Closure | N/R | N/A | N/R | N/R | 1.9E+04 |
| Stainless Steel (mt) | Construction | N/A | 2.2E+01 | N/R | N/R | 1.9E+04 |
| Hastelloy/Inconel (mt) | Construction | N/R | N/R | N/R | N/R | 2.3E+03 |
| Glass Formers (mt) | Operation | N/A | N/A | N/A | 1.1E+04 | 2.94E+05 |
| Process Chemicals (mt) | Operation | N/A | N/A | N/R | 6.8E+03 | 1.90E+05 |
| Bulk sulfur cement<br>sulfur (mt)<br>dicyclopentadine (mt)<br>oligomer (mt) | Operation | N/A | N/A | N/A | N/A | <br>1.30E+05<br>3.4E+03<br>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 | ~~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 | ~~108~~ 112 | ~~106~~ 109 | ~~33~~ 32 | ~~108~~ 147 |
| | Construction/ Operation | ~~63~~ 146 | ~~63~~ 81 | ~~84~~ 88 | ~~84~~ 87 | ~~33~~ 32 | ~~84~~ 123 |
| | Closure | 20 | 20 | 24 | 22 | 0 | 24 |
| Borrow Pit Disturbed Area (hectares) based on an excavation depth of 3 meters | McGee Ranch | 16 | 16 | ~~21~~ 25 | ~~18~~ 21 | ~~0~~ 1 | ~~21~~ 25 |
| | Pit 30 | ~~44~~ 47 | 44 | ~~59~~ 68 | ~~32~~ 48 | ~~0~~ 1 | ~~51~~ 74 |
| | Vernita Quarry | 21 | 21 | ~~27~~ 31 | ~~23~~ 26 | 0 | ~~27~~ 31 |
| Water, Total (cubic meters) | Sanitary plus Raw Water | 2.8E+06 | 2.4E+06 | 3.39E+07 | 1.35E+07 | 2.8E+06 | 1.08E+07 |
| Water, Sanitary (cubic meters) | Total | 2.34E+06 | 3.6E+05 | 3.9E+06 | 2.5E+06 | 6.3E+05 | 3.08E+06 |
| | Construction | 2.39E+05 | 2.39E+05 | 5.29E+05 | 4.19E+05 | 3.9E+05 | 2.54E+05 |
| | Operation | 2.06E+06 | 2.08E+06 | 3.21E+06 | 3.08E06 | 2.2E+05 | 2.77E+06 |
| | Closure | 4.13E+04 | 4.13E+04 | 2.05E+05 | 4.9E+04 | 1.6E+04 | 6.03E+04 |
| Water, Raw (cubic meters) | Total | 4.62E+05 | 8.58E+04 | 3.0E+07 | 1.1E+07 | 2.2E+06 | 5.5E+06 |
| | Construction | N/R | N/R | N/R | 5.5E+06 | N/R | N/R |
| | Operation | 4.62E+05 | 8.58E+04 | 3.0E+07 | 5.5E+06 | 2.2E+06 | 7.7E+06 |
| | Closure | N/R | N/R | N/R | N/R | N/R | N/R |

Page A-10
Rev 8-15-96



deis\appenb\appenb.d11

Table B.10.0.3 Resource Summary, Tank Waste Alternatives (cont'd)

| Resource | Phase | Ex Situ No Separations Alternative (Vitrification) | Ex Situ No Separations Alternative (Calcination) | Ex Situ Extensive Separations Alternative | Ex Situ/ In Situ Combination Alternative | Phased Implementation Alternative (Phase 1) | Phased Implementation Alternative (Phase 2) |
|---|---|---|---|---|---|---|---|
| Energy Electricity (Gwh) | Total | 4.72E+03 | 4.72E+03 | 1.67E+04 | 4.54E+03 | 1.7E+03 | 6.14E+03 |
| | Construction | 3.0E+01 | 3.0E+01 | 8.9E+01 | 3.8E+01 | 5.0E+01 | 3.73E+01 |
| | Operation | 4.69E+03 | 4.69E+03 | 1.66E+04 | 4.5E+03 | 1.6E+03 | 6.1E+03 |
| | Closure | N/R | N/R | N/R | N/R | N/R | N/R |
| Gasoline (cubic meters) | Total | 5.4E+03 | 5.4E+03 | 1.0E+04 | 3.0E+05 | 6.8E+03 | 5.1E+03 |
| | Construction | 5.1E+03 | 5.1E+03 | 9.7E+03 | 3.0E+05 | 6.5E+03 | 4.71E+03 |
| | Operation | N/R | N/R | N/R | N/R | N/R | N/R |
| | Closure | 3.01E+02 | 3.01E+02 | 3.91E+02 | 3.36E+02 | 3.3E+02 | 3.91E+02 |
| Diesel (cubic meters) | Total | 6.51E+04 | 6.4E+04 | 9.72E+04 | 5.16E+05 | 3.6E+04 | 3.2E+04 |
| | Construction | 1.19E+04 | 1.19E+04 | 2.9E+04 | 4.54E+05 | 1.8E+04 | 1.3E+04 |
| | Operation | 1.02E+03 | 1.02E+02 | 1.02E+03 | 4.17E+03 | 2.0E+02 | 1.22E+03 |
| | Closure | 5.22E+04 | 5.22E+04 | 6.72E+04 | 5.8E+04 | 1.8E+04 | 1.8E+04 |
| Kerosene (cubic meters) | Operation | 5.64E+04 | 8.05E+04 | 9.36E+04 | 2.9E+04 | 9.8E+02 | 3.0E+04 |
| Materials: Concrete (cubic meters) | Total | 2.33E+06 | 1.27E+06 | 6.69E+05 | 3.74E+05 | 2.4E+04 | 6.5E+04 |
| | Construction | 2.66E+05 | 2.66E+05 | 5.0E+05 | 2.7E+05 | 2.4E+04 | 2.9E+04 |
| | Operation | 2.04E+06 | 9.8E+05 | 1.5E+05 | 8.5E+04 | 4.4E+02 | 1.7E+04 |
| | Closure | 1.9E+04 | 1.9E+04 | 1.9E+04 | 1.9E+04 | 0 | 1.9E+04 |

Page A-11
PBW 8-15-96

Table B.10.0.3 Resource Summary, Tank Waste Alternatives (cont'd)

| Resource | Phase | Ex Situ No Separations Alternative (Vitrification) | Ex Situ No Separations Alternative (Calcination) | Ex Situ Extensive Separations Alternative | Ex Situ/ In Situ Combination Alternative | Phased Implementation Alternative (Phase 1) | Phased Implementation Alternative (Phase 2) |
|---|---|---|---|---|---|---|---|
| Carbon Steel (metric tons) | Total | 2.32E+05 | 1.32E+05 | 1.98E+05 | 8.21E+04 | 8.3E+04 | 7.85E+04 |
| | Construction | 6.12E+04 | 6.12E+04 | 1.4E+05 | 5.35E+04 | 8.3E+04 | 5.85E+04 |
| | Operation | 1.46E+05 | 7.04E+04 | 1.62E+04 | 9.6E+03 | 2.9E+02 | 2.0E+04 |
| | Closure | N/A | N/A | N/A | N/A | N/A | N/A |
| Stainless Steel (mt) | Construction | 1.26E+04 | 1.26E+04 | 2.1E+04 | 9.5E+03 | 1.5E+04 | 1.15E+04 |
| Hastelloy/Inconel (mt) | Construction | 1.51E+03 | 1.51E+03 | 1.80E+03 | 1.15E+03 | 2.6E+03 | 1.15E+04 |
| Glass Formers (mt) | Operation | 2.5E+05 | N/A | 3.55E+05 | 1.47E+05 | 1.3E+05 | 2.8E+05 |
| Process Chemicals (mt) | Operation | 1.95E+05 | 3.06E+05 | 8.86E+05 | 9.55E+04 | 5.8E+04 | 1.5E+05 |
| Bulk sulfur cement<br>sulfur (mt)<br>dicyclopentadine (mt)<br>oligomer (mt) | Operation | <br>N/A<br>N/A<br>N/A | <br>N/A<br>N/A<br>N/A | <br>1.7E+05<br>4.46E+03<br>4.46E+03 | <br>6.5E+04<br>2.65E+03<br>1.70E+03 | <br>5.2E+04<br>7.4E+02<br>6.8E+02 | <br>1.2E+05<br>3.4E+03<br>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<br>6.45 | ~~4.36~~E+05<br>5.11 | 0 | ~~5.26~~E+05<br>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<br>9.31 | ~~7.0~~E+05<br>7.85 | N/A | ~~8.05~~E+05<br>9.31 |

deis\appenb\appenb.d11



Page A-12
Rev 2-15-96

Page A-13
RDW 2-15-96

# TWRS EIS
# CALCULATION COVER SHEET

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

ORIGINATOR Colin Henderson DATE 1/27/96

REVISION NO. 0

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

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

ASSUMPTIONS Noted.

(Continue on another sheet if necessary)

J C Henderson
SIGNATURE

CALCULATION & RESULTS ATTACHED

JACOBS\FORMS\CALCVR.SHT

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.

Page A-15
RDW 2-15-96



| 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 Stone | |
| | | | | | |
| | | | | | |
| | | | | Σ W oxides | |
| | | | | | |
| | | | | | |
| | | | | | |
| | | m NaOH ÷ (.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 | | 166,188 ~~108388~~ |
| Number of 0.62 m^3 canisters per HMPC | | | 4 | | 4 |
| Number of trips to the repository | | | 14686 | 14678 | 4150 ~~2710~~ |
| Based on 10 HMPCs per train | | | | | |
| | | | | | |
| Note: Curies from decay daughter products not included | | | | | |
| | | | | | |
| | | | | | 108388 |
| | | | | | 587000 |
| | | | | | |
| | | | | | |
| | | | | | b = 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 | | |

RDW 2-15-96

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

20 wt% waste oxide loading, 1.5 blending factor

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

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

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

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

Note: Curies from decay daughter products not included



a 10/10

Page A-23
RJW 2-15-96

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Assumptions: | | | | | | | | | | |
| 1. HLW glass waste oxide loading basis to be 20 wt% waste oxides (excluding Na2O and SiO2) | | | | | | | | | | |
| 2. Using the WHC engineering data package material balance calculate the waste oxide loading | | | | | | | | | | |
| and adjust mass of the glass produced to achieve a 20 wt % waste oxide loading | | | | | | | | | | |
| 3. LAW glass sodium oxide loading basis is to be 15 wt% | | | | | | | | | | |
| | | | | | | | | | | |
| | | | | | | | | | | |
| | | | | | | | | | | |
| | Input Stream | | | LAW | | | HLW | | | HLW fraction |
| | STREAM 1 | | | 407 | 437 | | 314 | 344 | | |
| | solids | liquids | | FRIT | GLASS | | FRIT | GLASS | | |
| Volume kilo-liters | | | | | | | | | | |
| Specific Gravity | | | | | | | | | | |
| Cs and Ba, (MCi) | 5.28E+00 | 6.28E+01 | | | 4.93E-01 | | | 6.74E+01 | | 0.990011751 |
| Sr and Y, (MCi) | 1.05E+02 | 2.10E+00 | | | 1.90E+00 | | | 1.05E+02 | | 0.980392157 |
| Tc, (MCi) | 5.89E-03 | 2.61E-02 | | | 2.59E-02 | | | 5.91E-03 | | 0.184745233 |
| Am, (MCi) | 9.51E-02 | 8.61E-03 | | | 8.60E-03 | | | 9.52E-02 | | 0.917944268 |
| Np, (MCi) | 9.29E-05 | 1.03E-05 | | | 1.03E-05 | | | 9.29E-05 | | 0.900193798 |
| Pu-239, (MCi) | 2.47E-02 | 1.67E-03 | | | 1.67E-03 | | | 2.47E-02 | | 0.936670459 |
| Pu-240, (MCi) | 6.28E-03 | 4.14E-04 | | | 4.14E-04 | | | 6.28E-03 | | 0.93815357 |
| Pu-241,(MCi) | 7.34E-02 | 1.49E-03 | | | 1.48E-03 | | | 7.34E-02 | | 0.980104153 |
| Total TRU, (MCi) | 2.00E-01 | 1.22E-02 | | | 1.22E-02 | | | 2.00E-01 | | 0.942507069 |
| Total MCi | 1.11E+02 | 6.49E+01 | | | 2.43E+00 | | | 1.73E+02 | | 0.98351336 |
| Total Mass Flow (MT) | 1.94E+04 | 7.10E+05 | | 2.81E+05 | 3.87E+05 | | 1.36E+04 | 2.51E+04 | | |
| Total Cr, (MT) | 1.32E+02 | 5.15E+01 | | | 1.44E+02 | | | 3.96E+01 | | |
| Total Na, (MT) | 1.24E+03 | 6.51E+04 | | | 7.18E+04 | | | 2.33E+03 | | |
| Total Si, (MT) | 5.24E+02 | 5.65E+00 | | 1.07E+05 | 1.07E+05 | | 5.29E+03 | 5.83E+03 | | |
| Total P, (MT) | 7.80E+02 | 8.42E+02 | | | 1.35E+03 | | | 2.72E+02 | | |
| Total NO2-, (MT) | 7.38E+01 | 9.54E+03 | | | | | | | | |
| Total NO3-, (MT) | 1.03E+03 | 1.06E+05 | | | | | | | | |
| AG+ | 1.38E+00 | 3.28E-01 | | | | | | | | |
| AG2O | | | | | 3.52E-01 | | | 1.48E+00 | | |
| AL+3 | 2.37E+03 | | | | | | | | | |
| AL2O3 | | | | 1.32E+04 | 1.94E+04 | | | 1.73E+03 | | |
| AL(OH)4- | | 4.83E+03 | | | | | | | | |
| AM+3 | 2.77E-02 | 2.51E-03 | | | | | | | | |
| AM2O3 | | | | | 2.76E-03 | | | 3.05E-02 | | |
| AS+5 | 4.98E-01 | 7.70E-01 | | | | | | | | |
| AS2O5 | | | | | 1.18E+00 | | | 7.66E-01 | | |
| B+3 | 9.94E-01 | 5.19E-01 | | | | | | | | |
| B2O3 | | | | | 1.67E+00 | | 1.75E+03 | 1.76E+03 | | |
| BA+2 | 3.09E+00 | 7.91E-01 | | | | | | | | |
| BAO | | | | | 8.81E-01 | | | 3.45E+00 | | |
| BE+2 | 7.61E-03 | 8.19E-02 | | | | | | | | |
| BEO | | | | | 2.27E-01 | | | 2.16E-02 | | |
| BI+3 | 1.96E+02 | 6.76E+01 | | | | | | | | |
| BI2O3 | | | | | 7.52E+01 | | | 2.19E+02 | | |
| C14 | 4.53E-04 | 7.43E-04 | | | | | | | | |
| CA+2 | 1.33E+02 | 1.67E+01 | | | | | | | | |
| CANCRINITE | 2.70E+03 | | | | | | | | | |
| CAO | | | | 3.87E+04 | 3.87E+04 | | | 1.89E+02 | | |
| CD+2 | 7.93E+00 | 2.09E+00 | | | | | | | | |
| CDO | | | | | 2.38E+00 | | | 9.06E+00 | | |
| CE+3 | 2.35E+02 | 2.37E+00 | | | | | | | | |
| CE2O3 | | | | | 2.79E+00 | | | 2.76E+02 | | |
| CL- | 3.49E+00 | 3.11E+02 | | | | | | | | |
| CL2 | | | | | | | | | | |
| CO | | | | | | | | | | |
| CO2 | | | | | | | | | | |
| CO3-2 | 2.25E+02 | 3.37E+03 | | | | | | | | |
| CR+3 | 1.32E+02 | | | | | | | | | |
| CR2O3 | | | | | 2.11E+02 | | | 5.79E+01 | | |
| CR(OH)4- | | 1.19E+02 | | | | | | | | |
| CS+ | 9.25E-02 | 8.19E-01 | | | | | | | | |
| CS2O | | | | | 6.83E-03 | | | 9.58E-01 | | |
| CU+2 | 7.46E-01 | 1.77E-01 | | | | | | | | |
| CUO | | | | | 2.21E-01 | | | 9.34E-01 | | |

Page A-24
Rev 2-15-96

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| 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** | | | | | | | | | | |

Page A-26
RDW 8-15-96

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| 15 wt. % sodium oxide loading | | | | | | | | | | |
| Blending factor | | | | 1 | 1.25 | 1.5 | 2 | 3.5 | | |
| Mass of glass required to achieve 15% wo loading, MT | | | | 6.45E+05 | 8.07E+05 | 9.68E+05 | 1.29E+06 | 2.26E+06 | | |
| additional frit required (equals increased glass) MT | | | | 3.64E+05 | 5.26E+05 | 6.87E+05 | 1.01E+06 | 1.98E+06 | | |
| total frit required, MT | | | | 6.45E+05 | 8.07E+05 | 9.68E+05 | 1.29E+06 | 2.26E+06 | | |
| | | | | | | | | | | |
| glass density (MT/m^3) | 2.63 | | | | | | | | | |
| cullet packing fraction | 0.7 | | | | | | | | | |
| | | | | | | | | | | |
| Waste volume (m^3) | | | | 3.51E+05 | 4.38E+05 | 5.26E+05 | 7.01E+05 | 1.23E+06 | | |
| | | | | | | | | | | |
| Number of 5300 m^3 vaults | | | | 66 | 83 | 99 | 132 | 231 | | |
| | | | | | | | | | | |
| LAW facility sizing | | | | | | | | | | |
| Schedule, years | 14 | | | | | | | | | |
| Capacity MT/day | 200 | | | | | | | | | |
| | | | | | | | | | | |
| Overall efficiency, % | | | | 63% | 79% | 95% | 126% | 221% | | |
| Required capacity MT/day (assuming 14 yrs ops, 60% OE) | | | | 210.48 | 263.10 | 315.72 | 420.96 | 736.68 | | |
| Required operating duration yrs (assuming 200 MT/day, 60% OE) | | | | 14.73 | 18.42 | 22.10 | 29.47 | 51.57 | | |
| | | | | | | | | | | |
| 10 wt. % sodium oxide loading | | | | | | | | | | |
| Blending factor | | | | 1 | | | 2 | 3.5 | | |
| Mass of glass required to achieve 10 wt% Na2O | | | | 968000 | | | 1936000 | 3388000 | | |
| | | | | | | | | | | |
| Waste volume, m^3 | | | | 525801.195 | | | 1051602.39 | 1840304.183 | | |
| Number of 5,300 m^3 vaults | | | | 99 | | | 198 | 347 | | |
| | | | | | | | | | | |
| 25 wt. % sodium oxide loading | | | | | | | | | | |
| Blending factor | | | | 1 | | | 2 | 3.5 | | |
| Mass of glass required to achive 25 wt % Na2O | | | | 387200 | | | 774400 | 1355200 | | |
| | | | | | | | | | | |
| Waste Volume | | | | 210320.478 | | | 420640.956 | 736121.673 | | |
| Number of 5,300 m^3 vaults | | | | 40 | | | 79 | 139 | | |

use 10% LAW + 15% HLW } as a case + Calculate Column as for table B10.0.3

and calculate to give trips required - additional.

Page A-27
ADW - 2-15-96



| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| 15 wt. % sodium oxide loading | | | | | | | | | | |
| Blending factor | | | | 1 | 1.25 | 1.5 | 2 | 3.5 | | |
| Mass of glass required to achieve 15% wo loading, MT | | | | 6.45E+05 | 8.07E+05 | 9.68E+05 | 1.29E+06 | 2.26E+06 | | |
| additional frit required (equals increased glass) MT | | | | 3.64E+05 | 5.26E+05 | 6.87E+05 | 1.01E+06 | 1.98E+06 | | |
| total frit required, MT | | | | 6.45E+05 | 8.07E+05 | 9.68E+05 | 1.29E+06 | 2.26E+06 | | |
| | | | | | | | | | | |
| glass density (MT/m^3) | 2.63 | | | | | | | | | |
| cullet packing fraction | 0.7 | | | | | | | | | |
| | | | | | | | | | | |
| Waste volume (m^3) | | | | 3.51E+05 | 4.38E+05 | 5.26E+05 | 7.01E+05 | 1.23E+06 | | |
| | | | | | | | | | | |
| Number of 5300 m^3 vaults | | | | 66 | 83 | 99 | 132 | 231 | | |
| | | | | | | | | | | |
| LAW facility sizing | | | | | | | | | | |
| Schedule, years | 14 | | | | | | | | | |
| Capacity MT/day | 200 | | | | | | | | | |
| | | | | | | | | | | |
| Overall efficiency, % | | | | 63% | 79% | 95% | 126% | 221% | | |
| Required capacity MT/day (assuming 14 yrs ops, 60% OE) | | | | 210.48 | 263.10 | 315.72 | 420.96 | 736.68 | | |
| Required operating duration yrs (assuming 200 MT/day, 60% OE) | | | | 14.73 | 18.42 | 22.10 | 29.47 | 51.57 | | |
| | | | | | | | | | | |
| 10 wt. % sodium oxide loading | | | | | | | | | | |
| Blending factor | | | | 1 | 1.25 | | 2 | 3.5 | | |
| Mass of glass required to achieve 10 | | | | 968000 | 1210000 | | 1936000 | 3388000 | | |
| | | | | | | | | | | |
| Waste volume, m^3 | | | | 525801.195 | 657251.4938 | | 1051602.39 | 1840304.183 | | |
| Number of 5,300 m^3 vaults | | | | 99 | 124 | | 198 | 347 | | |
| | | | | | | | | | | |
| 25 wt. % sodium oxide loading | | | | | | | | | | |
| Blending factor | | | | 1 | 1.25 | | 2 | 3.5 | | |
| Mass of glass required to achive 25 wt % Na2O | | | | 387200 | 484000 | | 774400 | 1355200 | | |
| | | | | | | | | | | |
| Waste Volume | | | | 210320.478 | 262900.5975 | | 420640.956 | 736121.673 | | |
| Number of 5,300 m^3 vaults | | | | 40 | 50 | | 79 | 139 | | |

Page A-28
RJW - 2-15-96

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

Page A-29
RDW 2-15-96

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

PAGE A-30
RDO 2-15-96

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| NIO | | | | 2.27E+02 | | | |
| NO | | | | | | | |
| NO2 | | | | | | | |
| NO2- | 9.54E+03 | 7.38E+01 | | | | | |
| NO3- | 1.06E+05 | 1.03E+03 | | | | | |
| NP+4 | 1.46E-02 | 1.32E-01 | | | | | |
| NPO2 | | | | 1.66E-01 | | | |
| O2 | | | | | | | |
| OH- | 6.44E+03 | 5.00E+03 | | | | | |
| PB+4 | 1.96E+00 | 3.28E+00 | | | | | |
| PBO2 | | | | 6.05E+00 | | | |
| PO4-3 | 2.58E+03 | 2.39E+03 | | | | | |
| P2O5 | | | | 3.71E+03 | | | |
| P2O5:24W | | 5.21E-01 | | | | | |
| PU+4 | 2.88E-02 | 4.27E-01 | | | | | |
| PUO2 | | | | 5.16E-01 | | | |
| S | | | | | | | |
| SI+4 | 5.65E+00 | 7.90E+01 | | | | | |
| SIO2 | | | 2.04E+05 | 2.06E+05 | * | | |
| SO2 | | | | | | | |
| SO4-2 | 2.01E+03 | 3.97E+01 | | | | | |
| SR+2 | 3.75E-01 | 3.64E+01 | | | | | |
| SRO | | | | 4.33E+01 | | | |
| TCO2 | | | | | | | |
| TCO4- | 2.52E+00 | 5.68E-01 | | | | | |
| TC2O7 | | | | 2.94E+00 | | | |
| TOC | 1.42E+03 | 1.16E+02 | | | | | |
| UO2+2 | 8.52E+01 | 1.58E+03 | | | | | |
| UO3 | | | | 1.76E+03 | | | |
| V+5 | 6.20E-02 | 1.88E-01 | | | | | |
| V2O5 | | | | 4.46E-01 | | | |
| W+6 | 7.47E-01 | | | | | | |
| WO2 | | | | 4.41E-01 | | | |
| WO3 | | | | 9.42E-01 | | | |
| ZN+2 | 3.59E+00 | 9.45E-01 | | | | | |
| ZNO | | | | 5.65E+00 | | | |
| ZR+4 | 4.48E-01 | 2.77E+02 | | | | | |
| ZRO2 | | | | 7.07E+02 | | | |
| ZRO2:2H2 | 2.15E+01 | 4.09E+02 | | | | | |
| | | | | | | | |
| WHC data package basis: | | | | | | | |
| mass waste oxides | | | | 1.08E+05 | 1.168E5 | | |
| waste loading (wt%) | | | | 30% | | | |
| sodium oxide loading | | | | 25% | | | |
| | | | | | | | |
| **20 wt. % sodium oxide loading** | | | | | | | |
| Blending factor | | | 1 | 1.25 | 1.5 | 2 | 3.5 |
| Mass of glass required to achieve 20% sodium loading, M | | | 4.47E+05 | 5.59E+05 | 6.71E+05 | 8.94E+05 | 1564500 |
| additional frit required (equals increased glass) MT | | | 9.00E+04 | 2.02E+05 | 3.14E+05 | 5.37E+05 | 1.21E+06 |

p-ref A-31
Rdw 2-15-96

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

page A-32
RDW 2-15-96

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Assumptions: | | | | | | | | |
| 1. HLW glass waste oxide loading basis to be 20 wt% waste oxides (excluding Na2O and SiO2) | | | | | | | | |
| 2. Using the WHC engineering data package material balance calculate the waste oxide loading | | | | | | | | |
| and adjust mass of the glass produced to achieve a 20 wt % waste oxide loading | | | | | | | | |
| not counting the SiO2 or the Na2O | | | | | | | | |
| | | | | | | | | |
| | | | | | | | | |
| | Input Stream | | | LAW | | | HLW | |
| | STREAM 1 | | | 407 | 437 | | 1314 | 1344 |
| | solids | liquids | | FRIT | GLASS | | FRIT | GLASS |
| | | | | | | | | |
| Volume kilo-liters | | 5.84E+05 | | | | | | |
| Specific Gravity | | 1.21E+00 | | | | | | |
| Cs and Ba, (MCi) | 7.60E+00 | 6.72E+01 | | | 6.86E-02 | | | 7.46E+01 |
| Sr and Y, (MCi) | 1.37E+02 | 1.41E+00 | | | 1.40E-02 | | | 1.37E+02 |
| Tc, (MCi) | 5.89E-03 | 2.61E-02 | | | 1.53E-04 | | | 3.17E-02 |
| Am, (MCi) | | | | | | | | |
| Np, (MCi) | | | | | | | | |
| Pu-239, (MCi) | | | | | | | | |
| Pu-240, (MCi) | | | | | | | | |
| Pu-241,(MCi) | | | | | | | | |
| Total TRU, (MCi) | 1.92E-01 | 1.52E-02 | | | 1.20E-03 | | | 2.06E-01 |
| Total MCi | 1.45E+02 | 6.87E+01 | | | 8.39E-02 | | | 2.12E+02 |
| Total Mass Flow (MT) | 2.37E+04 | 7.06E+05 | | 2.65E+05 | 3.86E+05 | | 8.73E+02 | 1.32E+03 |
| Total Cr, (MT) | | | | | | | | |
| Total Na, (MT) | | | | | | | | |
| Total Si, (MT) | | | | | | | | |
| Total P, (MT) | | | | | | | | |
| Total NO2-, (MT) | | | | | | | | |
| Total NO3-, (MT) | | | | | | | | |
| AG+ | 1.38E+00 | 3.28E-01 | | | | | | |
| AG2O | | | | | 4.07E-01 | | | 1.43E+00 |
| AL+3 | 2.37E+03 | | | | | | | |
| AL2O3 | | | | 1.16E+04 | 1.93E+04 | | | 1.94E+02 |
| AL(OH)4- | | 4.83E+03 | | | | | | |
| AM+3 | 2.77E-02 | 2.51E-03 | | | | | | |
| AM2O3 | | | | | 3.41E-05 | | | 3.32E-02 |
| APM- | | | | | | | | 3.44E-03 |
| AS+5 | 4.98E-01 | 7.70E-01 | | | | | | |
| AS2O5 | | | | | 4.33E-01 | | | 1.51E+00 |
| B+3 | 9.94E-01 | 5.19E-01 | | | | | | |
| B2O3 | | | | | 4.82E+00 | | 1.22E+02 | 1.22E+02 |
| BA+2 | 3.09E+00 | 7.91E-01 | | | | | | |
| BAO | | | | | 8.76E-01 | | | 3.46E+00 |
| BE+2 | 7.61E-03 | 8.19E-02 | | | | | | |
| BEO | | | | | 5.53E-02 | | | 1.93E-01 |
| BI+3 | 1.96E+02 | 6.76E+01 | | | | | | |
| BI2O3 | | | | | 2.90E+02 | | | 3.45E+00 |
| C14 | 4.53E-04 | 7.43E-04 | | | | | | |

page A-33
KJW 2-15-96

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

Page A-34
RDW 2-15-96

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

Page A-35
RDW 2-15-96

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Mass LAW waste oxides | | | | | 121198.787 | | | |
| LAW waste loading (waste oxides) | | | | | 31% | | | |
| LAW waste loading (sodium oxide) | | | | | 25% | | | |
| Mass HLW waste oxides | | | | | | | | 3.42E+02 |
| HLW waste loading | | | | | | | | 26% |
| | | | | | | | | |
| **HLW** | | | | | | | | |
| | | | | | | | | |
| 20 wt. % waste oxide loading | | | | | | | | |
| Blending factor | | | | 1 | 1.25 | 1.5 | 2 | 3.5 |
| Mass of glass required to achieve 20% wo loading, MT | | | | 1707.54219 | 2134.42773 | 2561.313278 | 3415.08437 | 5976.397648 |
| additional frit required (equals increased glass) MT | | | | 3.88E+02 | 8.14E+02 | 1.24E+03 | 2.10E+03 | 4.66E+03 |
| total frit required, MT | | | | 1.26E+03 | 1.69E+03 | 2.11E+03 | 2.97E+03 | 5.53E+03 |
| | | | | | | | | |
| glass density (MT/m^3) | 2.63 | | | | | | | |
| cullet packing fraction | 0.7 | (LAW only) | | | | | | |
| | | | | | | | | |
| Waste volume (m^3) | | | | 6.49E+02 | 8.12E+02 | 9.74E+02 | 1.30E+03 | 2.27E+03 |
| Canister Volume (m^3) | 0.62 | | | | | | | |
| Number of Canisters (1x) | | | | 1.05E+03 | 1.31E+03 | 1.57E+03 | 2.09E+03 | 3.67E+03 |
| Nu. of Canisters /HMPC | 4 | | | | | | | |
| Number of HMPCs | | | | 2.62E+02 | 3.27E+02 | 3.93E+02 | 5.24E+02 | 9.16E+02 |
| Number of trips @ 10 HMPCs /trip | | | | 26 | 33 | 39 | 52 | 92 |
| | | | | | | | | |
| Glass formulation: | | | | | | | | |
| (ref Ext. Sep Data Pkg.) | acceptable range | | | 1 | 1.25 | 1.5 | 2 | 3.5 |
| | | | | | | | | |
| SiO2 | 42 to 57 wt % | | | 62.58% | 66.39% | 68.94% | 72.12% | 76.21% |
| B2O3 | 5 to 20 wt % | | | 10.32% | 11.06% | 11.55% | 12.16% | 12.95% |
| Na20 | 5 to 20 wt % | | | 4.48% | 4.14% | 3.91% | 3.62% | 3.25% |
| Li2O | 1 to 7 wt % | | | 1.11% | 1.19% | 1.24% | 1.31% | 1.39% |
| Fe2O3 | 2 to 15 wt % | | | 2.48% | 0.00% | 0.00% | 0.00% | 0.00% |
| CaO | < or= 10 wt % | | | 0.14% | 0.11% | 0.09% | 0.07% | 0.04% |
| MgO | < or = 8 wt % | | | 0.01% | 0.01% | 0.01% | 0.01% | 0.00% |
| Al2O3 | < or = 15 wt % | | | 11.36% | 9.09% | 7.57% | 5.68% | 3.25% |
| ZrO2 | < or = 13 wt % | | | 0.50% | 0.40% | 0.33% | 0.25% | 0.14% |
| Cr2O3 | < or = 0.5 wt % | | | 0.08% | 0.06% | 0.05% | 0.04% | 0.02% |
| P2O5 | < or = 3 wt % | | | 2.32% | 1.86% | 1.55% | 1.16% | 0.66% |
| SO3 | < or = 0.5 wt % | | | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| | | | | | | | | |
| HLW Facility Sizing | | | | | | | | |
| Schedule | 14 yrs | | | | | | | |
| Capacity MT/day | 1 | | | | | | | |
| | | | | | | | | |
| Overall efficiency, % | | | | 33% | 42% | 50% | 67% | 117% |
| Required capacity MT/day (assuming 14 yrs ops, 60% OE) | | | | 0.56 | 0.70 | 0.84 | 1.11 | 1.95 |
| Required operating duration yrs (assuming 1 MT/day, 60% OE) | | | | | 9.75 | 11.70 | 15.59 | 27.29 |
| | | | | | | | | |

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

Page A-37
RDW 2-15-96

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| **LAW** | | | | | | | | |
| | | | | | | | | |
| 15 wt. % sodium oxide loading | | | | | | | | |
| Blending factor | | | | 1 | 1.25 | 1.5 | 2 | 3.5 |
| Mass of glass required to achieve 15% wo loading, MT | | | | 6.43E+05 | 8.04E+05 | 9.65E+05 | 1.29E+06 | 2.25E+06 |
| additional frit required (equals increased glass) MT | | | | 2.57E+05 | 4.18E+05 | 5.79E+05 | 9.01E+05 | 1.87E+06 |
| total frit required, MT | | | | 5.22E+05 | 6.83E+05 | 8.44E+05 | 1.17E+06 | 2.13E+06 |
| | | | | | | | | |
| glass density (MT/m^3) | 2.63 | | | | | | | |
| cullet packing fraction | 0.7 | | | | | | | |
| | | | | | | | | |
| Waste volume (m^3) | | | | 3.49E+05 | 4.37E+05 | 5.24E+05 | 6.99E+05 | 1.22E+06 |
| | | | | | | | | |
| Number of 5300 m^3 vaults | | | | 66 | 82 | 99 | 132 | 231 |
| | | | | | | | | |
| LAW facility sizing | | | | | | | | |
| Schedule, years | 19 | | | | | | | |
| Capacity MT/day | 200 | | | | | | | |
| | | | | | | | | |
| Overall efficiency, % | | | | 46% | 58% | 70% | 93% | 162% |
| Required capacity MT/day (assuming 19 yrs ops, 60% OE) | | | | 154.61 | 193.26 | 231.92 | 309.22 | 541.14 |
| Required operating duration yrs (assuming 200 MT/day, 60% | | | | 14.69 | 18.36 | 22.03 | 29.38 | 51.41 |
| | | | | | | | | |
| 10 wt. % sodium oxide loading | | | | | | | | |
| Blending factor | | | | 1 | 1.25 | 1.5 | 2 | 3.5 |
| Mass of glass required to achieve 10 | | | | 9.65E+05 | 1.21E+06 | 1.45E+06 | 1.93E+06 | 3.38E+06 |
| | | | | | | | | |
| Waste volume, m^3 | | | | 5.24E+05 | 6.55E+05 | 7.86E+05 | 1.05E+06 | 1.83E+06 |
| Number of 5,300 m^3 vaults | | | | 99 | 124 | 148 | 198 | 346 |
| | | | | | | | | |
| 25 wt. % sodium oxide loading | | | | | | | | |
| Blending factor | | | | 1 | 1.25 | 1.5 | 2 | 3.5 |
| Mass of glass required to achive 25 wt % Na2O | | | | 3.86E+05 | 4.83E+05 | 5.79E+05 | 7.72E+05 | 1.35E+06 |
| | | | | | | | | |
| Waste Volume | | | | 2.10E+05 | 2.62E+05 | 3.15E+05 | 4.19E+05 | 7.34E+05 |
| Number of 5,300 m^3 vaults | | | | 40 | 49 | 59 | 79 | 138 |

Ex Situ alternative comparison

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

Phased 26

Page A-38
RDW 2-15-96

not sys 15 2 it col.

others at 19

| SELECTIVE RETRIEVAL INVENTORY RECOVERED | | | | | |
|---|---|---|---|---|---|
| DECAYED TO 12/31/95 | | | | | % OF TOTAL |
| Radionuclides | 3WDS | 3EDS | 5EDS | TOTAL | DST INVENTORY |
| 14C | 0.00E+00 | 2.30E+03 | 1.49E+00 | 2.30E+03 | 99% |
| 90Sr | 3.52E+04 | 9.64E+06 | 3.82E+03 | 9.68E+06 | 87% |
| 90Y | 3.52E+04 | 9.64E+06 | 3.82E+03 | 9.68E+06 | 87% |
| 99Tc | 3.62E+03 | 1.51E+04 | 6.08E+02 | 1.93E+04 | 92% |
| 137Cs | 3.57E+06 | 2.08E+07 | 1.89E+06 | 2.63E+07 | 89% |
| 137Ba | 3.39E+06 | 1.98E+07 | 1.79E+06 | 2.50E+07 | 85% |
| 154Eu | 0.00E+00 | 7.43E+04 | 0.00E+00 | 7.43E+04 | 100% |
| 237Np | 0.00E+00 | 4.46E+01 | 0.00E+00 | 4.46E+01 | 98% |
| 238Pu | 0.00E+00 | 1.69E+02 | 0.00E+00 | 1.69E+02 | 12% |
| 239Pu | 5.79E+01 | 2.25E+03 | 5.39E+01 | 2.36E+03 | 28% |
| 240Pu | 1.45E+01 | 5.98E+02 | 1.35E+01 | 6.26E+02 | 26% |
| 241Pu | 3.18E+01 | 1.14E+04 | 2.96E+01 | 1.15E+04 | 29% |
| 241Am | 5.07E+02 | 4.96E+04 | 1.36E+02 | 5.03E+04 | 71% |
| Total Curies | 7.03E+06 | 6.00E+07 | 3.69E+06 | 7.08E+07 | 87% |

Page H-35
ABW 2-15-96

Page A-40
RDW 2-15-96

Table A.7
SST Radionuclide Inventory by Tank Group

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Ra-225 | 1.13E-06 | 1.30E-06 | 5.22E-06 | 1.65E-06 | 2.73E-06 | 1.20E-05 | 77% |
| Ra-226 | 5.37E-08 | 3.24E-08 | 4.78E-08 | 2.64E-08 | 1.33E-08 | 1.74E-07 | 83% |
| Ra-228 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | |
| Rh-106 | 5.40E-05 | 1.10E-02 | 7.58E-02 | 8.60E-02 | 3.35E-01 | 5.08E-01 | 86% |
| Rn-219 | 4.57E-03 | 2.75E-03 | 8.13E-03 | 1.37E-03 | 2.34E-04 | 1.71E-02 | 85% |
| Rn-220 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | |
| Rn-222 | 5.37E-08 | 3.24E-08 | 4.78E-08 | 2.64E-08 | 1.33E-08 | 1.74E-07 | 83% |
| Ru-106 | 5.85E-05 | 7.82E-03 | 7.93E-02 | 9.63E-02 | 3.43E-02 | 2.18E-01 | 37% |
| Sb-126 | 7.62E+00 | 1.21E+01 | 6.24E+00 | 1.33E+01 | 2.45E+01 | 6.38E+01 | 73% |
| Sb-126m | 5.44E+01 | 8.62E+01 | 4.46E+01 | 9.51E+01 | 1.75E+02 | 4.55E+02 | 73% |
| Se-79 | 8.02E+01 | 2.31E+02 | 4.90E+02 | 3.05E+01 | 6.15E+00 | 8.38E+02 | 92% |
| Sm-151 | 5.88E+04 | 9.46E+04 | 5.01E+04 | 9.46E+04 | 1.71E+05 | 4.69E+05 | 72% |
| Sn-126 | 5.44E+01 | 8.62E+01 | 4.46E+01 | 9.51E+01 | 1.75E+02 | 4.55E+02 | 73% |
| Sr-90 | 1.29E+06 | 6.84E+06 | 7.57E+06 | 4.65E+06 | 1.12E+07 | 3.16E+07 | 66% |
| Tc-99 | 9.67E+02 | 2.78E+03 | 5.91E+03 | 3.72E+02 | 7.43E+01 | 1.01E+04 | 92% |
| Th-227 | 4.47E-03 | 3.79E-03 | 7.88E-03 | 1.40E-03 | 1.85E-04 | 1.77E-02 | 89% |
| Th-228 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | |
| Th-229 | 1.13E-06 | 1.30E-06 | 5.22E-06 | 1.65E-06 | 2.73E-06 | 1.20E-05 | 77% |
| Th-230 | 7.89E-06 | 4.87E-06 | 6.85E-06 | 3.85E-06 | 2.73E-06 | 2.62E-05 | 82% |
| Th-231 | 6.93E+00 | 2.28E+00 | 6.48E+00 | 2.48E+00 | 5.72E-01 | 1.87E+01 | 91% |
| Th-232 | 1.77E-14 | 2.78E-14 | 2.93E-14 | 4.92E-14 | 4.32E-14 | 1.67E-13 | 86% |
| Th-234 | 1.65E+02 | 5.10E+01 | 1.53E+02 | 5.66E+01 | 1.37E+01 | 4.39E+02 | 91% |
| Tl-207 | 4.52E-03 | 3.83E-03 | 7.97E-03 | 1.42E-03 | 1.87E-04 | 1.79E-02 | 89% |
| Tl-208 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | |
| Tl-209 | 3.26E-08 | 5.60E-08 | 1.18E-07 | 4.44E-08 | 4.15E-08 | 2.92E-07 | 86% |
| U-233 | 8.15E-04 | 8.91E-04 | 5.29E-03 | 5.72E-04 | 1.08E-03 | 8.65E-03 | 80% |
| U-234 | 4.28E-02 | 2.82E-02 | 3.90E-02 | 2.72E-02 | 1.90E-02 | 1.56E-01 | 81% |
| U-235 | 6.93E+00 | 2.28E+00 | 6.48E+00 | 2.48E+00 | 5.72E-01 | 1.87E+01 | 91% |
| U-236 | 2.08E-04 | 3.25E-04 | 3.43E-04 | 5.76E-04 | 5.06E-04 | 1.96E-03 | 86% |
| U-237 | 9.22E-02 | 1.21E-01 | 1.94E-01 | 2.85E-01 | 2.23E-01 | 9.15E-01 | 87% |
| U-238 | 1.65E+02 | 5.10E+01 | 1.53E+02 | 5.66E+01 | 1.37E+01 | 4.39E+02 | 91% |
| Y-90 | 1.31E+06 | 6.92E+06 | 7.65E+06 | 4.69E+06 | 1.13E+07 | 3.19E+07 | 66% |
| Zr-93 | 3.41E+01 | 3.78E+02 | 2.23E+02 | 5.35E+02 | 1.46E+03 | 2.63E+03 | 67% |
| TOTAL | | | | | | 7.95E+07 | 69% |

Page A-41
RDW 2-15-96

# Table A.7
## SST Radionuclide Inventory by Tank Group

| Radionuclide | 12/31/95 | CURIES | SELECTIVE RETRIEVAL INVENTORY RECOVERED | | | | % OF TOTAL |
|---|---|---|---|---|---|---|---|
| SST group | 1WSS | 2WSS | 1ESS | 2ESS | 4ESS | Total | SST RAD |
| Number of Tanks | 40 | 43 | 40 | 16 | 10 | 149 | INVENTORY |
| Ac-225 | 1.13E-06 | 1.30E-06 | 5.22E-06 | 1.65E-06 | 2.73E-06 | 1.20E-05 | 77% |
| Ac-227 | 4.53E-03 | 3.84E-03 | 7.99E-03 | 1.42E-03 | 1.88E-04 | 1.80E-02 | 89% |
| Am-241 | 1.52E+03 | 7.08E+03 | 7.21E+03 | 9.51E+03 | 4.07E+03 | 2.94E+04 | 89% |
| Am-242 | 2.45E+00 | 1.52E+01 | 1.82E+01 | 1.97E+01 | 7.59E+00 | 6.31E+01 | 91% |
| Am-242m | 2.46E+00 | 1.52E+01 | 1.83E+01 | 1.98E+01 | 7.62E+00 | 6.34E+01 | 91% |
| Am-243 | 8.95E-01 | 6.53E+00 | 9.23E+00 | 1.15E+01 | 2.50E+00 | 3.07E+01 | 92% |
| At-217 | 1.13E-06 | 1.30E-06 | 5.22E-06 | 1.65E-06 | 2.73E-06 | 1.20E-05 | 77% |
| Ba-137m | 7.12E+05 | 3.35E+06 | 3.22E+06 | 7.44E+04 | 8.29E+04 | 7.44E+06 | 88% |
| Bi-210 | 1.33E-08 | 7.53E-09 | 1.23E-08 | 5.85E-09 | 1.69E-09 | 4.07E-08 | 82% |
| Bi-211 | 4.53E-03 | 3.84E-03 | 7.99E-03 | 1.42E-03 | 1.88E-04 | 1.80E-02 | 89% |
| Bi-212 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | |
| Bi-213 | 1.13E-06 | 1.30E-06 | 5.22E-06 | 1.65E-06 | 2.73E-06 | 1.20E-05 | 77% |
| Bi-214 | 5.37E-08 | 3.25E-08 | 4.78E-08 | 2.63E-08 | 1.33E-08 | 1.74E-07 | 83% |
| C-14 | 2.48E+02 | 4.49E+02 | 1.73E+03 | 2.07E+02 | 1.62E+02 | 2.80E+03 | 93% |
| Cm-242 | 2.03E+00 | 1.26E+01 | 1.51E+01 | 1.63E+01 | 6.29E+00 | 5.24E+01 | 91% |
| Cm-244 | 2.58E+00 | 2.28E+01 | 4.73E+01 | 5.29E+01 | 3.94E+00 | 1.29E+02 | 94% |
| Cm-245 | 1.64E-04 | 1.66E-03 | 3.61E-03 | 4.05E-03 | 3.02E-04 | 9.79E-03 | 94% |
| Cs-135 | 1.62E+01 | 5.73E+01 | 4.72E+01 | 8.91E-01 | 1.47E+00 | 1.23E+02 | 85% |
| Cs-137 | 7.52E+05 | 3.54E+06 | 3.40E+06 | 7.86E+04 | 8.76E+04 | 7.87E+06 | 88% |
| Fr-221 | 1.13E-06 | 1.30E-06 | 5.22E-06 | 1.65E-06 | 2.73E-06 | 1.20E-05 | 77% |
| Fr-223 | 6.25E-05 | 5.30E-05 | 1.10E-04 | 1.96E-05 | 2.59E-06 | 2.48E-04 | 89% |
| I-129 | 1.40E+00 | 4.03E+00 | 8.59E+00 | 5.66E-01 | 1.10E-01 | 1.47E+01 | 92% |
| Nb-93m | 7.44E+01 | 4.03E+02 | 3.52E+02 | 3.79E+02 | 1.11E+03 | 2.32E+03 | 76% |
| Ni-59 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0% |
| Ni-63 | 4.79E+03 | 2.21E+04 | 4.81E+04 | 5.47E+04 | 9.07E+04 | 2.20E+05 | 80% |
| Np-237 | 6.93E+00 | 9.19E+00 | 4.61E+01 | 7.24E-02 | 3.46E-01 | 6.26E+01 | 90% |
| Np-238 | 1.13E-02 | 7.73E-02 | 8.68E-02 | 9.44E-02 | 3.31E-02 | 3.03E-01 | 91% |
| Np-239 | 8.95E-01 | 6.53E+00 | 9.23E+00 | 1.15E+01 | 2.49E+00 | 3.07E+01 | 92% |
| Pa-231 | 8.61E-03 | 6.58E-03 | 1.40E-02 | 3.13E-03 | 4.49E-04 | 3.27E-02 | 90% |
| Pa-233 | 6.93E+00 | 9.20E+00 | 4.61E+01 | 7.17E-02 | 3.46E-01 | 6.26E+01 | 90% |
| Pa-234 | 2.64E-01 | 8.16E-02 | 2.44E-01 | 9.06E-02 | 2.20E-02 | 7.03E-01 | 91% |
| Pa-234m | 1.65E+02 | 5.10E+01 | 1.53E+02 | 5.66E+01 | 1.37E+01 | 4.39E+02 | 91% |
| Pb-209 | 1.13E-06 | 1.30E-06 | 5.22E-06 | 1.65E-06 | 2.73E-06 | 1.20E-05 | 77% |
| Pb-210 | 1.33E-08 | 7.53E-09 | 1.23E-08 | 5.84E-09 | 1.69E-09 | 4.07E-08 | 82% |
| Pb-211 | 4.53E-03 | 3.84E-03 | 7.99E-03 | 1.42E-03 | 1.88E-04 | 1.80E-02 | 89% |
| Pb-212 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | |
| Pb-214 | 5.37E-08 | 3.24E-08 | 4.78E-08 | 2.63E-08 | 1.33E-08 | 1.74E-07 | 83% |
| Pd-107 | 7.49E+00 | 2.15E+01 | 4.67E+01 | 3.50E+00 | 6.21E-01 | 7.98E+01 | 92% |
| Po-210 | 1.33E-08 | 7.54E-09 | 1.23E-08 | 5.80E-09 | 1.64E-09 | 4.06E-08 | 82% |
| Po-211 | 1.26E-05 | 7.55E-06 | 2.22E-05 | 3.49E-06 | 4.42E-07 | 4.63E-05 | 84% |
| Po-212 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | |
| Po-213 | 1.11E-06 | 1.28E-06 | 5.11E-06 | 1.61E-06 | 2.67E-06 | 1.18E-05 | 77% |
| Po-214 | 5.37E-08 | 3.24E-08 | 4.78E-08 | 2.63E-08 | 1.33E-08 | 1.74E-07 | 83% |
| Po-215 | 4.53E-03 | 3.84E-03 | 7.99E-03 | 1.42E-03 | 1.88E-04 | 1.80E-02 | 89% |
| Po-216 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | |
| Po-218 | 5.37E-08 | 3.24E-08 | 4.78E-08 | 2.63E-08 | 1.33E-08 | 1.74E-07 | 83% |
| Pu-238 | 1.69E+02 | 1.71E+02 | 1.62E+02 | 1.77E+02 | 1.50E+02 | 8.30E+02 | 75% |
| Pu-239 | 1.48E+03 | 2.17E+03 | 2.47E+03 | 4.40E+03 | 3.68E+03 | 1.42E+04 | 79% |
| Pu-240 | 3.09E+02 | 4.80E+02 | 6.09E+02 | 1.13E+03 | 9.18E+02 | 3.45E+03 | 80% |
| Pu-241 | 3.44E+03 | 3.98E+03 | 7.65E+03 | 1.23E+04 | 7.74E+03 | 3.52E+04 | 82% |
| Pu-242 | 9.46E-06 | 5.80E-05 | 7.93E-05 | 8.99E-05 | 3.44E-05 | 2.71E-04 | 79% |
| Ra-223 | 4.53E-03 | 3.84E-03 | 7.99E-03 | 1.42E-03 | 1.88E-04 | 1.80E-02 | 89% |
| Ra-224 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | |

Page A-42
RDW 2-15-96

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Assumptions: | | | | | | | | | | |
| 1. Phased Implementation Separations and Treatment is similar to Intermediate Separations | | | | | | | | | | |
| except the separations for Sr, Tc, and TRU elements are taken from Extensive Separations | | | | | | | | | | |
| 2. HLW glass waste oxide loading basis to be 20 wt% waste oxides | | | | | | | | | | |
| not counting the Na2O or SiO2 in the waste feed streatm | | | | | | | | | | |
| 3. Using the WHC engineering data package material balance calculate the waste oxide loading | | | | | | | | | | |
| and adjust mass of the glass produced to achieve a 20 wt % waste oxide loading | | | | | | | | | | |
| 4. LAW glass sodium oxide loading basis is to be 15 wt% | | | | | | | | | | |
| | | | | | | | | | | |
| | | | | | | | | | | |
| | | | | | | | | | | |
| | Input Stream | | | LAW | | | HLW | | | |
| | STREAM 1 | | | 407 | 437 | | 314 | 344 | | |
| | solids | liquids | | FRIT | GLASS | | FRIT | GLASS | | HLW |
| Volume kilo-liters | | | | | | | | | | fraction |
| Specific Gravity | | | | | | | | | | |
| Cs and Ba, (MCi) | 5.28E+00 | 6.28E+01 | | | 6.81E-01 | | | 6.74E+01 | | 0.99 |
| Sr and Y, (MCi) | 1.05E+02 | 2.10E+00 | | | 1.07E+00 | | | 1.06E+02 | | 0.99 |
| Tc, (MCi) | 5.89E-03 | 2.61E-02 | | | 3.20E-04 | | | 3.17E-02 | | 0.99 |
| Am, (MCi) | 9.51E-02 | 8.61E-03 | | | 1.04E-03 | | | 1.03E-01 | | 0.99 |
| Np, (MCi) | 9.29E-05 | 1.03E-05 | | | 1.03E-06 | | | 1.02E-04 | | 0.99 |
| Pu-239, (MCi) | 2.47E-02 | 1.67E-03 | | | 2.64E-04 | | | 2.61E-02 | | 0.99 |
| Pu-240, (MCi) | 6.28E-03 | 4.14E-04 | | | 6.69E-05 | | | 6.63E-03 | | 0.99 |
| Pu-241,(MCi) | 7.34E-02 | 1.49E-03 | | | 7.49E-04 | | | 7.41E-02 | | 0.99 |
| Total TRU, (MCi) | 2.00E-01 | 1.22E-02 | | | 2.12E-03 | | | 2.10E-01 | | 0.99 |
| Total MCi | 1.11E+02 | 6.49E+01 | | | 1.76E+00 | | | 1.74E+02 | | 0.99 |
| Total Mass Flow (MT) | 1.94E+04 | 7.10E+05 | | 2.81E+05 | 3.87E+05 | | 1.36E+04 | 2.51E+04 | | |
| Total Cr, (MT) | 1.32E+02 | 5.15E+01 | | | 1.44E+02 | | | 3.96E+01 | | |
| Total Na, (MT) | 1.24E+03 | 6.51E+04 | | | 7.18E+04 | | | 2.33E+03 | | |
| Total Si, (MT) | 5.24E+02 | 5.65E+00 | | 1.07E+05 | 1.07E+05 | | 5.29E+03 | 5.83E+03 | | |
| Total P, (MT) | 7.80E+02 | 8.42E+02 | | | 1.35E+03 | | | 2.72E+02 | | |
| Total NO2-, (MT) | 7.38E+01 | 9.54E+03 | | | | | | | | |
| Total NO3-, (MT) | 1.03E+03 | 1.06E+05 | | | | | | | | |
| AG+ | 1.38E+00 | 3.28E-01 | | | | | | | | |
| AG2O | | | | | 3.52E-01 | | | 1.48E+00 | | |
| AL+3 | 2.37E+03 | | | | | | | | | |
| AL2O3 | | | | 1.32E+04 | 1.94E+04 | | | 1.73E+03 | | |
| AL(OH)4- | | 4.83E+03 | | | | | | | | |
| AM+3 | 2.77E-02 | 2.51E-03 | | | | | | | | |
| AM2O3 | | | | | 2.76E-03 | | | 3.05E-02 | | |
| AS+5 | 4.98E-01 | 7.70E-01 | | | | | | | | |
| AS2O5 | | | | | 1.18E+00 | | | 7.66E-01 | | |
| B+3 | 9.94E-01 | 5.19E-01 | | | | | | | | |
| B2O3 | | | | | 1.67E+00 | | 1.75E+03 | 1.76E+03 | | |
| BA+2 | 3.09E+00 | 7.91E-01 | | | | | | | | |
| BAO | | | | | 8.81E-01 | | | 3.45E+00 | | |
| BE+2 | 7.61E-03 | 8.19E-02 | | | | | | | | |
| BEO | | | | | 2.27E-01 | | | 2.16E-02 | | |
| BI+3 | 1.96E+02 | 6.76E+01 | | | | | | | | |
| BI2O3 | | | | | 7.52E+01 | | | 2.19E+02 | | |
| C14 | 4.53E-04 | 7.43E-04 | | | | | | | | |
| CA+2 | 1.33E+02 | 1.67E+01 | | | | | | | | |
| CANCRINITE | 2.70E+03 | | | | | | | | | |
| CAO | | | | 3.87E+04 | 3.87E+04 | | | 1.89E+02 | | |
| CD+2 | 7.93E+00 | 2.09E+00 | | | | | | | | |
| CDO | | | | | 2.38E+00 | | | 9.06E+00 | | |
| CE+3 | 2.35E+02 | 2.37E+00 | | | | | | | | |
| CE2O3 | | | | | 2.79E+00 | | | 2.76E+02 | | |
| CL- | 3.49E+00 | 3.11E+02 | | | | | | | | |
| CL2 | | | | | | | | | | |
| CO | | | | | | | | | | |
| CO2 | | | | | | | | | | |
| CO3-2 | 2.25E+02 | 3.37E+03 | | | | | | | | |
| CR+3 | 1.32E+02 | | | | | | | | | |
| CR203 | | | | | 2.11E+02 | | | 5.79E+01 | | |
| CR(OH)4- | | 1.19E+02 | | | | | | | | |
| CS+ | 9.25E-02 | 8.19E-01 | | | | | | | | |

Page A-43
ADW 6-15-96

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| CS2O | | | | | 6.83E-03 | | | 9.58E-01 | | |
| CU+2 | 7.46E-01 | 1.77E-01 | | | | | | | | |
| CUO | | | | | 2.21E-01 | | | 9.34E-01 | | |
| CUSO4 | | | | | | | | | | |
| F- | 5.97E+01 | 1.12E+03 | | | | | | | | |
| F2 | | | | | | | | | | |
| FE+3 | 7.63E+02 | 1.44E+01 | | | | | | | | |
| FE2O3 | | | | | 2.06E+01 | | | 1.21E+03 | | |
| H2 | | | | | | | | | | |
| 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 | | |

Page A-44
RDW 2-15-96



| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| WO3 | | | | | 9.40E-01 | | | 2.06E-03 | | |
| ZN+2 | 9.45E-01 | 3.59E+00 | | | | | | | | |
| ZNO | | | | | 4.46E+00 | | | 1.19E+00 | | |
| ZR+4 | 2.77E+02 | 4.48E-01 | | | | | | | | |
| ZRO2 | | | | | 6.49E-01 | | | 6.90E+02 | | |
| ZRO2:2H2 | 4.09E+02 | 2.15E+01 | | | | | | | | |
| | | | | | | | | | | |
| WHC Data Package Basis: | | | | | | | | | | |
| Mass LAW waste oxides | | | | | 106542.3696 | | | | | |
| LAW waste loading (waste oxide) | | | | | 28% | | | | | |
| LAW waste loading (sodium oxide) | | | | | 25% | | | | | |
| Mass HLW waste oxides | | | | | | | | 7.26E+03 | | |
| HLW waste loading (waste oxides) | | | | | | | | 29% | | |
| | | | | | | | | | | |
| **HLW** | | | | | | | | | | |
| | | | | | | | | | | |
| 20 wt. % waste oxide loading | | | | | | | | | | |
| Blending factor | | | | 1 | 1.25 | 1.5 | 2 | 3.5 | | |
| Mass of glass required to achieve 20% wo loading, MT | | | | 36304.93905 | 45381.17381 | 54457.40858 | 72609.8781 | 127067.2867 | | |
| additional frit required (equals increased glass) MT | | | | 1.12E+04 | 2.03E+04 | 2.94E+04 | 4.75E+04 | 1.02E+05 | | |
| total frit required, MT | | | | 2.48E+04 | 3.39E+04 | 4.30E+04 | 6.11E+04 | 1.16E+05 | | |
| | | | | | | | | | | |
| glass density (MT/m^3) | 2.63 | | | | | | | | | |
| cullet packing fraction | 0.7 | (LAW only) | | | | | | | | |
| | | | | | | | | | | |
| Waste volume (m^3) | | | | 1.38E+04 | 1.73E+04 | 2.07E+04 | 2.76E+04 | 4.83E+04 | | |
| Canister Volume (m^3) | 0.62 | | | | | | | | | |
| Number of Canisters (1x) | | | | 2.23E+04 | 2.78E+04 | 3.34E+04 | 4.45E+04 | 7.79E+04 | | |
| Nu. of Canisters /HMPC | 4 | | | | | | | | | |
| Number of HMPCs | | | | 5.57E+03 | 6.96E+03 | 8.35E+03 | 1.11E+04 | 1.95E+04 | | |
| Number of trips @ 10 HMPCs /trip | | | | 557 | 696 | 835 | 1113 | 1948 | | |
| | | | | | | | | | | |
| Glass formulation: | | | | | | | | | | |
| (ref Ext. Sep Data Pkg.) | acceptable range | | | 1 | 1.25 | 1.5 | 2 | 3.5 | | |
| | | | | | | | | | | |
| SiO2 | 42 to 57 wt % | | | 60.08% | 64.68% | 67.75% | 71.59% | 76.52% | | |
| B2O3 | 5 to 20 wt % | | | 8.82% | 9.63% | 10.17% | 10.84% | 11.71% | | |
| 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~~ | | | | not valid for Phased Implementation taken from Ext Sep | | | | | |
| 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 | | |

PMP A-45
RDW 2-15-96

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| **LAW** | | | | | | | | | | |
| 15 wt. % sodium oxide loading | | | | | | | | | | |
| Blending factor | | | | 1 | 1.25 | 1.5 | 2 | 3.5 | | |
| Mass of glass required to achieve 15% wo loading, MT | | | | 6.45E+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 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.

Page A-47
RDW 2-15-96
TG 2/3

FROM the Intermediate Separations Alternative

Mass of LAW = 8.07E+05 mt

Mass of HLW = 54400 mt

Phase 1 Waste Processed

LAW = 2 x 20 mt/day x 365 day/yr x 0.6(OE) x 10 yr

= 87600 mt

HLW = 1 x 1 mt/day x 365 day/yr x 0.6(OE) x 10 yr (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:

$$LAW = 2 \times 40\ mt/day \times 11\ yrs \times 365\ day/yr \times 0.85$$
$$= 273{,}000\ mt\ LAW.$$

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:

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

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

Page A-49
Rev 2-15-96

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.





Page A-50
RDW 2-15-96

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

Δ Other Op. Costs

| | # | $ previous | HLW ratio | LAW ratio | $ Δ |
|---|---|---|---|---|---|
| Vaults | (45) | 225,000,000 | — | $\frac{83}{40} = 2.08$ | 243,000,000 |
| Canisters | (6820) | 68,200,000 | $\frac{33,586}{68.00} = 4.91$ | — | 266,662,000 * |
| Containers | (1705) | 42,625,000 | 4.91 | — | 166,663,000 |
| casks | (1705) | 102,300,000 | 4.91 | — | 399,993,000 |
| pads | (1) | 26,000,000 | 4.91 | — | 101,660,000 |

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

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

FORM 97-005-1 (4/81)

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 wit. requires 1.1E+07 staff-hrs

LAW wit. requires 1.1E+07 staff-hrs

total staff hrs (everything) → 3.1E+07

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

2.2E+07 total

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

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

2.43E+07 new

vs 2.2E+07 previous

Δ labor cost = (2.43E+07) − (2.2E+07) × $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 $m^3$
# Canisters – 44,500
above/below from mass balance info

**Low Bounding Case HLW glass**

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

(total now, total prev., formers prev)

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

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**

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

(total now, total prev, formers prev)

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

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

FORM 97-005-T (4/81)

JACOBS ENGINEERING GROUP INC.

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

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

1.57 E+04 MT glass formers (2.72 − 2.51 + 1.36 = 1.57) (total now, total pre, formers pre)
2.72E+04 MT glass product

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

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

High Bounding Case LAW glass – 25%, 1.25 blend

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

High Bounding Case LAW glass

3.78 E+05 MT glass formers (4.84 − 3.87 + 2.81 = 3.78)
4.84 E+05 MT glass product

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

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

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

| | | | |
|---|---|---|---|
| $SiO_2$ | 9160 | 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 | $\frac{167,700}{68,200}=2.46$ | — | 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 cost

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 cost = (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

10-

JE 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 Treat 4820 6835 *

WR+T Treat 4820 5577 **

WR+T Treat 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

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| 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 | 1210000 | | 1936000 | 3388000 | |
| | | | | | | | | |
| Waste volume, m^3 | | | 525801.195 | 657251.49 | | 1051602.39 | 1840304.183 | |
| Number of 5,300 m^3 vaults | | | 99 | 124 | | 198 | 347 | |
| | | | | | | | | |
| 25 wt. % sodium oxide loading | | | | | | | | |
| Blending factor | | | 1 | [illegible] | | 2 | 3.5 | |
| Mass of glass required to achive 25 wt % Na2O | | | 387200 | 484000 | | 774400 | 1355200 | |
| | | | | | | | | |
| Waste Volume | | | 210320.478 | 262900.59 | | 420640.956 | 736121.673 | |
| Number of 5,300 m^3 vaults | | | 40 | 50 | | 79 | 139 | |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 15 wt. % sodium oxide loading | | | | | | | |
| Blending factor | | 1 | 1.25 | 1.5 | 2 | 3.5 | |
| Mass of glass required to achieve 15% wo loading, MT | | 6.45E+05 | 8.07E+05 | 9.68E+05 | 1.29E+06 | 2.26E+06 | |
| additional frit required (equals increased glass) MT | | 3.64E+05 | 5.26E+05 | 6.87E+05 | 1.01E+06 | 1.98E+06 | |
| total frit required, MT | | 6.45E+05 | 8.07E+05 | 9.68E+05 | 1.29E+06 | 2.26E+06 | |
| | | | | | | | |
| glass density (MT/m^3) | 2.63 | | | | | | |
| cullet packing fraction | 0.7 | | | | | | |
| | | | | | | | |
| Waste volume (m^3) | | 3.51E+05 | 4.38E+05 | 5.26E+05 | 7.01E+05 | 1.23E+06 | |
| | | | | | | | |
| Number of 5300 m^3 vaults | | 66 | 83 | 99 | 132 | 231 | |
| | | | | | | | |
| LAW facility sizing | | | | | | | |
| Schedule, years | 14 | | | | | | |
| Capacity MT/day | 200 | | | | | | |
| | | | | | | | |
| Overall efficiency, % | | 63% | 79% | 95% | 126% | 221% | |
| Required capacity MT/day (assuming 14 yrs ops, 60% OE) | | 210.48 | 263.10 | 315.72 | 420.96 | 736.68 | |
| Required operating duration yrs (assuming 200 MT/day, 60% OE) | | 14.73 | 18.42 | 22.10 | 29.47 | 51.57 | |
| | | | | | | | |
| 10 wt. % sodium oxide loading | | | | | | | |
| Blending factor | | 1 | 1.25 | | 2 | 3.5 | |
| Mass of glass required to achieve 10 | | 968000 | 1210000 | | 1936000 | 3388000 | |
| | | | | | | | |
| Waste volume, m^3 | | 525801.195 | 637251.4938 | | 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 | |

17-

## 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 |

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



19-

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





20

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 $ (Thou) | 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 Sup. 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 Sup. vitrification)

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

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

FORM 91-005-1 (4/81)

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** |

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.

25-

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.

26 –

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.

27-

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).

28-

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.

29-

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

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

Notes:

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

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

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

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

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

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

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

36-

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

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

32-

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| NIO | | | | 2.27E+02 | | | |
| NO | | | | | | | |
| NO2 | | | | | | | |
| NO2- | 9.54E+03 | 7.38E+01 | | | | | |
| NO3- | 1.06E+05 | 1.03E+03 | | | | | |
| NP+4 | 1.46E-02 | 1.32E-01 | | | | | |
| NPO2 | | | | 1.66E-01 | | | |
| O2 | | | | | | | |
| OH- | 6.44E+03 | 5.00E+03 | | | | | |
| PB+4 | 1.96E+00 | 3.28E+00 | | | | | |
| PBO2 | | | | 6.05E+00 | | | |
| PO4-3 | 2.58E+03 | 2.39E+03 | | | | | |
| P2O5 | | | | 3.71E+03 | | | |
| P2O5:24W | | 5.21E-01 | | | | | |
| PU+4 | 2.88E-02 | 4.27E-01 | | | | | |
| PUO2 | | | | 5.16E-01 | | | |
| S | | | | | | | |
| SI+4 | 5.65E+00 | 7.90E+01 | | | | | |
| SIO2 | | | 2.04E+05 | 2.06E+05 | | | |
| SO2 | | | | | | | |
| SO4-2 | 2.01E+03 | 3.97E+01 | | | | | |
| SR+2 | 3.75E-01 | 3.64E+01 | | | | | |
| SRO | | | | 4.33E+01 | | | |
| TCO2 | | | | | | | |
| TCO4- | 2.52E+00 | 5.68E-01 | | | | | |
| TC2O7 | | | | 2.94E+00 | | | |
| TOC | 1.42E+03 | 1.16E+02 | | | | | |
| UO2+2 | 8.52E+01 | 1.58E+03 | | | | | |
| UO3 | | | | 1.76E+03 | | | |
| V+5 | 6.20E-02 | 1.88E-01 | | | | | |
| V2O5 | | | | 4.46E-01 | | | |
| W+6 | 7.47E-01 | | | | | | |
| WO2 | | | | 4.41E-01 | | | |
| WO3 | | | | 9.42E-01 | | | |
| ZN+2 | 3.59E+00 | 9.45E-01 | | | | | |
| ZNO | | | | 5.65E+00 | | | |
| ZR+4 | 4.48E-01 | 2.77E+02 | | | | | |
| ZRO2 | | | | 7.07E+02 | | | |
| ZRO2:2H2 | 2.15E+01 | 4.09E+02 | | | | | |
| | | | | | | | |
| WHC data package basis: | | | | | | | |
| mass waste oxides | | | | 1.08E+05 | 1.168E5 | | |
| 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 |

33-

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 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 2/19/94 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.

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

Add

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

subtract

| | | | | |
|---|---|---|---|---|
| canisters | $20,000/each | x 10,300 | = | 206,000,000 |
| containers | | | | |
| casks | $65,000/each | x 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

# 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.SET

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 | | |
| | | |
| | | 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 @ 40 HMPC/trip | | 835 |
| | | |
| Note: Curies from decay daughter products not included | | |

| | | |
|---|---|---|
| Ex Situ / In Situ Combination Alternative New Base Case (1/26/96) | | |
| 20 wt% waste oxide loading, 1.5 blending factor | | |
| Radionuclide Inventory | HLW glass | Sel Ret. Recovery fraction |
| | Ci/m^3 | |
| Am-241 | 6.97E+00 | 7.67E-01 |
| Am-243 | 2.67E-03 | 9.20E-01 |
| C-14 | 0.00E+00 | 9.00E-01 |
| Cm-244 | 5.04E-03 | 9.40E-01 |
| Cs-135 | 1.16E-02 | 8.50E-01 |
| Cs-137 | 2.96E+03 | 8.80E-01 |
| I-129 | 0.00E+00 | 9.00E-01 |
| Ni-63 | 2.03E+01 | 8.00E-01 |
| Np-237 | 5.58E-03 | 9.32E-01 |
| Pu-238 | 3.97E-02 | 3.97E-01 |
| Pu-239 | 1.48E+00 | 6.27E-01 |
| Pu-240 | 3.69E-01 | 6.07E-01 |
| Pu-241 | 4.01E+00 | 5.65E-01 |
| Ra-226 | 0.00E+00 | 8.30E-01 |
| Ru-106 | 1.28E-06 | 3.70E-01 |
| Sm-151 | 4.32E+01 | 7.20E-01 |
| Sn-126 | 3.32E-02 | 7.30E-01 |
| Sr-90 | 3.56E+03 | 7.00E-01 |
| Tc-99 | 5.15E-01 | 9.00E-01 |
| Th-230 | 3.05E-09 | 8.20E-01 |
| U-233 | 8.72E-07 | 8.00E-01 |
| U-234 | 1.54E-05 | 8.10E-01 |
| U-235 | 1.74E-03 | 9.10E-01 |
| U-238 | 3.92E-02 | 9.00E-01 |
| Zr-93 | 2.49E-01 | 6.70E-01 |
| Total (m3) | 1.03E+04 | |
| Number of 0.62 m^3 canisters | ~~16694~~ 16613 | |
| Number of 0.62 m^3 can/HMPC | 4 | |
| Number of HMPCs | 4174 4154 | |
| Number of trips to the repository @ 10 HMPC per trip | 418 416 | |
| Note the combination alt. retrieval fraction is calculated from the % of SST and DST inventory recovered as follows: recovery fraction = (curies recovered from SSTs ÷ Curies from DSTs) divided by (total curies in the SSTs÷total curies in DSTs) | | |
| The combination alternative volume of HLW glass is 1/2 of the Intermediate Separations | | |
| Note: Curies from decay daughter products not included | | |

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
2.65E+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 | 1574/448 = 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 |
| | | | | | | | | |

Extensive Separations

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

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| **LAW** | | | | | | | | |
| | | | | | | | | |
| 15 wt. % sodium oxide loading | | | | | | | | |
| Blending factor | | | | 1 | 1.25 | 1.5 | 2 | 3.5 |
| Mass of glass required to achieve 15% wo loading, MT | | | | 6.43E+05 | 8.04E+05 | 9.65E+05 | 1.29E+06 | 2.25E+06 |
| additional frit required (equals increased glass) MT | | | | 2.57E+05 | 4.18E+05 | 5.79E+05 | 9.01E+05 | 1.87E+06 |
| total frit required, MT | | | | 5.22E+05 | 6.83E+05 | 8.44E+05 | 1.17E+06 | 2.13E+06 |
| | | | | | | | | |
| glass density (MT/m^3) | 2.63 | | | | | | | |
| cullet packing fraction | 0.7 | | | | | | | |
| | | | | | | | | |
| Waste volume (m^3) | | | | 3.49E+05 | 4.37E+05 | 5.24E+05 | 6.99E+05 | 1.22E+06 |
| | | | | | | | | |
| Number of 5300 m^3 vaults | | | | 66 | 82 | 99 | 132 | 231 |
| | | | | | | | | |
| LAW facility sizing | | | | | | | | |
| Schedule, years | 19 | | | | | | | |
| Capacity MT/day | 200 | | | | | | | |
| | | | | | | | | |
| Overall efficiency, % | | | | 46% | 58% | 70% | 93% | 162% |
| Required capacity MT/day (assuming 19 yrs ops, 60% OE) | | | | 154.61 | 193.26 | 231.92 | 309.22 | 541.14 |
| Required operating duration yrs (assuming 200 MT/day, 60% | | | | 14.69 | 18.36 | 22.03 | 29.38 | 51.41 |
| | | | | | | | | |
| 10 wt. % sodium oxide loading | | | | | | | | |
| Blending factor | | | | 1 | 1.25 | 1.5 | 2 | 3.5 |
| Mass of glass required to achieve 10 | | | | 9.65E+05 | 1.21E+06 | 1.45E+06 | 1.93E+06 | 3.38E+06 |
| | | | | | | | | |
| Waste volume, m^3 | | | | 5.24E+05 | 6.55E+05 | 7.86E+05 | 1.05E+06 | 1.83E+06 |
| Number of 5,300 m^3 vaults | | | | 99 | 124 | 148 | 198 | 346 |
| | | | | | | | | |
| 25 wt. % sodium oxide loading | | | | | | | | |
| Blending factor | | | | 1 | 1.25 | 1.5 | 2 | 3.5 |
| Mass of glass required to achive 25 wt % Na2O | | | | 3.86E+05 | 4.83E+05 | 5.79E+05 | 7.72E+05 | 1.35E+06 |
| | | | | | | | | |
| Waste Volume | | | | 2.10E+05 | 2.62E+05 | 3.15E+05 | 4.19E+05 | 7.34E+05 |
| Number of 5,300 m^3 vaults | | | | 40 | 49 | 59 | 79 | 138 |

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

| | Construction | Operating Labor | Operating Equipment | Materials and Supplies | | | LLW 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.





Extensive Separations

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.



55

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

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

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

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

Notes:

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

Annual equipment purchase estimated by K. D. Boomer.

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

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

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

Notes:

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

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

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

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

RECEIVED
6 1995
0617

L. Lauerhass
Pacific Northwest Laboratory

## 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 | Operating Labor | Operating Equipment | Materials and Supplies | | | LLW Vault | HLW Canisters | R&D | Repository | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Start-up | D&D | 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.





66

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

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

Notes:

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

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

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



67

68 -

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

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

69 -

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.

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

72

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.

73-

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

Notes (continued):

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

[2]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.

74

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

| Construction | | | |
|---|---|---|---|
| Option | Start | Finish | Facility Configuration Study |
| Pretreatment + HLW vitrification<br>Standalone LLW vitrification<br>Overall | July 2001<br>December 1997<br>December 1997 | December 2006<br>July 2005<br>December 2006 | page 114<br>page 63 |
| Operation | | | |
| Pretreatment<br>HLW vitrification<br>LLW vitrification<br>Overall | January 2004<br>March 2005<br>September 2005<br>January 2004 | January 2018<br>March 2019<br>September 2019<br>September 2019 | pages 114, 33<br>pages 114, 33<br>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.<br><br>Monitoring and maintenance is assumed to start with the completion of HLW vitrification.<br><br>Monitoring and maintenance is assumed to finish when the last multi-purpose canisters is shipped to the repository.<br><br>Shipments to the repository start in 2035[1].<br><br>Based on discussions with K. D. Boomer, 1,000 canisters are assumed, 250 multi-purpose canisters.<br><br>10 multi-purpose canisters would be transported per week (Slaathaug 1995, Table 9-7, footnote 5).<br><br>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 :

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

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 Δ = $830 − 650 = $180 million

FORM 91-005-1 (4/81)

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

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 |
| Continued 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 | ~~$7,863~~ | ~~$9,365~~ $9294 | |
| Repository Fee | | $6,500 | $6,500 | Same as Intermediate Separations |
| Sub Total | $7,866 | ~~$22,863~~ $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.

80-

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 operation

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 JOB NO. 81-

BY D Stein CHKD.

| | 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 LSW Plants during Phase 2.

The modified LSW Plants would process:

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

The Phase 2 High Capacity Plants must then process

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

The High Capacity Plants must then be sized at:

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

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

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 | |

not valid for [illegible] [illegible] taken from Ind Sep

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 DLS 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 / 1705 base | = | 130,000,000 |
| | | | total | | $539,875,000 |
| | | | or | | $540 million |

FORM 91-005-1 (4/81)

JACOBS ENGINEERING GROUP INC.

DATE 2/15/91 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 Situ 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 (4/89)

JACOBS ENGINEERING GROUP INC.

95-

DATE 12/28 SUBJECT SHEET NO. 6-7

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 Pg 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 barrier

disposal vault

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 (4/87)

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 | 9.37 actual (6.52 net) 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

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

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)

DECISION SCIENCES CORPORATION
Saint Louis, Missouri

Providing crystal-clear perspectives
for sound management decisions

## Technical Support

Telephone: 314/739-2662 Facsimile: 314/536-1001

First Edition
July 1993

Copyright
© Decision Sciences Corporation, 1993. All rights reserved. No part of this publication may be reproduced, transmitted, transcribed, stored in a retrieval system, or translated into any language in any form by any means without the written permission of Decision Sciences Corporation.

## Software License Notice

The REP/PC License, signed by a representative of your organization, specifies the permitted and prohibited uses of this software, its trade secret heuristics, and this guide. Any unauthorized duplication or use of any of these materials, in whole or in part, in print or in any other storage and retrieval systems, is forbidden. *Use of REP/PC outside of the country identified in your REP/PC License is strictly prohibited.*

## Trademarks

REP and REP/PC are trademarks of Decision Sciences Corporation. MS-DOS is a registered trademark of Microsoft Corporation. Windows is a trademark of Microsoft Corporation. IBM is a registered trademark of International Business Machines Corporation.

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 D 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.

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.

| NUM | ELEMENT | ALTERNATIVE: NO. SEP VITR | NO. SEP CALC. | INTER. SEP. | IN SITU/ EX SITU | PHASED IMPL. | EXT SEP. |
|---|---|---|---|---|---|---|---|
| 10 | REPOSITORY FEE | | | | | | |
| | PROB. RANGE | 100% -80%, +0% | 100% -60%, +0% | 100% -40%, +0% | 100% -25%, +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.

JE® JACOBS ENGINEERING GROUP INC

DATE 2/5/96 SUBJECT

BY DSkin CHKD.

*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

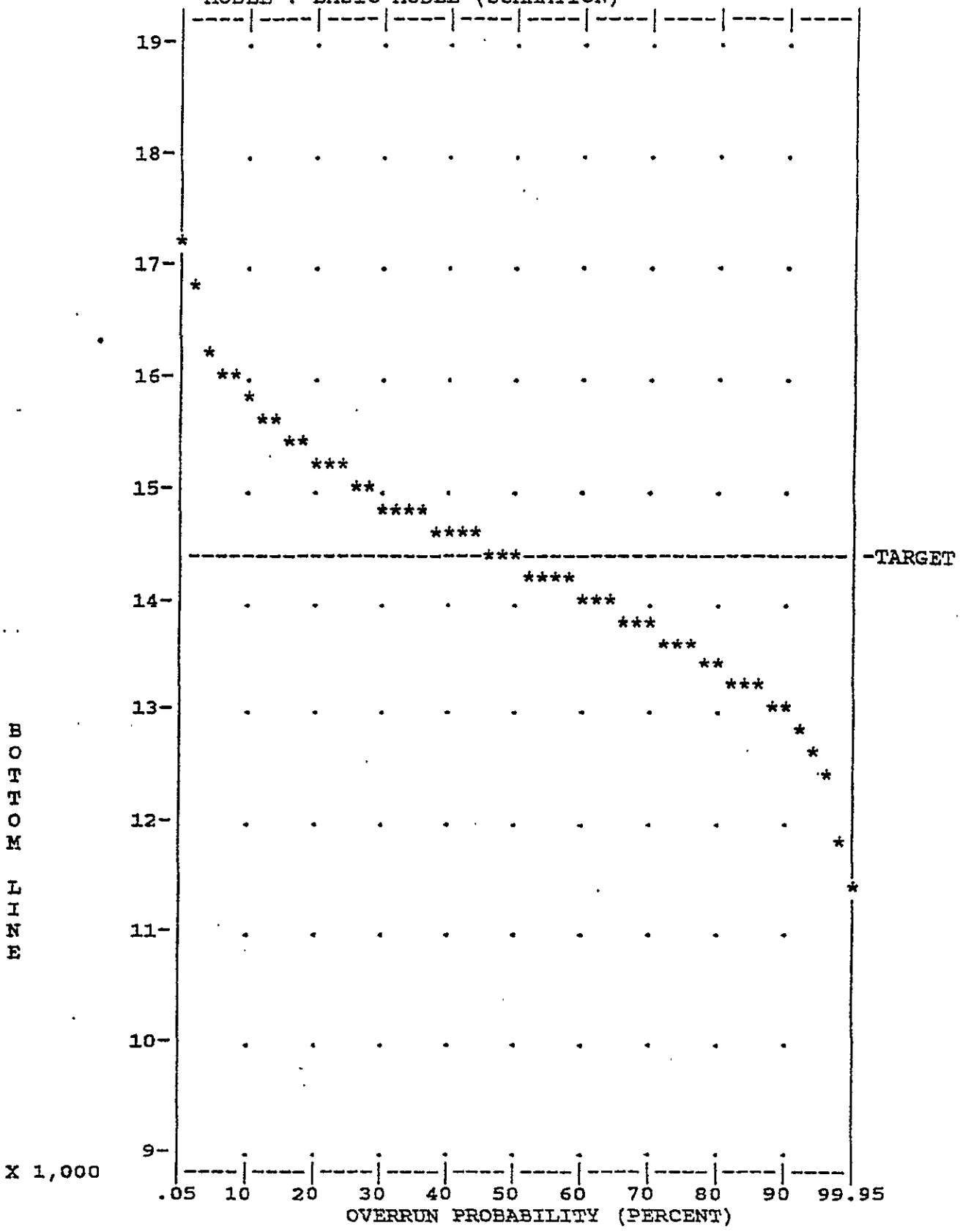
DATA : ExSitu Exten. Case 01
MODEL : BASIC MODEL (SUMMATION)

| 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<br>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)

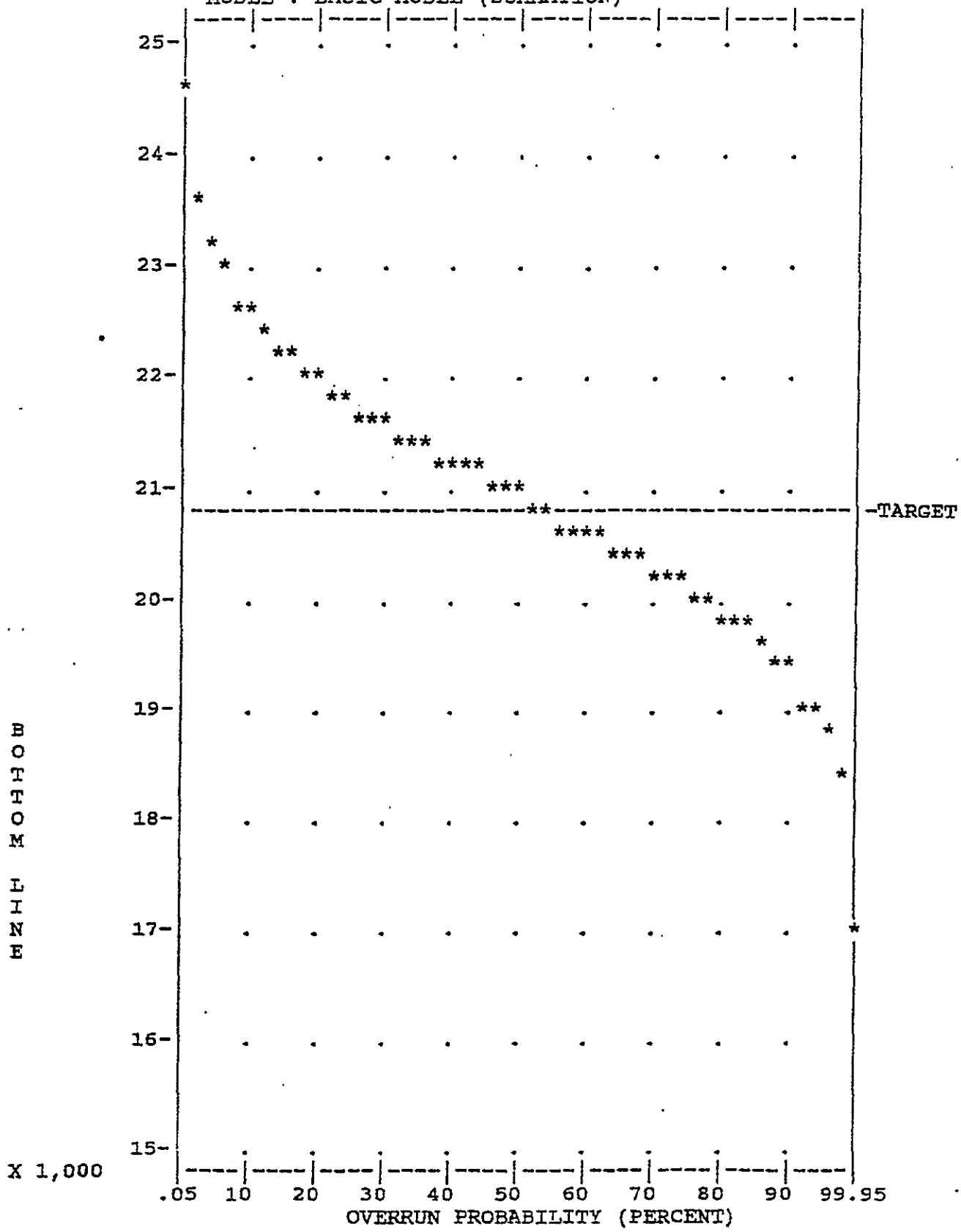
REP/PC (Ver 4.0) - MGMT REPORT 1 RANGE ESTIMATE : 02-06-96

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 | 25781 |
| | | | | | (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 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)

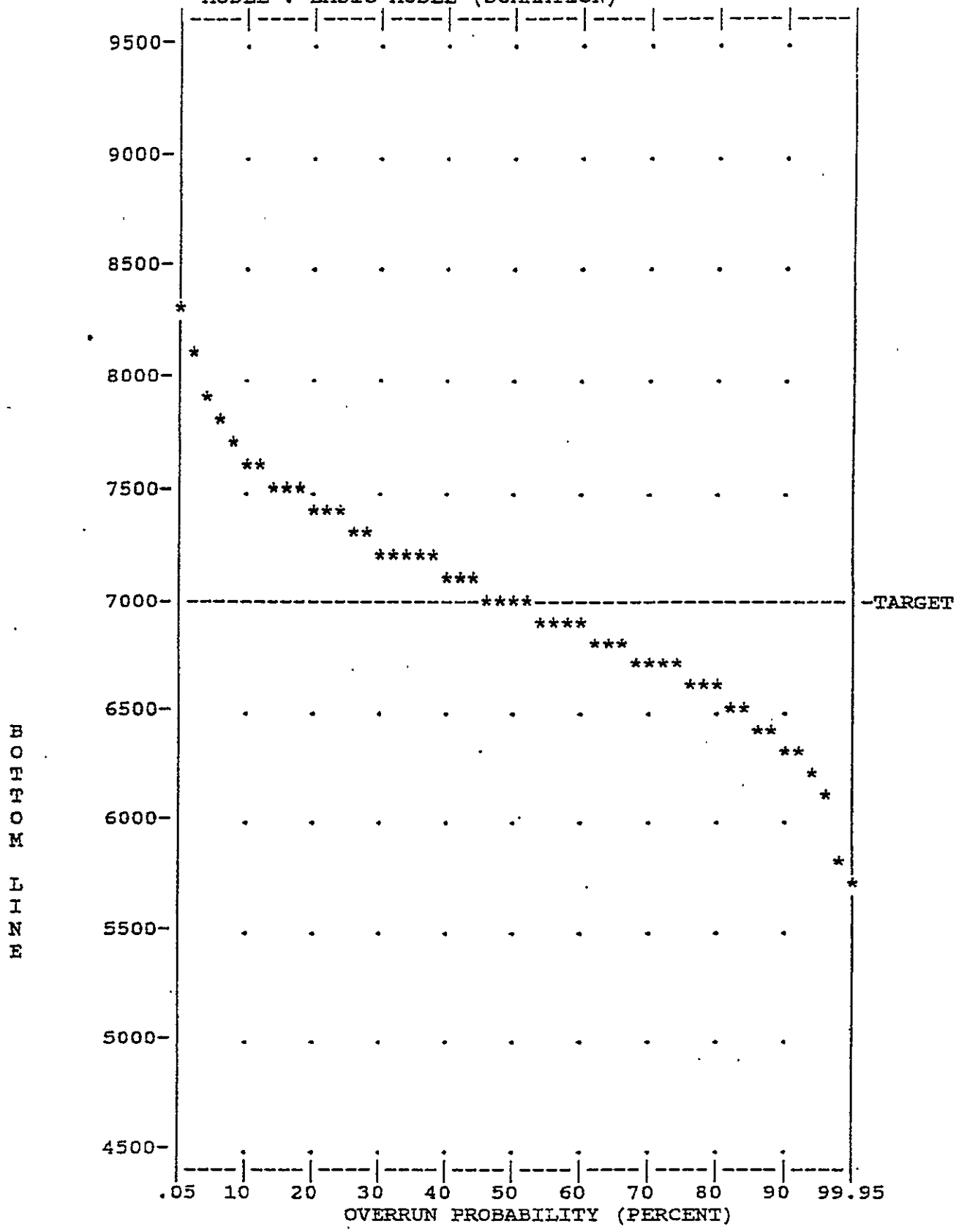
REP/PC (Ver 4.0) - MGMT REPORT 1 RANGE ESTIMATE : 02-06-96

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<br>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)

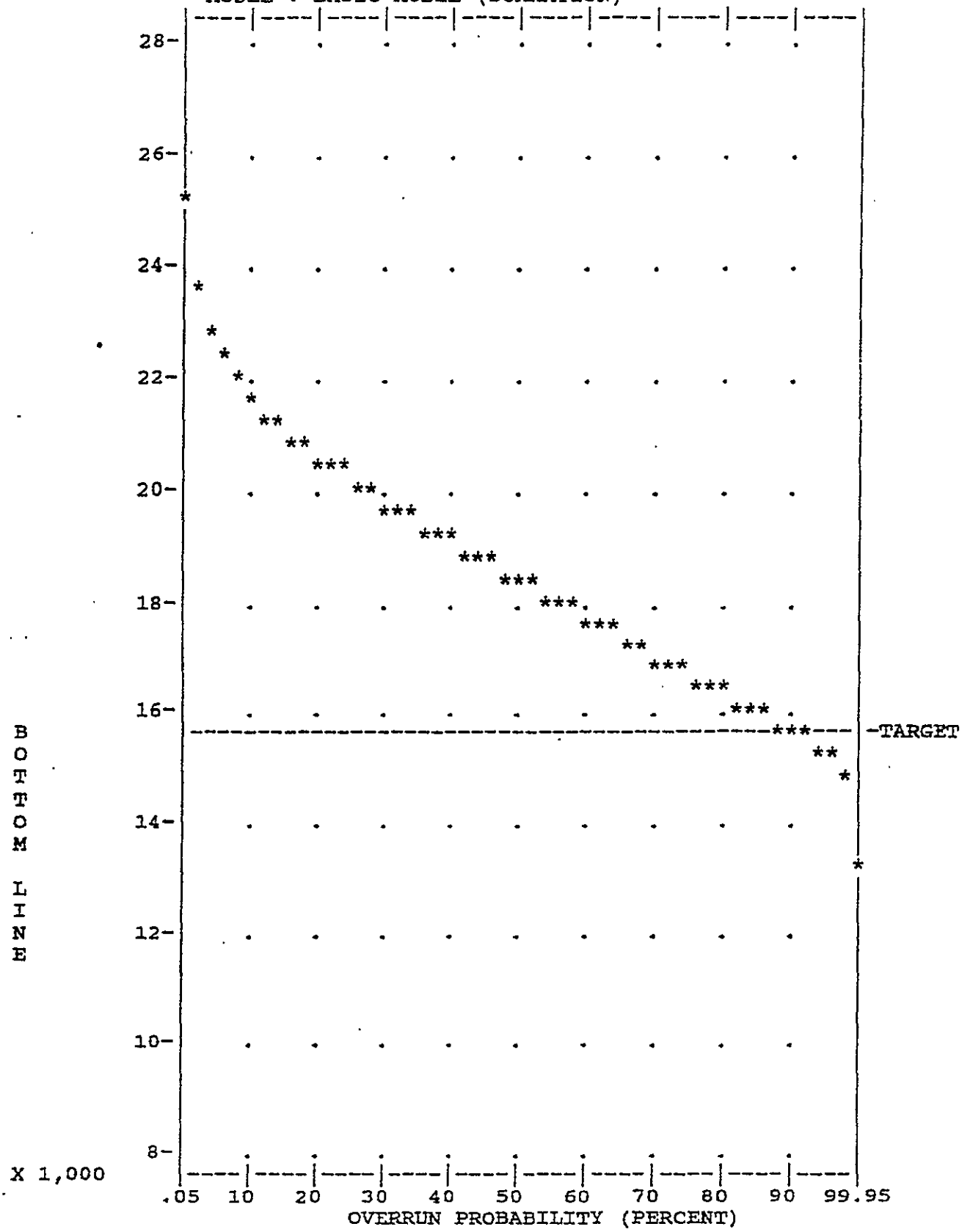
REP/PC (Ver 4.0) - MGMT REPORT 1 RANGE ESTIMATE : 02-06-96

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)

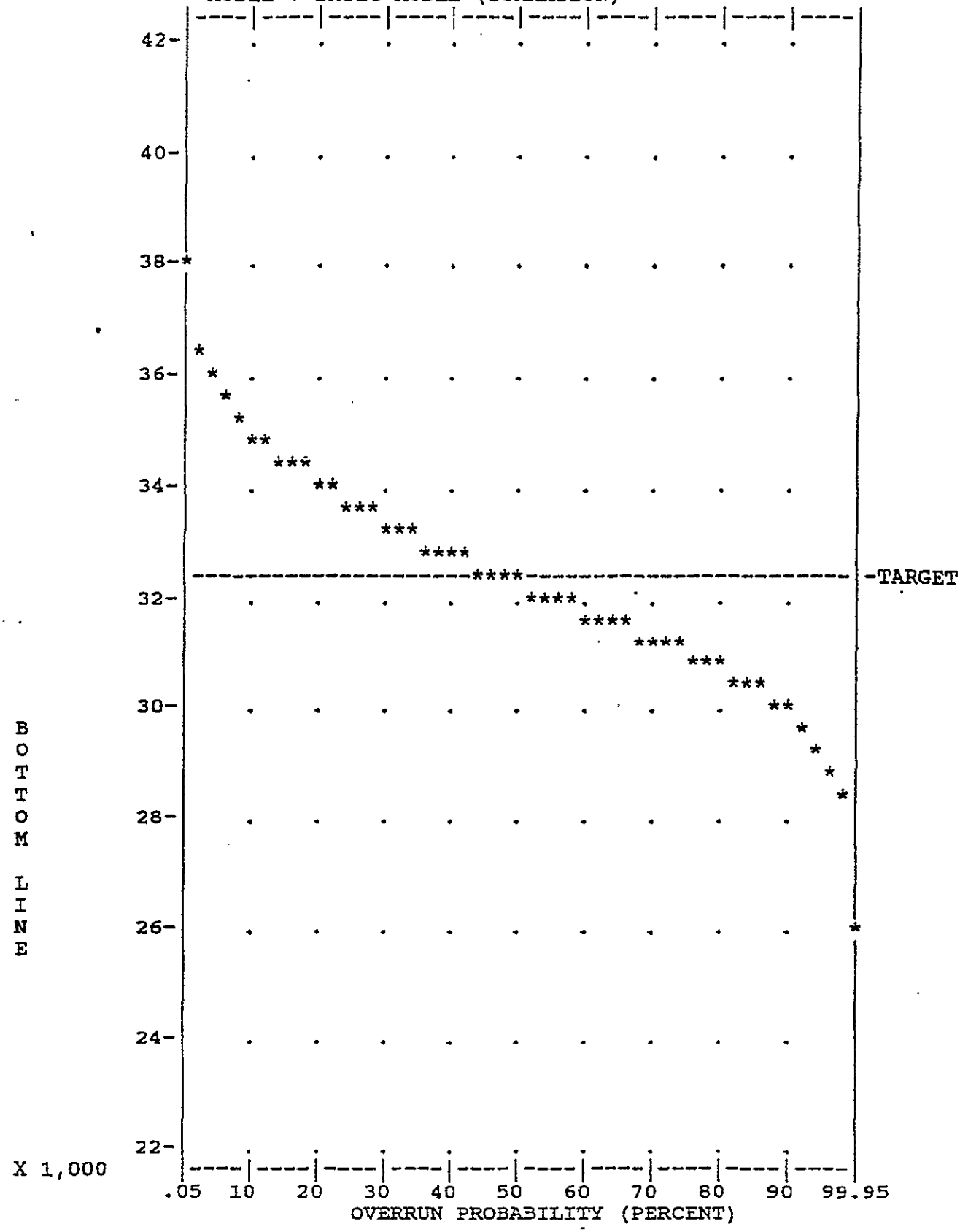
REP/PC (Ver-4.0) - MGMT REPORT 1 RANGE ESTIMATE : 02-06-96

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)

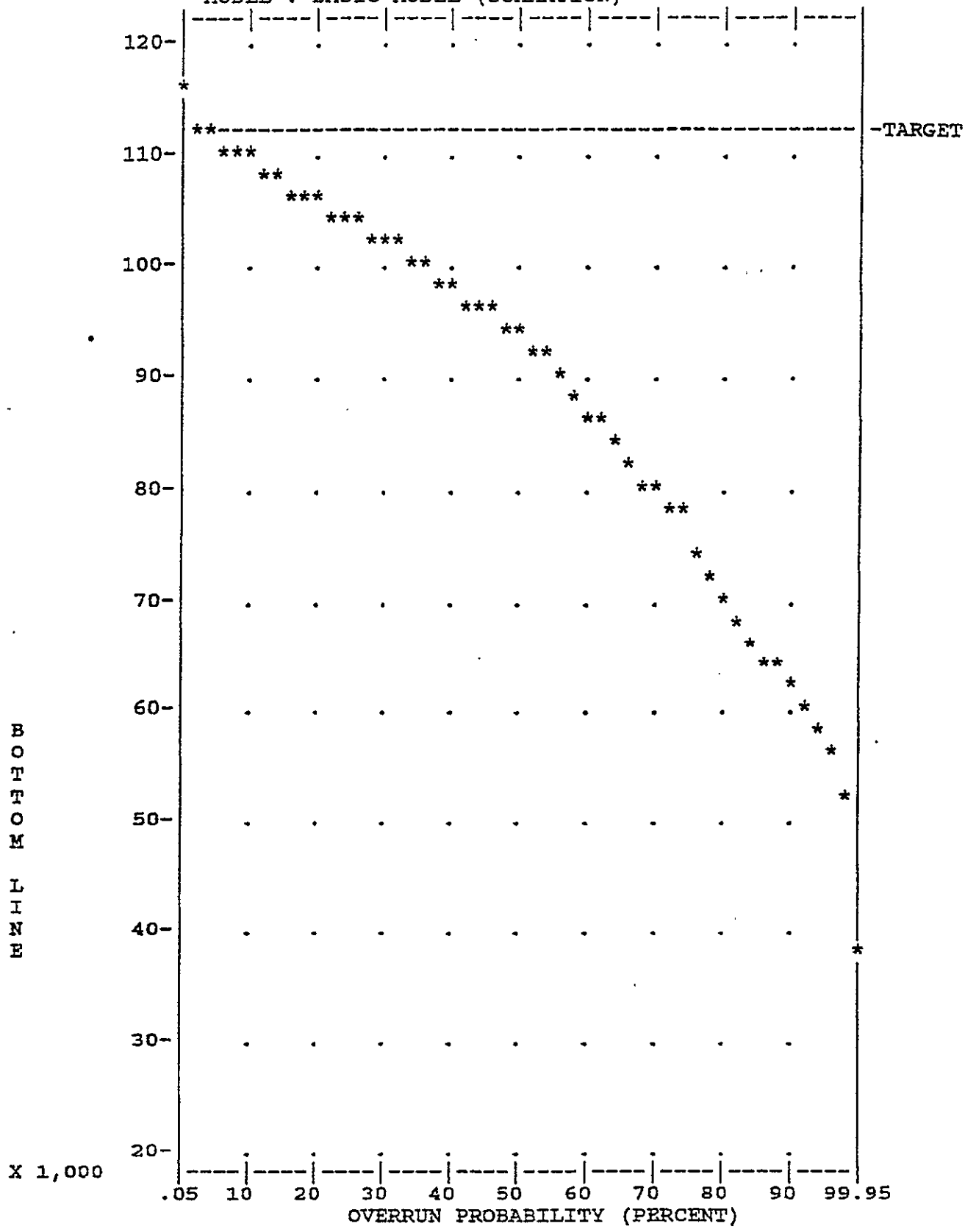
| NUM | ELEMENT | UNIT | TARGET | PROB+ | LOW | HIGH |
|---|---|---|---|---|---|---|
| 1 | Current Operations | | 8325 | 50 | 6660 | 9990 |
| 2 | R&D Waste Ret. & Transfer | | 190.00 | | 190.00 | 190.00 |
| 3 | R&D Treatment | | 280 | | 280 | 280 |
| 4 | Capital Waste Ret. & Transfer | | 2280 | 50 | 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)

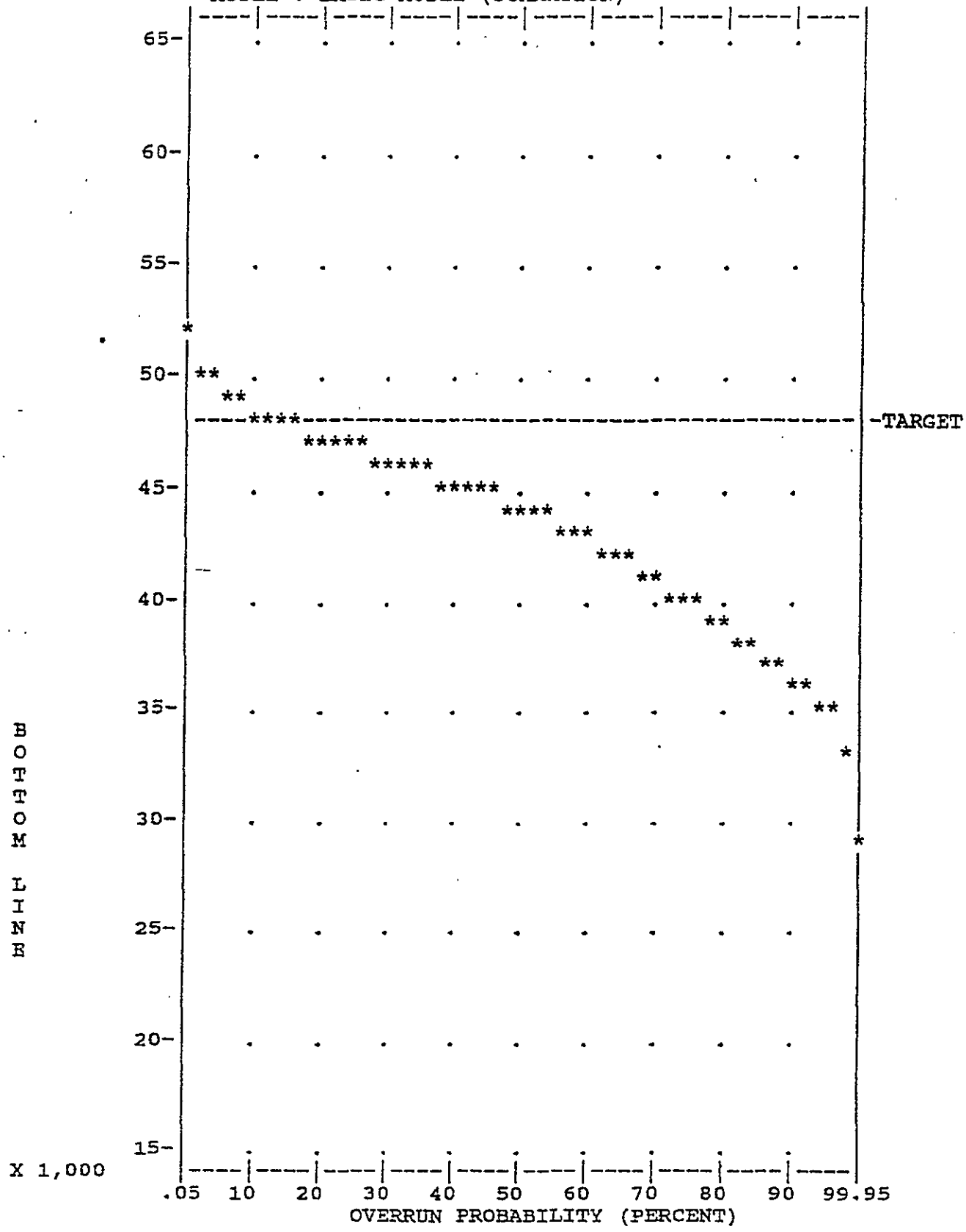
REP/PC (Ver-4.0) - MGMT REPORT 1 RANGE ESTIMATE : 02-06-96

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)

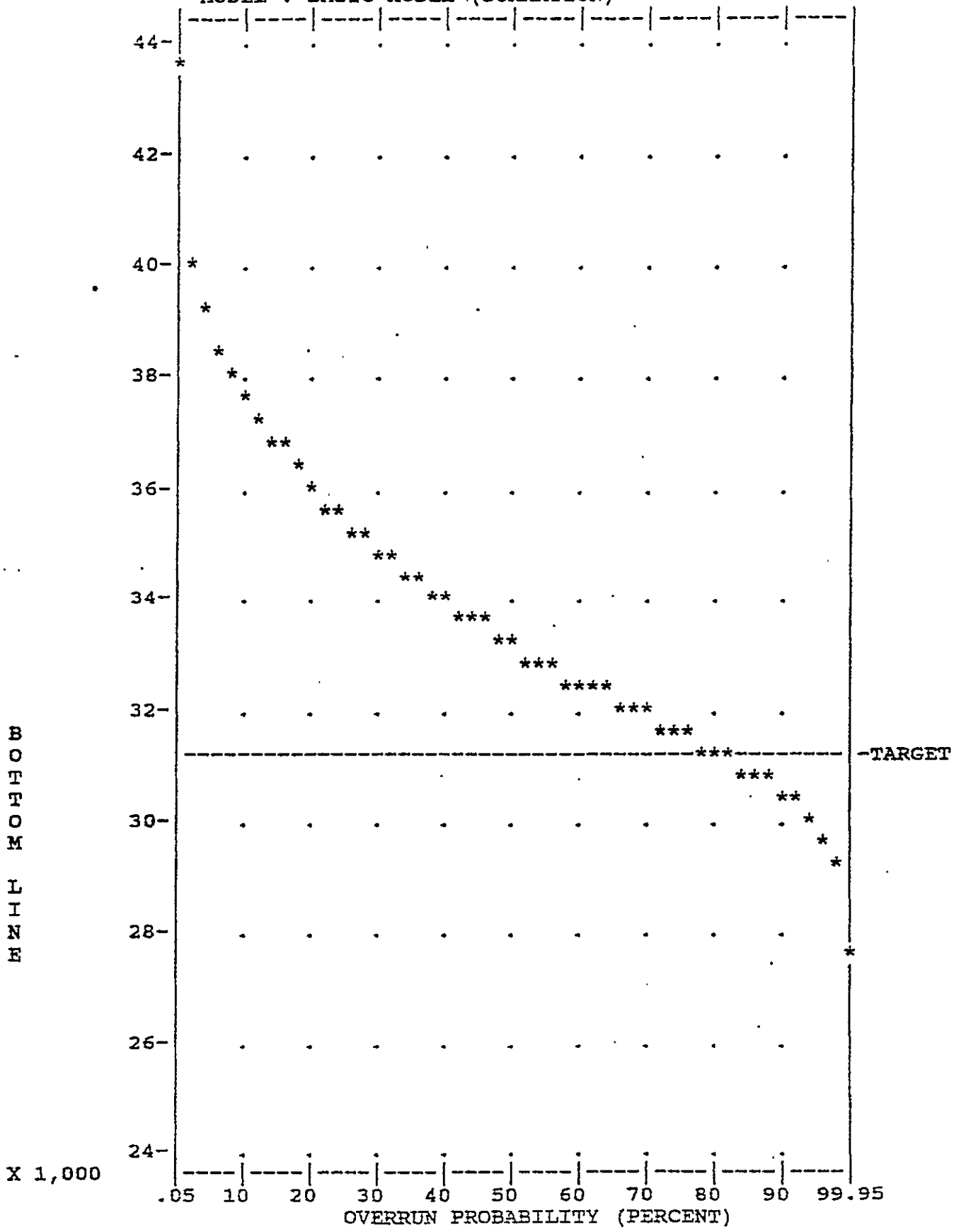
| NUM | ELEMENT | UNIT | TARGET | PROB+ | LOW | HIGH |
|---|---|---|---|---|---|---|
| 1 | Current Operations | | 8600 | 50 | 6880 | 10320 |
| 2 | R&D Waste Ret. & Transfer | | 190.00 | | 190.00 | 190.00 |
| 3 | R&D Treatment | | 1300 | | 1300 | 1300 |
| 4 | Capital Waste Ret. & Transfer | | 2280 | 50 | 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)

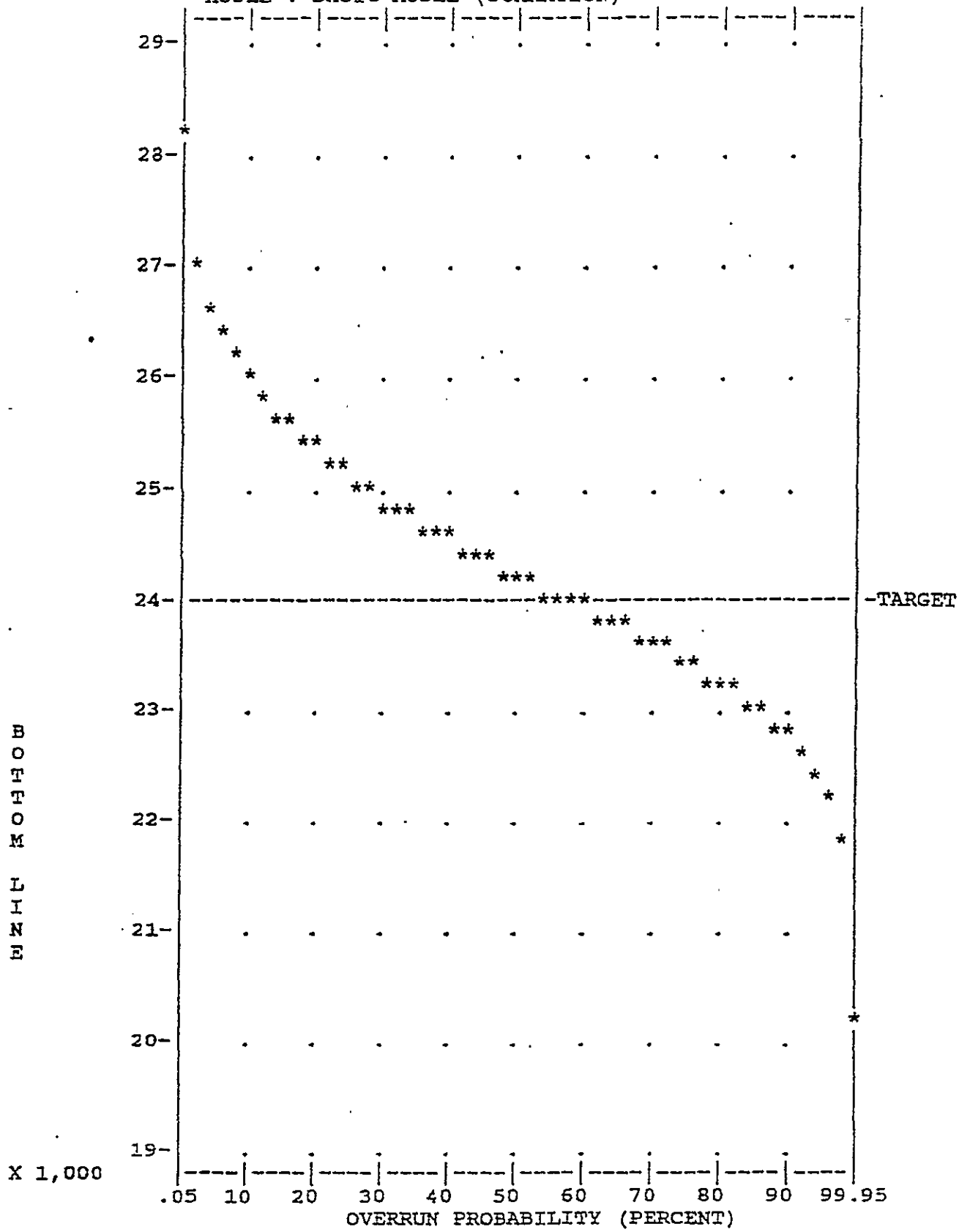
REP/PC (Ver 4.0) - MGMT REPORT 1 RANGE ESTIMATE : 02-06-96

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)

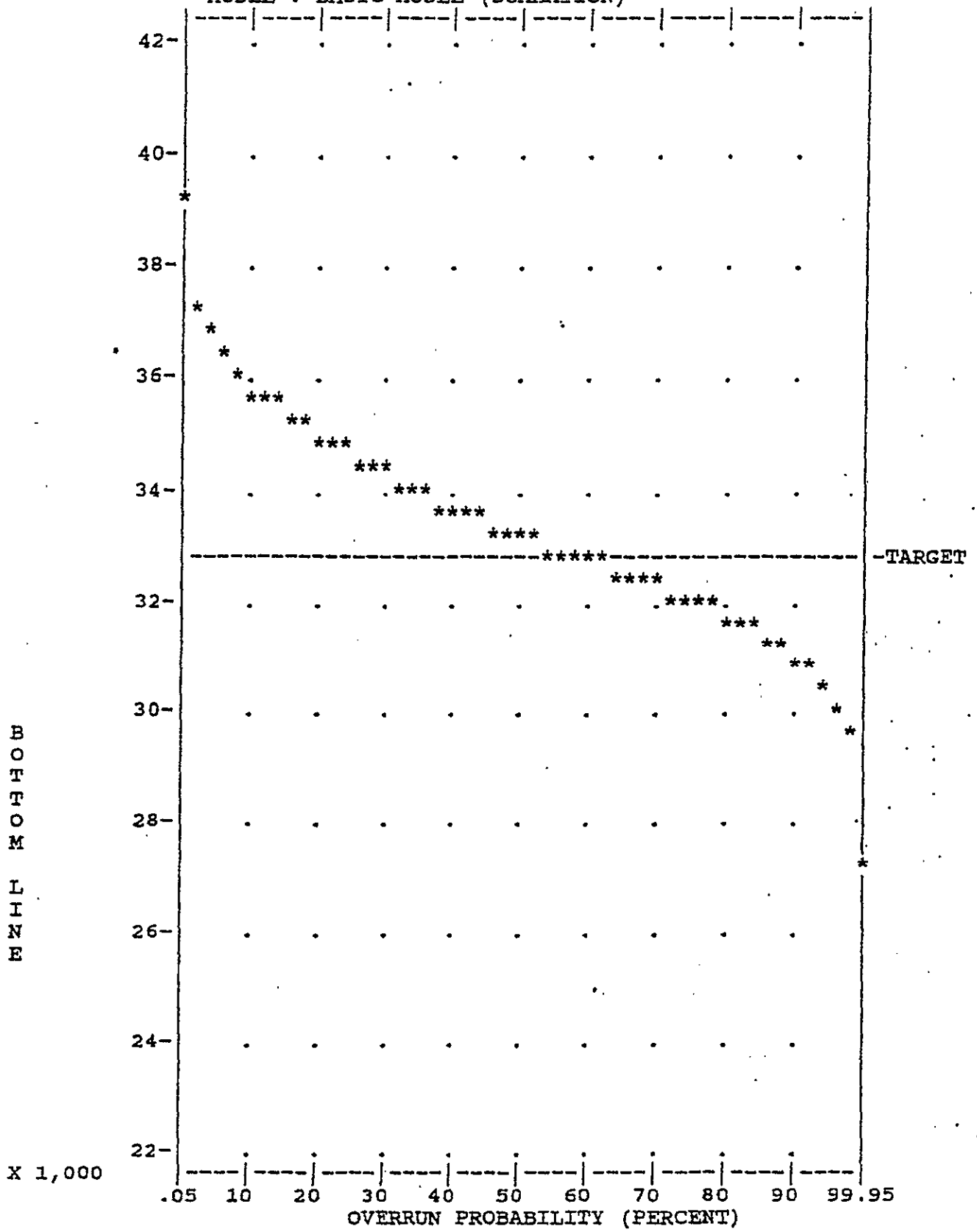
REP/PC (Ver 4.0) - MGMT REPORT 1 RANGE ESTIMATE : 02-12-96

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 Sep 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 = 115,000 $m^3$ 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. Weed 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)
- 86,250 $m^3$ SILT Barrier
- 103,500 $m^3$ (Aggregate Barrier)
- 94 500 $m^3$ Rip Rap Barrier

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

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 Feed from 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 PGW 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

| 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 | 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

WHC-SD-WM-EV-101 Rev. 0
UC-630

# 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<br>10. System/Bldg./Facility: n/a |
| 11. Receiver Remarks: | | 12. Major Assm. Dwg. No.: n/a<br>13. Permit/Permit Application No.: n/a<br>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<br>7-17-95<br>Signature of EDT Originator Date | L. E. Borneman<br>7/18/95<br>Authorized Representative for Receiving Organization Date | J. S. Garfield<br>7-17-95<br>Cognizant Manager Date | Ctrl. No.<br>[ ] Approved<br>[ ] Approved w/comments<br>[ ] Disapproved w/comments<br>[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 F&C
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 F&C
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

WHC-SD-WM-EV-107, Rev 0
UC-2030

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

P. L. Kline
H. Hampt
W. A. Skelly

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

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. 3 of this document. The only significant changes in this revision, relative to Rev. 3, 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 | | | | | | | | | |
| | | 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 7/15/95 Signature of EDT Originator Date | L. E. Borneman 7/15/95 Authorized Representative for Receiving Organization Date | 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 | | 51-57 | | |
| 1 | / | Safety | J.H. 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.L. Seaglan 2/28/95<br>Signature of EDT Originator Date | L.E. Bomeman 2/28/95<br>Authorized Representative for Receiving Organization Date | L.E. Bomeman 2/28/95<br>Cognizant Manager Date | Ctrl. No.<br>[] Approved<br>[] Approved w/comments<br>[] 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 | 128,526 | 98,336 | 247,428 | 209,904 | 212,377 | 252,130 | 214,450 | 250,908 | 247,428 | 320,621 | 129,580 | 247,785 |
| Eng/Inspect | 250,652 | 196,475 | 494,656 | 419,809 | 424,754 | 504,860 | 428,912 | 513,815 | 494,656 | 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 | 800,815 |
| Site Work | 76,577 | 58,706 | 172,756 | 138,295 | 140,162 | 177,304 | 142,070 | 174,752 | 172,756 | 241,596 | 77,322 | 167,975 |
| Base Course | 43,653 | 33,757 | 83,514 | 71,072 | 71,897 | 85,173 | 72,587 | 86,743 | 83,514 | 107,759 | 44,274 | 81,610 |
| Asphalt | 1,096,842 | 844,178 | 2,088,454 | 1,777,317 | 1,797,943 | 2,129,938 | 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 | 174,096 | 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 | 48,881 | 34,881 | 109,292 | 89,737 | 90,875 | 111,885 | 92,061 | 113,354 | 109,292 | 147,481 | 48,475 | 106,013 |
| Sand Filter | 32,381 | 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 | 57,186 | 46,853 | 47,505 | 58,556 | 48,079 | 59,301 | 57,186 | 77,357 | 25,633 | 55,770 |
| Lower SR | 140,781 | 87,030 | 337,489 | 272,967 | 276,872 | 348,007 | 280,559 | 349,531 | 337,489 | 463,456 | 142,614 | 324,634 |
| Upper SR | 175,202 | 122,872 | 405,196 | 330,262 | 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 | 12,556 | 13,758 | 12,618 | 14,207 | 13,600 | 15,796 | 9,440 | 13,444 |
| CON SUBTOTAL | 2,843,588 | 2,257,571 | 5,659,114 | 4,803,570 | 4,859,946 | 5,773,150 | 4,907,349 | 5,875,242 | 5,659,114 | 7,327,914 | 2,872,173 | 5,541,655 |
| TOTAL | 3,288,326 | 2,612,043 | 6,461,157 | 5,493,042 | 5,556,836 | 6,590,199 | 5,610,476 | 6,705,724 | 6,461,157 | 8,349,536 | 3,420,672 | 6,324,470 |

| MATERIAL | DST AN | DST AP | DST AW | DST AY | DST AZ | DST SY | EX PRE OPT B | EX PRE OPT A | TPA GLASS | TOTALS |
|---|---|---|---|---|---|---|---|---|---|---|
| Dat Design | 180,130 | 168,913 | 134,841 | 66,730 | 66,730 | 100,770 | 5,858,499 | 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 | 22,315,164 |
| SRDI Test | 59,759 | 59,759 | 59,759 | 59,759 | 59,759 | 59,759 | 59,759 | 59,759 | 59,759 | 1,254,039 |
| ENG SUBTOTAL | 601,049 | 566,497 | 464,283 | 259,949 | 259,949 | 362,069 | 17,630,456 | 3,176,323 | 3,010,000 | 34,727,088 |
| 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 | 46,036 | 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 | 120,527 | 113,274 | 90,224 | 50,124 | 50,124 | 73,174 | 3,528,642 | 675,589 | 641,877 | 7,140,040 |
| Batch | 1,821,323 | 1,548,969 | 1,257,185 | 677,616 | 677,616 | 987,401 | 50,662,065 | 7,835,675 | 7,473,781 | 95,246,595 |
| Gravel Filter | 75,005 | 67,954 | 52,009 | 20,118 | 20,118 | 30,064 | 3,145,201 | 537,960 | 507,183 | 5,505,579 |
| Sand Filter | 49,874 | 45,167 | 34,475 | 13,090 | 13,090 | 23,783 | 2,136,894 | 383,657 | 342,727 | 3,759,982 |
| Geotextile | 39,090 | 35,330 | 26,967 | 10,239 | 10,239 | 16,603 | 1,671,353 | 284,457 | 268,080 | 2,941,104 |
| Lower SR | 223,328 | 200,592 | 150,681 | 50,800 | 50,800 | 100,731 | 10,778,043 | 1,783,667 | 1,677,545 | 18,389,604 |
| Upper SR | 274,365 | 246,546 | 188,919 | 67,687 | 67,687 | 127,293 | 12,268,394 | 2,065,082 | 1,944,652 | 21,320,393 |
| Road | 11,341 | 11,341 | 9,574 | 6,340 | 6,340 | 8,007 | 72,151 | 29,599 | 29,064 | 332,474 |
| 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 2.8% 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 Calculate 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 $m^2$

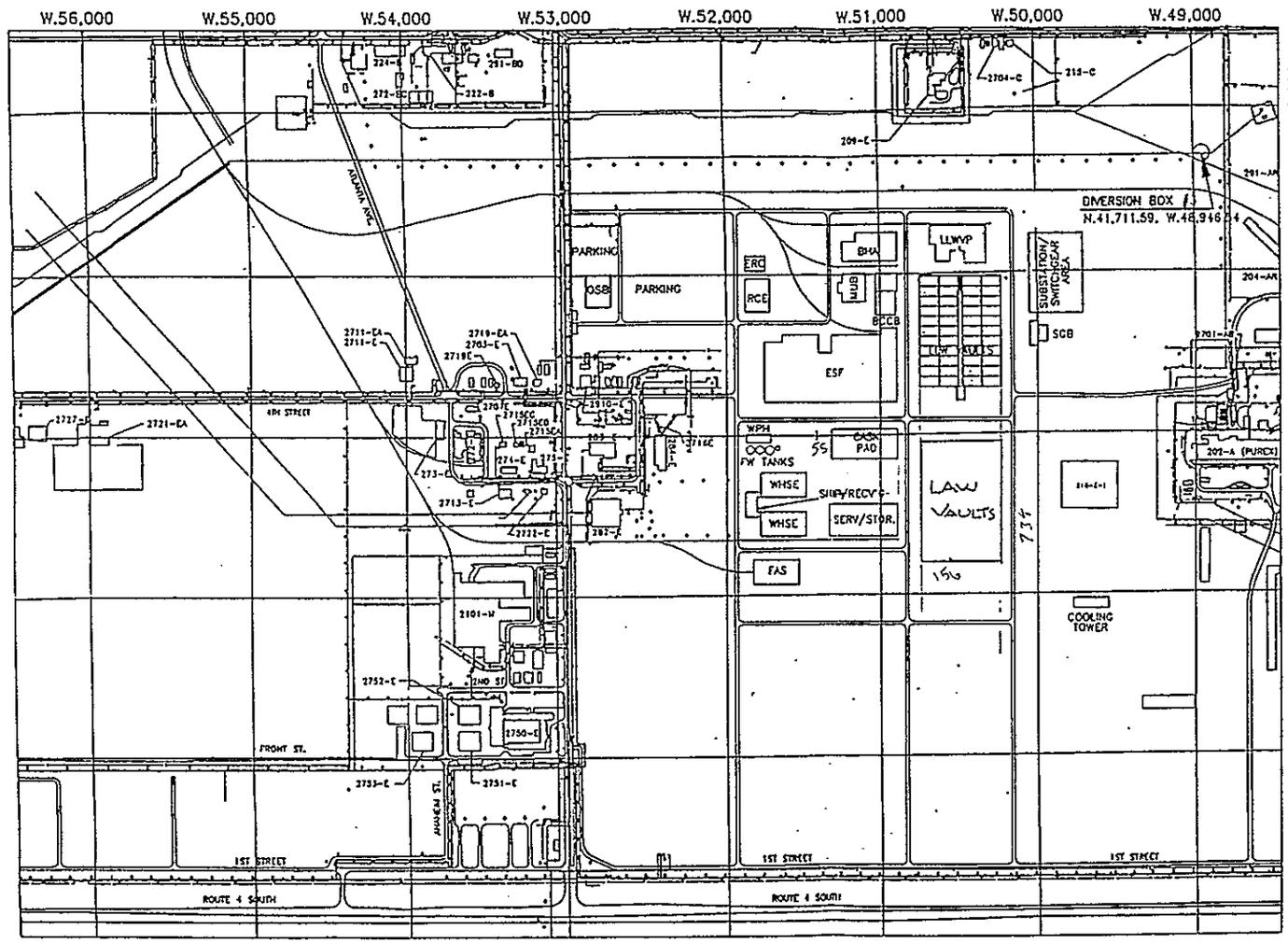
Required STORAGE SPACE:
$393 \times (3 \times 3) \times 1.10 = 3890$
Req for upright stacking.

⇒ Existing Pad is sufficient for Interim Storage.

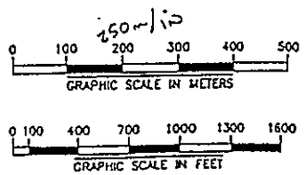
Additional LAW VAULTS = 36500 $m^2$

12 ea

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 |
| | HCHA/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

EIS
EXTENSIVE SEPARATIONS ALTERNATIVE WITH LLW GLASS SITE PLAN

1:3000

REFERENCE DRAWINGS

NOT USED ON

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 PGW 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. SEPARATIONS |
|---|---|---|---|---|---|---|
| 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 | 72,000 ~~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<br>- Vitrification<br>- Calcination | <br>Aggregate<br>Aggregate | <br>123,000 (4.4E+06)<br>123,000 (4.4E+06) | <br>Pit 30<br>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<br>Riprap<br>Aggregate/Sand | 377,000 (1.3E+07)<br>638,000 (2.3E+07)<br>415,000 (1.5E+07) | McGee Ranch<br>Vernita Quarry<br>Pit 30 |
| Ex Situ Intermediate Separations, Extensive Separations, or Phased Implementation (Phase 2) [2] | Silt 645,000<br>Riprap 931,000<br>Aggregate/Sand 744,000 | ~~530,000~~ (~~1.9E+07~~) 2.3E+07<br>~~805,000~~ (~~2.9E+07~~) 3.3<br>~~606,000~~ (~~2.2E+07~~) 2.7 | McGee Ranch<br>Vernita Quarry<br>Pit 30 |
| Ex Situ/In Situ Combination | Silt 511,000<br>Riprap 785,000<br>Aggregate/Sand 580,000 | ~~436,000~~ (~~1.6E+07~~) 1.9<br>~~400,000~~ (~~1.7E+07~~) 2.0<br>~~700,000~~ (2.5E+07) | McGee Ranch<br>Vernita Quarry<br>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 changes 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 = $\frac{645000\ m^3}{3\ m\ depth} = 2.15E5\ m^2 \times \frac{1\ ha}{10{,}000\ m^2} = 22\ ha.$

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 Present = 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 $m^2$

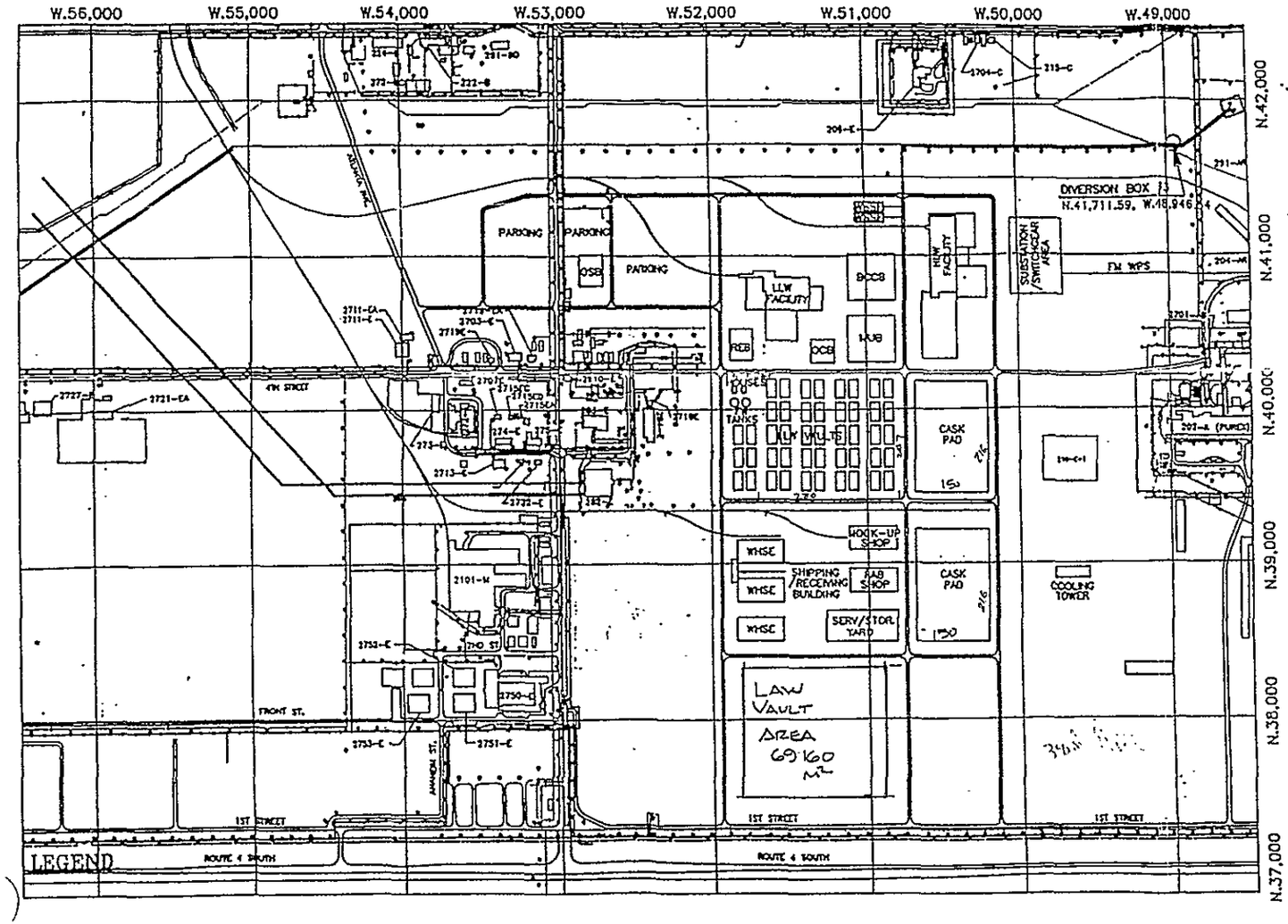
⇒ EXISTING PAD AREA IS ADEQUATE FOR INTERIM STORAGE of HLW

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

| | |
|---|---|
| BCCB | 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 PREFERRRED ALTERNATIVE
SITE PLAN

ES-ALT8A-03 2

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 RGW 2-13-96

J.C. Henderson
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 = 35000m² 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. Dennis 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

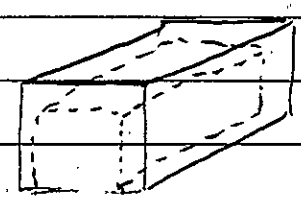
1@ 139m x 292m

HMPC 5m long x 2m dia.

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

$\rho_{concrete} \approx 2.3$ 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 = 187,000

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:

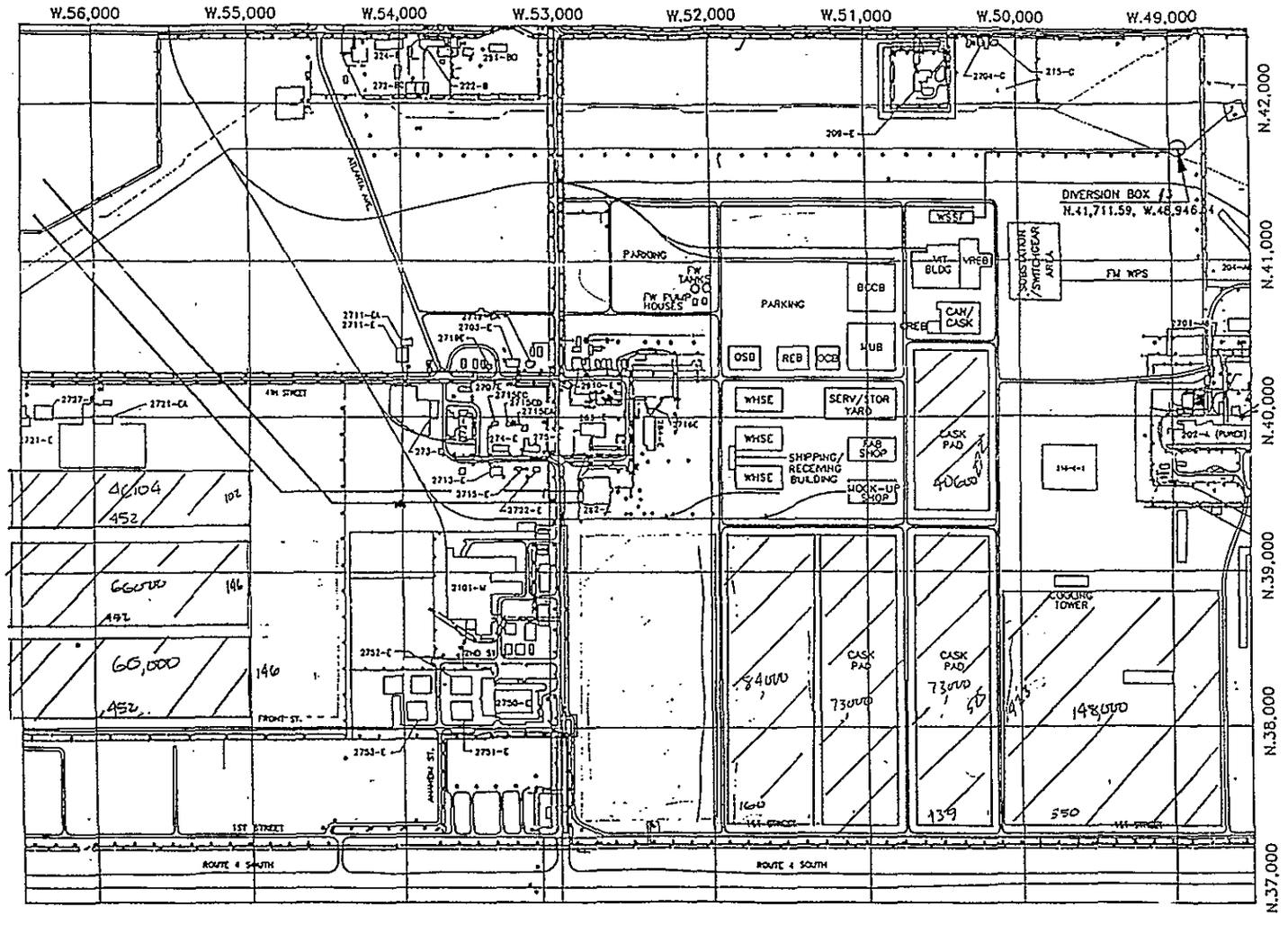
Vitrification = $1.012 \times 10^6$ m$^2$
this is an increase of 825400 m$^2$.
83 ha

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.




200 EAST AREA

(730,704 m²)

INTERIM HLW Storage.

233.5 m/in

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 |
| VREB | VITRIFICATION REGULATED ENTRANCE BUILDING |
| WHSE | WAREHOUSE |

CASE 8A EIS

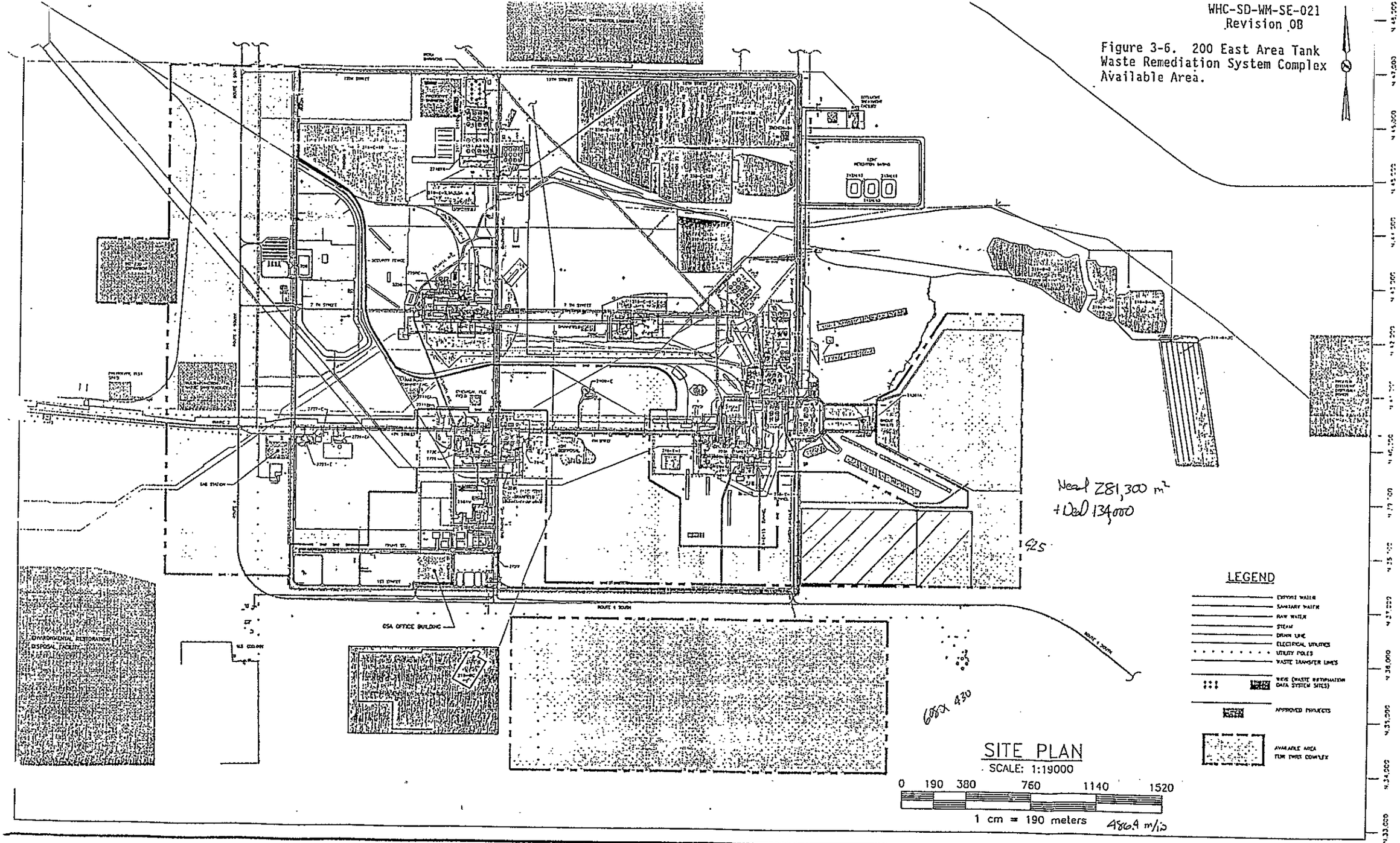
U.S.DEPARTMENT OF ENERGY

FLUOR DANIEL, INC. ADVANCED TECHNOLOGY DIVISION

EIS
NO PRETREATMENT
SITE PLAN

ES-ALT8A-03

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 ACTIVITES.

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.

JACOBS ENGINEERING GROUP INC.

DATE _____ SUBJECT _____ SHEET NO. _____

BY _____ CHKD. _____ JOB NO. _____

| | 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:~~

RCSTS 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.

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

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 as required for transfer flexibility and ease of maintenance. However, national pipe thread connections shall not be used for piping in contact with the waste. Provisions for maintenance shall be incorporated.

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<br>0.0404 (non-Newtonian) | 0.5 to 4,000 μm<br>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 = 740-1120 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)

Donald J. Murray
SIGNATURE

CALCULATION & RESULTS ATTACHED

JACOBS\FORMS\CALCVR.SHT

JACOBS ENGINEERING GROUP INC.

DATE 5/24 SUBJECT Sective Retrieval Costs SHEET NO. 1/19

BY [illegible] 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

JACOBS ENGINEERING GROUP INC.

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 Moni (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.





6/19

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 |

7/19

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.





8/19

9/19

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

10/19

11/19

.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.

12/19

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

13/19

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 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

$3/$m^3$ = $0.01/gal (1¢/gal)

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) ~~$13.5/$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~~ ~~$35.6/114.9~~ 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. Δ = 39.4 in this case.

# TWRS EIS
# CALCULATION COVER SHEET

DISCIPLINE & TITLE ENGINEERING - Calculation of DATA Revisions FOR DRAFT TWR-EIS

ORIGINATOR Ronald D. WEED DATE 2-15-96

REVISION NO. 0

OBJECTIVE Calculate DATA FOR TRANSPORTATION Evaluations BASED ON REVISED FROM table B.10.0.3.

METHODOLOGY applied INPUT data to obtain the new values FOR inclusion IN THE TRANSPORTATION tables and Accident ANALYSIS WORK within OTHERS SECTIONS of THE TWRS-EIS.

ASSUMPTIONS See Calculation. sheet 1 of contains a listing of the tables and calculations covered within this Calculation.

(Continue on another sheet if necessary)

Ronald D. Weed
SIGNATURE

CHECKED CH 1/22/96.

CALCULATION & RESULTS ATTACHED

Cover sheet - 1
Pages - 37
appended material pages - B-1 Through B-50

JACOBS\FORMS\CALCVR.SHT

JACOBS ENGINEERING GROUP INC.

DATE 2-15-96 SUBJECT SHEET NO. 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 on 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 ExSite 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


FORM 91-005-1 (4/81)

JACOBS ENGINEERING GROUP INC.

DATE 2-15-96 SUBJECT SHEET NO. 2 of 37

BY RDU CHKD. JOB NO. 01K4 7101


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 (6/81)

JACOBS ENGINEERING GROUP INC.

DATE 2-15-96 SUBJECT SHEET NO. 3 of 37

BY RDW CHKD. JOB NO. 01K 47101

The object of this calculation is to prepare the data from Table B.10.0.3 recalculation and to obtain the number of trips to be made in order to provide the new increased quantities of material for the various alternatives so that an accident analysis can be performed.

table I

| | 1 | 2 | 3 | 4 | 5 | 6 |
|---|---|---|---|---|---|---|
| 1. Gasoline ($m^3$) | 54.6 | NA | NA | 54.6 | 20 | 75.5 |
| (gal) | 14414.4 | NA | NA | 14414.4 | 5280 | 19932 |
| 2. Diesel ($m^3$) | 3.51E+03 | 1.4E+04 | 6.044E+04 | 2.3E+04 | 5.05E+03 | 4.78E+03 |
| (gal) | 9.27E+05 | 3.7E+06 | 1.6E+07 | 6.07E+06 | 1.333E+06 | 1.262E+06 |
| 3. Kerosene ($m^3$) | 4.06E+04 | 1.06E+05 | NA | 1.404E+05 | 2.03E+04 | 2.1E+04 |
| (gal) | 1.072E+07 | 2.80E+07 | NA | 3.71E+07 | 5.36E+06 | 5.544E+06 |
| 4. Concrete ($m^3$) | 2.67E+05 | 1.66E+05 | 2.23E+04 | 2.58E+05 | 9.9E+04 | 1.98E+05 |
| ($yds^3$) | 3.5E+05 | 2.18E+05 | 2.92E+04 | 3.38E+05 | 1.297E+05 | 2.59E+05 |
| (tons) | 4.7E+05 | 2.92E+05 | 3.93E+04 | 4.54E+05 | 1.74E+05 | 3.49E+05 |
| 4a Cement (tons) | 4.7E+05 | 2.92E+05 | 3.93E+04 | 4.54E+05 | 1.74E+05 | 3.49E+05 |
| 4b Sand ($yds^3$) | 3.5E+05 | 2.18E+05 | 2.92E+04 | 3.38E+05 | 1.297E+05 | 2.59E+05 |
| 4c Gravel ($yds^3$) | 3.5E+05 | 2.18E+05 | 2.92E+04 | 3.38E+05 | 1.297E+05 | 2.59E+05 |
| 5* Concrete ($m^3$) | 3.77E+05 | 7.13E+06 | 9.52E+05 | 8.11E+03 | 1.88E+05 | 3.77E+05 |
| Prefab Shapes (tons) | 6.64E+05 | 1.255E+07 | 1.68E+06 | 1.43E+04 | 3.31E+05 | 6.64E+05 |
| (Number of units) | 6645 | 125600 | 16797 | 143 | 3222 | 6645 |
| 6. Carbon Steel (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 | 1.052E+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 | 1.06E+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 Formers (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 (yds) 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 ($yds^3$) | 4.94E+05 | 9.58E+06 | 1.21E+06 | 1.06E+04 | 2.46E+05 | 4.94E+05 |
| 5a* Cement (tons) | 6.64E+05 | 1.255E+07 | 1.68E+06 | 1.43E+04 | 3.64E+05 | 6.64E+05 |
| 5b Sand (yds) | 4.94E+05 | 9.58E+06 | 1.21E+06 | 1.06E+04 | 2.46E+05 | 4.94E+05 |
| 5c Gravel (yds) | 4.94E+05 | 9.58E+06 | 1.21E+06 | 1.06E+04 | 2.46E+05 | 4.94E+05 |

FORM 91-006 (4/81)

JACOBS ENGINEERING GROUP INC.

DATE 2-15-96 SUBJECT SHEET NO. 4 of 37

BY RAW CHKD. JOB NO. 01447101

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/Insitu combination
6. Phased Implementation - phase 2.

Conversion factors used

gallons = ($m^3$) (264)

Cubic yds = ($m^3$) (1.31)

Tons = (m Tons) 1.1)

tons = ($m^3$) (1.76)

With the information in Table I above the information for Table II is generated using certain assumptions with respect to shippment origin and mode of transportation which is either by rail car or by truck and with respect to trucks can vary by cubic yards, gallons and/or tonnage. This is identified for each material in determining the number of trips to the 200E/200W area of the Hanford Nuclear site.

FORM 91.006.1 (4/81)

JACOBS ENGINEERING GROUP INC.

DATE 2-15-96 SUBJECT SHEET NO. 5 of 37

BY RDW CHKD. JOB NO. 01K47101

Table II Number of trips required (Continued on sheet 6 for Columns 5+6

| | Material item | Size & Mode of Transport | Point of Origin | 1 | 2 | 3 | 4 |
|---|---|---|---|---|---|---|---|
| 1 | Gasoline | 5000 gallons tank truck | Tri Cities | 3 | NA | NA | 3 |
| 2 | Diesel fuel | 5000 gallon Tank Truck | Tri Cities | 186 | 740 | 3200 | 1214 |
| 3 | Kerosene | 5000 gallon tank truck | Tri Cities | 2144 | 5600 | NA | 7420 |
| 4 | Concrete | 6 Cubic yard Cement truck | Site Concrete Plant | 58,334 | 36,334 | 4867 | 56334 |
| | a Cement | 25 Tons/Load TRUCK | SEATTLE PORTLAND. | 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 unit. Tri Cities | 6645 | 125,600 | 16797 | 143 |
| | Concrete shapes | Cast on site with Concrete Plant source | | | | | |
| | a Concrete | 6 Cu yd Cement Truck | Site Concrete Plant. | 82334 | 1596667 | 201667 | 1767 |
| | b Cement | 25 TONS/Load TRUCK | SEATTLE PORTLAND | 26560 | 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 m³ Prefab shapes bottles | 20 ton TRUCK | Seattle Portland | 7000 | NA | NA | 6950 |
| 8. | Stainless steel Prefab .0162 m³ cylinder | 20 ton truck | Seattle Portland | 2425 | 24200 | 4470 | 66 |
| 9. | Glass Formers | 20 ton TRUCK | — | 11550 | 12000 | NA | 29500 |
| | a Sand (0.816) | 16 Cu yd dump truck | Tri Cities | 1403 | 14588 | NA | 35700 |
| | b Other material (0.1837) | 20 ton TRUCK | Seattle Portland | 2122 | 2205 | NA | 5420 |
| 10 | Process Chemicals | 20 ton TRUCK | Seattle Portland | 28350 | 19600 | 16850 | 72500 |
| | a Oxygen | 25 ton tank TRUCK. | Seattle Portland | 14320 | 15240 | 11680 | 20400 |
| 11 | Sulfur Cement | | | | | | |
| | a Sulfur | 45,000 lb/Load tank TRUCK | SEATTLE PORTLAND | 4449 | NA | NA | 12489 |
| | b Dicyclopentadiene | 45 ton RAIL TANKCAR | SEATTLE PORTLAND | 59 | NA | NA | 165 |
| | c. Oligomer | 20 ton TRUCK | SEATTLE PORTLAND | 131 | NA | NA | 371 |

FORM 01 005 1 (1/84)

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 Combustion
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 PGW CHKD. JOB NO. 01K4710/

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 Parker.

A. Ex Site 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

Gasoline = 3

Diesel fuel = 186

Kerosene = 2144

Σ = 2333 Trips/yr = 2333/19 = 123

Σ for table entry = 5200 + 123

= 5.3 E+03 trips/yr

FORM 91-005-1 (4/91)

JACOBS ENGINEERING GROUP INC.

DATE 2-15-96 SUBJECT SHEET NO. 8 of 37

BY RDW 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

FORM 91.005 (4/81)

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

FORM 01.006.1 (4/91)

JACOBS ENGINEERING GROUP INC.

DATE 2-15-96 SUBJECT SHEET NO. 10 of 37

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 Tri 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

JACOBS ENGINEERING GROUP INC.

DATE 2-15-96 SUBJECT SHEET NO. 11 of 38

BY RDW CHKD. JOB NO. 01K 47101

D. Ex Situ Extensive separations alternative

1. onsite truck Borrow site Trips

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
Resources = 7420
total = 8780

Σ for Table entry = (8780) + (27000)
= 35780
= 3.58 E+04

3 Offsite Truck portland/Sealite 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 phosphorus/chemicals

oxygen = 20400
other materials = 5420 Trip/year period = 19
sulfur = 12489
DCP = 371
total = 38680 trips/year = 2036

FORM 01.005.1 (4/91)

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

D = pD = 165

Trips/yr = 165/19 = 9

E for table entry = (9) + (637)
= 6.46 E+02

7. offsite Rail - yucca mountain = 3.9 E+01

E. Ex Situ / Insitu Combination Alternative

1. onsite truck borrow site trips

Sand = 21617

Gravel = 21617

total = 43234

E for Table entry = (4.32E+04) + (2.60E+04)
= 6.92 E+04

2. offsite concrete truck

Portland cement = 6960

Concrete Prof Shapes = 3222

total = 10182

E for Table entry = (10182) + (14500)
= 2.47E+04

JACOBS ENGINEERING GROUP INC.

DATE 2-15-96 SUBJECT SHEET NO. 13 of 37

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 formers / 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

FORM 91-005.1 (4/81)

JACOBS ENGINEERING GROUP INC.

DATE 2-15-96 SUBJECT SHEET NO. 14 of 37

BY RDW CHKD. JOB NO. 01K47101

7. offsite Rail glass forming 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

JACOBS ENGINEERING GROUP INC.

DATE 2-15-96 SUBJECT SHEET NO. 15 of 37

BY RDW CHKD. JOB NO. 01K47101

4. Offsite Truck Miscellaneous

Gasoline = 4
Diesel fuel = 253
Kerosene = 1109
total = 1366

E for table entry = (1366) + (29200)
= 30566 = 3.06 E+04

5. Processing offsite Truck Slow foam Chemicals

oxygen = 14320
other materials = 2021
Sulfur = 4107
oligomer = 131
total = 20579

E for table entry = (20579) + (3720)
= 24299 = 2.43 E+04

6. processing offsite Truck pressure material

Sand = 11000

E for table ENTRY = (11000) + (3570)
= 14570 = 1.46 E+04

7. offsite rail glass former chemicals.

DCPD = Dicyclopentadiene
= 59

E for Table ENTRY = (59) + (2750)
= 2.81 E+03.

8. offsite Rail - Yucca mountain = 8.35 E+02

FORM 01.006.1 (4/84)

To provide information on the sensitivity of the process to changes in the sodium or waste oxide loading of the glass and the use of the 1.5 and 1.25 blending factors respectively for HLW and LAW the following calculations have been assembled and performed for comparative purposes. The intermediate separations alternative has been selected for this evaluation.

1. This case is defined as LAW - 25 wt % $Na_2O$ loading of the glass waste with a blending factor of 1.25 applied; and HLW - 40 wt % waste oxides loading in the waste glass with a blending factor of 1.5 applied.

2. This case is defined as LAW - 15 wt % $Na_2O$ loading of the glass waste with a blending factor of 1.25 applied; and HLW - 20 wt % waste oxides loading of the waste glass with a blending factor of 1.5 applied.

3. This case is defined as LAW - 12 wt % $Na_2O$ loading of the glass waste with a blending factor of 1.25 applied; and HLW - 15 wt % waste oxides loading of the waste glass with a blending factor of 1.5 applied.

The items listed in Table I on page 2 and 3 above have been computed and are tabulated in the following Table, Table III for the sensitivity evaluation using the three cases numbered and defined above on page 16.

JACOBS ENGINEERING GROUP INC.

DATE 2-15-96 SUBJECT

BY RDW CHKD.

SHEET NO. 17 of 37

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 | $m^3$ | 463E+04 | 1.98E+05 | 3.79E+05 |
| | $yds^3$ | 6.07E+04 | 2.594E+05 | 4.97E+05 |
| | Tons | 8.15E+04 | 3.49E+05 | 6.67E+05 |
| a Cement | tons | 81500 | 349000 | 667000 |
| b sand | $yds^3$ | 60700 | 259000 | 497000 |
| c gravel | $yds^3$ | 60700 | 259000 | 497000 |
| 5 Concrete prefab. Shapes | $m^3$ | 1.4E+05 | 3.77E+05 | 5.34E+05 |
| | Tons | 2.464E+05 | 6.64E+05 | 9.4E+05 |
| | Number of units | 2470 | 6645 | 9420 |
| | $yds^3$ | 1.834E+05 | 4.94E+05 | 7.0E+05 |
| a Cement | tons | 246400 | 664000 | 940000 |
| b sand | $yds^3$ | 183400 | 494000 | 700000 |
| c gravel | $yds^3$ | 183400 | 494000 | 700000 |
| 6 Carbon steel rebar | mtons | 5.03E+03 | 2.24E+04 | 4.31E+04 |
| | Tons | 5533E+03 | 2.464E+04 | 4.741E+04 |
| 7 Carbon steel shapes | mtons | 6.37E+04 | 1.25E+05 | 1.58E+05 |
| | tons | 7.01E+04 | 1.375E+05 | 1.738E+05 |
| 8 Stainless steel shapes | mtons | 1.3E+04 | 2.51E+04 | 3.34E+04 |
| | tons | 14300 | 27610 | 36740 |
| 9 Glass 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 | 3.05E+05 | 4.07E+05 |
| | tons | 260700 | 357500 | 447700 |

FORM 91-005-1 (4/81)

JACOBS ENGINEERING GROUP INC.

DATE 2-15-94 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.

FORM 91-0061 (4/89)

JACOBS ENGINEERING GROUP INC.

DATE 2-15-96 SUBJECT

BY RDW 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 | 5207 | 5702 |
| 4 Concrete | 6 cu yd Cement + truck | Site concrete plant | 10117 | 43167 | 82834 |
| a Cement | 25 to m3/Load + TRUCK | Seattle Portland | 3260 | 13960 | 26680 |
| b Sand | 6 cu yd dump truck | Pit 30 | 10117 | 43167 | 82834 |
| c Gravel | 6 cu yd dump truck | Pit 30 | 10117 | 43167 | 82834 |
| 5 Concrete prefab shapes | Special walls and 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 Lb/load tank truck | Seattle Portland | 7872 | 9805 | 13543 |
| b. Dicyclopentadiene (DCPD) | 45 ton rail tank car | Seattle Portland | 104 | 142 | 177 |
| c. Oligomer (DCP) | 20 ton/Load + truck | Seattle Portland | 233 | 318 | 399 |
| HLW Waste Shipments. | | | | | |
| Rail car Trips to Yucca mountain | | | 418 | 835 | 1113 |

FORM 01205.1 (4/91)

JACOBS ENGINEERING GROUP INC.

DATE 2-15-96 SUBJECT SHEET NO. 20 of 37

BY RDW CHKD. JOB NO. 01K47101

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

E for Table entry = (20234) + (52000)

= 72234 = 7.22 E+04

2. off site Concrete truck

Portland cement = 3260

Concrete prefab shapes = 2470

Total = 5730

E 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

E for Table entry = (4497) + (9500)

= 13997

= 1.4 E+04

4 off site miscellaneous trucked materials

Gasoline = 1

Diesel fuel = 118

Kerosene = 3802

FORM 01/0057 (4/89)

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.

glassformer 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

Sand = 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 = 418

JACOBS ENGINEERING GROUP INC.

DATE 2-15-96 SUBJECT SHEET NO. 22 of 37

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

FORM 81.0054 (2/81)

JACOBS ENGINEERING GROUP INC.

DATE 2-15-96 SUBJECT SHEET NO. 23 of 37

BY RDW CHKD. JOB NO. 01K4710 1

5. processing offsite truck glass former 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 glass former chemicals trips/yr

2 cyclopentadiene = 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

FORM 01.005-1 (4/84)

JACOBS ENGINEERING GROUP INC.

DATE 2-15-96 SUBJECT SHEET NO. 24 of 37

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 Glassforms 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

FORM 91-005.1 (4/81)

JACOBS ENGINEERING GROUP INC.

DATE 2-15-96 SUBJECT SHEET NO. 25 of 37

BY RPW CHKD. JOB NO. 01K 47101

6. Processing offsite truck miscellaneous trips/yr.

Sand = 41824

total = 41824 trips/yr = 2202

Σ for table entry = (2202) + (5200)

= 7402 = 7.4E+03

7. offsite rail glass formers trips/year

Dicyclopentadiene = 177

total = 177 trips/yr = 10

Σ for table entry = (10) + (260)

= 270 = 2.7E+02

8. offsite rail trips to yucca mountain

HLW = 1113

Calculate the input for table B.10.0.7 Transportation summary for rail transport and truck transport.

a. Ex situ intermediate separations alternative

1. Rail transport distance Km

a. Seattle portland = (59)(8.0E+02) Km S/P = 8.00E+02 Km

= 47200 TC = 1.40E+01 Km

b. Yucca portland (835) − (170)(2.93E+03) YP = 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 |

JACOBS ENGINEERING GROUP INC.

DATE 2-15-96 SUBJECT SHEET NO. 26 of 37

BY RDW CHKD. JOB NO. OIK 4701

Coarse Sand and Gravel = (1.5 − 1.36) E+05 $m^3$

= 0.14 E+06 $m^3$

= (1.4 E+05) (1.31) = 1.834 E+05 $yds^3$

6 Cu yd Dump Truck = 30567 Trips

Borrow Site Silt = (6.45 − 5.20) E+05) = 1.19 E+05 $m^3$

= (1.19 E+05)(1.31) = 1.56 $yds^3$ E+05

= 156000

= 26000 trips

Borrow Site Basalt = (9.31 E+05) − (8.05 E+05) = 1.26 E+05 $m^3$

= (1.26 E+05)(1.31) = 165060 $yds^3$

= 27510 Trips

Σ from page 24 = 3654130 = 3.65 E+06 Km Cost on Site

Σ for Table entry = (- - - - - -) · (7.79 E+06) Km

Cost on site = 1.144 E+07 Km ; Cost off Site = 1.50 E+07 Km ←

Cost off site = 723438 = 7234380 = 7.24 E+06 Km

b. off sites

Tri Cities = (10381) (140) = 1.45 E+06 Cost off Site | (13936)(140) Con Site = 5.23 E+05

Portland/Seattle = (79532)(800) = 6.28 E+07 Cost on Site | C off Site = 4.16 E+07 (51992)(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 Km.

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

JACOBS ENGINEERING GROUP INC.

DATE 2-15-96 SUBJECT SHEET NO. 27 of 37

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 Tops Cost on Site cost off site = 53654

Tri cities = 146528 Tops 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

FORM 9-005-1 (4/81)

JE JACOBS ENGINEERING GROUP INC.
DATE 2-15-96 SUBJECT SHEET NO. 28 of 37
BY RDW CHKD. JOB NO. 01K 47101

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. Criteria Extensive 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. on site
Sand = 56334 cost off site
Gravel = 56334 cost off site
Sand = 1767 add for cost on site
Gravel = 1767 add for cost on site
Σ = (116202)(10) = 1162020 Km cost on site
(112668)(10) = 1126680 Km cost off site

JACOBS ENGINEERING GROUP INC.

DATE 2-15-96 SUBJECT SHEET NO. 29 of 37

BY RDW CHKD. JOB NO. 01K47101

Borrow Site Silt = (6.45 - 5.35) = 1.10 E+05 $m^3$
= 1.44 E+05 $yd^3$
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

$\Sigma$ = (24000) + (30567) + (27510)
= 82077
= (82077)(10) = 820770 Km

$\Sigma$ = (1162020) + (820770) = 1982790 Km = 1.98 E+06 Cost on Site
= (1126680) + 820770) = 1947450 Km = 1.95 E+06 Cost off Site

$\Sigma$ 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

$\Sigma$ 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/In Site combination alternative
1. Rail transport distance, Km
a. Seattle Portland = 30
b. Yucca mountain = 418 - 85 = 333

FORM 01 005 1 (4/81)

JACOBS ENGINEERING GROUP INC.

DATE 2-16-96 SUBJECT SHEET NO. 30 of 37

BY RDW CHKD. JOB NO. 01K 47101

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

FORM 81-005-1 (4/81)

JACOBS ENGINEERING GROUP INC.

DATE 2-15-96 SUBJECT SHEET NO. 32 of 37

BY RDW CHKD. JOB NO. OIK 47101

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

| Cost on Site | 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 $m^3$

= (1.19E+05)(1.31) = 1.56E+05 $yd^3$

6 $yd^3$ truck = 26000 = 26000

Borrow site Sand + gravel Volume = (1.5 − 1.36)E+06 $m^3$ = 1.4E+05 $m^3$

= (1.4E+05)(1.31) = 1.834E+05 $yd^3$

6 $yd^3$ truck = 30567 = 30567

Borrow site Basalt = (9.71 − 8.05)E+05 $m^3$ = 1.26E+05 $m^3$

= (1.26E+05)(1.31) = 1.651E+05 $yd^3$

6 $yd^3$ 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 on site = 8.01E+06 Km off site

JACOBS ENGINEERING GROUP INC.

DATE 2-15-96 SUBJECT SHEET NO. 32 of 37

BY RDW CHKD. JOB NO. 01K47101

b. off site truck distance km:

Tri cities = 21136 trips (-6645 if shaper cast on site)

Seattle Portland =

Cement = 13960 trips (+26560 if shaper 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 |

JACOBS ENGINEERING GROUP INC.

DATE 2-15-96 SUBJECT SHEET NO. 33 of 37

BY PAW CHKD. JOB NO. 01K47101

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

| | | |
|---|---|---|
| 4.72 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 |

JACOBS ENGINEERING GROUP INC.

DATE 2-15-96 SUBJECT SHEET NO. 34 of 37

BY RDW CHKD. JOB NO. 01K4701

Develop verification for number of rail cars per trip etc for better defense of rail transport risk analysis

| Glass Former | WCH data Backout | | |
|---|---|---|---|
| $B_2O_3$ | 5.75E+04 Mg | | |
| $Fe_2O_3$ | 1.4E+01 Mg | | |
| $Li_2O$ | 2.1E+03 Mg | | |
| $SiO_2$ | 2.87E+05 Mg | 4.35E+05 MT | |
| $Na_2O$ | 4.1E+03 Mg | | |
| CaO | 4.1E+03 Mg | | |
| | atlas | 9.8E+04 MT | 2396 |
| Resin | | | |
| R-F for Cs Removal | 9.0E+02 $m^3$ | | |
| CST for Sr Removal | 8.0E+02 $m^3$ | | |
| Prillex HPQ for Tc | 3.0E+03 $m^3$ | | |
| ANP for Cs | 1.6E+02 $m^3$ | | |
| Prillex HPQ for ANP/ANP | 5.0E+01 $m^3$ | | |
| Nitric acid 50% | 4.65E+05 Mg | * 4.65E+05 MT | 11367 Tank Cars |
| Na OH 50% | 1.5E+05 Mg | * 1.5E+05 MT | 3667 Tank Cars |
| Flocculant - 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 |
| Zirconium nitrate | 4.7E+01 Mg | | |
| $Mo_3$ DTPA | 1.96E+02 Mg | | |
| H PAM | 1.0E+01 Mg | | |

FORM 91-0001 (4/84)

JACOBS ENGINEERING GROUP INC.

DATE 2-15-96 SUBJECT SHEET NO. 35 of 37

BY RDW CHKD. JOB NO. 01K47101

| | | | |
|---|---|---|---|
| Hydroxylamine Nitrate | 9.5E+1 mg | | |
| Rail shipments | | | |
| 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 Rail wall | | | |
| Concrete | | | |
| Steel | 1.6E+04 mg. | | |
| | total steel = | 3.1E+05 MT | 7578 rail cars |
| decontamination chemicals | 1.4E+04 mg | | on 399/yr |
| | | | or 34/month |
| Kerosene | 9.356E+04 $m^3$ | 1.404E+05 $m^3$ | 3.71E+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 Rail per Trip

1 train/month = 37 cars
1 train/month = 33 cars
= 24 trains/year
= 456 total (1990)

JACOBS ENGINEERING GROUP INC.

DATE 2-15-96 SUBJECT SHEET NO. 36 of 37

BY RDW CHKD. JOB NO. 01K 47101

Based on calculational estimate above there are two rail trips per month for a total of 48 Trip year

add the construction number of 10 Trips per year

a total would equal 58 Trip year

If 20 Cars/train are assumed as in WHC report,

total Estimated = 15875 Cars
= 835.5 Cars/yr.
= 42 Trips/yr at 20 Cars/train

to carry total steel
by 45 Ton Capacity rail car.
7578 rail cars
= 399 cars/yr
= 34 rail cars/month
= 17 Cars each of two trains/month.

| | | | | | | cars/month |
|---|---|---|---|---|---|---|
| Σ other glass formers | = | 2396 | Rail Cars @ 45 Tons each. | Box car) | | 11 |
| Sodium oxalate | = | 511 | " | " | " | 3 |
| Sodium Bicarbonate | = | 306 | " | " | " | 2 |
| ammonia | = | 226 | Rail Tank Car @ 45 Tons each. | | | 1 |

Split = 1, 1, 2, 6, & 0, 1, 1, 5

= one train with 10 Cars; one train with 7 Cars

Still 2 trains per month.

1st train carries (37) + (17) + (10) = 64 Cars
2nd train Carries (33) + (17) + (7) = 57 Cars.

total Σ = 26892 Cars. = 1416 Cars/yr.
at 20 Cars/train = 71 Trips/yr. = 6 Trips/month.

FORM 91-005-1 (4/81)

JACOBS ENGINEERING GROUP INC.

DATE 2-15-96 SUBJECT SHEET NO. 37 of 37

BY RDW CHKD. JOB NO. 01K47101

The Westinghouse Document Table 9-7 for the extensive 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) m tons

= 6.74 E+03 m tons = 7.41 E+03 tons

= 7414 tons

= 390 tons/yr.

at 45 tons/car = 9 Cars per year.

Σ = 12740 + 9 = 12749 Cars/yr

at 20/train = 638 Trains/yr.

FORM 91-0051 (6/81)

Sheet B-1
RDW 2-15-96

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | EX SITU INTERMEDIATE SEPARATIONS ALTERNATIVE | | | | | | | |
| | | | | | | | | |
| RETRIEVAL | | | | | | | | |
| Waste Transport | | | | | | total | | |
| Onsite Truck | | | | | | 1.25E+04 | | |
| | | | | | | | Total | 1.25E+04 |
| Construction | | | | | | | | |
| Offsite Truck | | | trips/yr | km/trip | yr | total | | |
| | concrete | | 4.80E+02 | 1.40E+02 | 2.00E+01 | 1.34E+06 | | |
| | raw material | | 4.50E+01 | 8.00E+02 | 2.00E+01 | 7.20E+05 | | |
| | equipment | | 2.50E+01 | 1.00E+04 | 2.00E+01 | 5.00E+06 | | |
| | miscellaneous | | 5.20E+03 | 1.40E+02 | 2.00E+01 | 1.46E+07 | | |
| | steel W-314 | | 5.30E+01 | 8.00E+02 | | 4.24E+04 | | |
| | cement W-314 | | 1.00E+02 | 1.40E+02 | | 1.40E+04 | Total | 2.17E+07 |
| Offsite Rail | | | trips/yr | km/trip | yr | total | | |
| | raw material | | 1.00E+01 | 8.00E+02 | 2.00E+01 | 1.60E+05 | Total | 1.60E+05 |
| Onsite Truck | | | | | | | | |
| | borrow W-314 | | 1.38E+03 | 1.00E+01 | | 1.38E+04 | Total | 1.38E+04 |
| VITRIFICATION | | | | | | | | |
| Construction | | | | | | | | |
| Onsite Truck | | | trips | km/trip | | total | | |
| | borrow | 1.67E+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 | ~~9.54E+03~~ | ~~5.20E+03~~ | 1.40E+02 | 1.00E+01 | 7.28E+06 | | |
| | | | 5.3E+03 | | | | Total | 1.89E+07 |
| | | | | | | | | |
| Processing | | | | | | | | |
| Offsite Truck | | 1.13E+03 | trips/yr | km/trip | yr | total | | |
| | glassformer/chem | | ~~2.30E+01~~ | 8.00E+02 | 1.95E+01 | 3.59E+05 | | |
| | miscellaneous | ~~3.33E+03~~ | 5.20E+03 | 1.40E+02 | 1.95E+01 | 1.42E+07 | | |
| | | 6.7E+03 | 5.3E+03 | | | | Total | 1.46E+07 |
| | | | | | | | | |
| Offsite Rail | | ~~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 |
| | | | 2.64E+02 | | | | | |
| VITRIFIED HLW TRANSPORT | | | | | | | | |
| Offsite Rail | | | trips | km/trip | | total | | |
| | Yucca Mountain | | 1.70E+02 | 2.93E+03 | | 4.98E+05 | | |
| | | | 9.35E+02 | | | | Total | 4.98E+05 |
| | | | | | | | | |
| CLOSURE | | | | | | | | |
| Onsite Truck | | | cu yd | trip/cu yd | km/trip | total | | |
| | fill | | 9.86E+05 | 1.00E-01 | 1.00E+01 | 9.86E+05 | | |

Sheet B-2
RDW 2-15-96

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | | EX SITU NO SEPARATIONS ALTERNATIVE - Vitrification | | | | | |
| | | | | | | | | |
| RETRIEVAL | | | | | | | | |
| Waste Transport | | | | | | total | | |
| Onsite Truck | | | | | | 1.25E+04 | Total | 1.25E+04 |
| | | | | | | | | |
| Construction | | | | | | | | |
| Offsite Truck | | | trips/yr | km/trip | yr | total | | |
| | concrete | | 4.80E+02 | 1.40E+02 | 2.00E+01 | 1.34E+06 | | |
| | raw material | | 4.50E+01 | 8.00E+02 | 2.00E+01 | 7.20E+05 | | |
| | equipment | | 2.50E+01 | 1.00E+04 | 2.00E+01 | 5.00E+06 | | |
| | miscellaneous | | 5.20E+03 | 1.40E+02 | 2.00E+01 | 1.46E+07 | | |
| | steel W-314 | | 5.30E+01 | 8.00E+02 | | 4.24E+04 | | |
| | cement/misc W-314 | | 1.53E+02 | 1.40E+02 | | 2.14E+04 | Total | 2.17E+07 |
| Offsite Rail | | | trips/yr | km/trip | yr | total | | |
| | raw material | | 1.00E+01 | 8.00E+02 | 2.00E+01 | 1.60E+05 | Total | 1.60E+05 |
| Onsite Truck | | | | | | | | |
| | borrow W-314 | | 1.38E+03 | 1.00E+01 | | 1.38E+04 | Total | 1.38E+04 |
| VITRIFICATION | | | | | | | | |
| Construction | | | | | | | | |
| Onsite Truck | | | trips | km/trip | | total | | |
| | borrow | ~~1.18E+05~~ | ~~2.02E+04~~ | 1.00E+01 | | 2.02E+05 | Total | 2.02E+05 |
| | | | 9.29E+04 | | | | | |
| Offsite Truck | | 1.45E+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 |
| | | ~~3.06E+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
RDW 2-15-96

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | | EX SITU NO SEPARATIONS ALTERNATIVE -Calcination. | | | | | |
| | | | | | | | | |
| RETRIEVAL | | | | | | | | |
| Waste Transport | | | | | | total | | |
| Onsite Truck | | | | | | 1.25E+04 | Total | 1.25E+04 |
| | | | | | | | | |
| Construction | | | | | | | | |
| Offsite Truck | | | trips/yr | km/trip | yr | total | | |
| | concrete | | 4.80E+02 | 1.40E+02 | 2.00E+01 | 1.34E+06 | | |
| | raw material | | 4.50E+01 | 8.00E+02 | 2.00E+01 | 7.20E+05 | | |
| | equipment | | 2.50E+01 | 1.00E+04 | 2.00E+01 | 5.00E+06 | | |
| | miscellaneous | | 5.20E+03 | 1.40E+02 | 2.00E+01 | 1.46E+07 | | |
| | steel W-314 | | 5.30E+01 | 8.00E+02 | | 4.24E+04 | | |
| | cement/misc W-314 | | 1.53E+02 | 1.40E+02 | | 2.14E+04 | Total | 2.17E+07 |
| Offsite Rail | | | trips/yr | km/trip | yr | total | | |
| | raw material | | 1.00E+01 | 8.00E+02 | 2.00E+01 | 1.60E+05 | Total | 1.60E+05 |
| Onsite Truck | | | | | | | | |
| | borrow W-314 | | 1.38E+03 | 1.00E+01 | | 1.38E+04 | Total | 1.38E+04 |
| VITRIFICATION | | | | | | | | |
| Construction | | 3.0 | | | | | | |
| Onsite Truck | | ~~3.93~~ 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 | 3.4E+04 | ~~1.30E+04~~ | 1.40E+02 | | 1.82E+06 | | |
| 6.07E+4 | Portland/Seattle | 1.1E+04 | ~~5.00E+03~~ | 8.00E+02 | | 4.00E+06 | | |
| | | | trips/yr | km/trip | yr | | | |
| | miscellaneous | | 5.20E+03 | 1.40E+02 | 5.50E+00 | 4.00E+06 | Total | 9.82E+06 |
| | | | | | | | | |
| | | | | | | | | |
| Processing | | | | | | | | |
| 8.57 E+02 | Offsite Truck | 8.29E+02 | trips/yr | km/trip | yr | total | | |
| | Portand/Seattle | | ~~5.00E+01~~ | 8.00E+02 | 1.40E+01 | 5.60E+05 | | |
| | miscellaneous | | 5.20E+03 | 1.40E+02 | 1.40E+01 | 1.02E+07 | Total | 1.08E+07 |
| | | | | | | | | |
| | | | | | | | | |
| Offsite Rail | | | trips/yr | km/trip | yr | total | | |
| | Portland/Seattle | ok | 1.03E+02 | 8.00E+02 | 1.40E+01 | 1.15E+06 | Total | 1.15E+06 |
| | | | | | | | | |
| | | | | | | | | |
| VITRIFIED HLW TRANSPORT | | | | | | | | |
| Offsite Rail | | | trips | km/trip | | total | | |
| | Yucca Mountain | | ~~2.14E+03~~ | 2.93E+03 | | 6.27E+06 | Total | 6.27E+06 |
| | | | 2.710E+03 | | | | | |
| | | | | | | | | |
| CLOSURE | | | | | | | | |
| Onsite Truck | | | cu yd | trip/cu yd | km/trip | total | | |
| | fill | | 9.86E+05 | 1.00E-01 | 1.00E+01 | 9.86E+05 | | |

Sheet B-4
RDW 2-15-96

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | | | | | | | |
| | | EX SITU EXTENSIVE SEPARATIONS ALTERNATIVE | | | | | | |
| | | | | | | | | |
| RETRIEVAL | | | | | | | | |
| Waste Transport | | | | | | total | | |
| Onsite Truck | | | | | | 1.25E+04 | Total | 1.25E+04 |
| | | | | | | | | |
| Construction | | | | | | | | |
| Offsite Truck | | | trips/yr | km/trip | yr | total | | |
| | concrete | | 4.80E+02 | 1.40E+02 | 2.00E+01 | 1.34E+06 | | |
| | raw material | | 4.50E+01 | 8.00E+02 | 2.00E+01 | 7.20E+05 | | |
| | equipment | | 2.50E+01 | 1.00E+04 | 2.00E+01 | 5.00E+06 | | |
| | miscellaneous | | 5.20E+03 | 1.40E+02 | 2.00E+01 | 1.46E+07 | | |
| | steel W-314 | | 5.30E+01 | 8.00E+02 | | 4.24E+04 | | |
| | cement/misc W-314 | | 1.53E+02 | 1.40E+02 | | 2.14E+04 | Total | 2.17E+07 |
| Offsite Rail | | | trips/yr | km/trip | yr | total | | |
| | raw material | | 1.00E+01 | 8.00E+02 | 2.00E+01 | 1.60E+05 | Total | 1.60E+05 |
| Onsite Truck | | | | | | | | |
| | borrow | | 1.38E+03 | 1.00E+01 | | 1.38E+04 | Total | 1.38E+04 |
| VITRIFICATION | | | | | | | | |
| Construction | | | | | | | | |
| Onsite Truck | | | trips | km/trip | | total | | |
| | borrow | ~~2.12E+05~~ | ~~6.10E+04~~ | 1.00E+01 | | 6.10E+05 | Total | 6.10E+05 |
| | | | 1.74E+05 | | | | | |
| Offsite Truck | | 3.58E+04 | trips | km/trip | | total | | |
| | Tri-Cities | ~~1.07E+05~~ | 2.70E+04 | 1.40E+02 | | 3.78E+06 | | |
| | Portland/Seattle | ~~2.64~~ | 1.10E+04 | 8.00E+02 | | 8.80E+06 | | |
| | 3.78E+04 ~~2E+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 |
| | | | 7.11E+03 | | | | | |
| | | | | | | | | |
| Offsite Rail | | | trips/yr | km/trip | yr | total | | |
| | glassformer/chem | | ~~6.37E+02~~ | 8.00E+02 | 1.60E+01 | 8.15E+06 | Total | 8.15E+06 |
| | | | ~~6.77E+02~~ | | | | | |
| | | | 6.46E+02 | | | | | |
| VITRIFIED HLW TRANSPORT | | | | | | | | |
| Offsite Rail | | | trips | km/trip | | total | | |
| | Yucca Mountain | | 1.00E+01 | 2.93E+03 | | 2.93E+04 | Total | 2.93E+04 |
| | | | 3.9E+01 | | | | | |
| | | | | | | | | |
| CLOSURE | | | | | | | | |
| Onsite Truck | | | cu yd | trip/cu yd | km/trip | total | | |
| | fill | | 9.86E+05 | 1.00E-01 | 1.00E+01 | 9.86E+05 | | |

Sheet B-5
RDW 2-15-96

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | | EX SITU COMBINATION | | | | | |
| | | | | | | | | |
| RETRIEVAL | | | | | | | | |
| Waste Transport | | | | | | total | | |
| Onsite Truck | | | | | | 0.00E+00 | | |
| | | | | | | | | |
| Construction | | | | | | | | |
| Offsite Truck | | | trips/yr | km/trip | yr | total | | |
| | concrete | | 2.40E+02 | 1.40E+02 | 2.00E+01 | 6.72E+05 | | |
| | raw material | | 2.25E+01 | 8.00E+02 | 2.00E+01 | 3.60E+05 | | |
| | equipment | | 1.25E+01 | 1.00E+04 | 2.00E+01 | 2.50E+06 | | |
| | miscellaneous | | 2.60E+03 | 1.40E+02 | 2.00E+01 | 7.28E+06 | | |
| | steel W-314 | | 5.30E+01 | 8.00E+02 | | 4.24E+04 | | |
| | cement/misc W-314 | | 1.53E+02 | 1.40E+02 | | 2.14E+04 | Total | 1.09E+07 |
| Offsite Rail | | | trips/yr | km/trip | yr | total | | |
| | raw material | | 5.00E+00 | 8.00E+02 | 2.00E+01 | 8.00E+04 | Total | 8.00E+04 |
| Onsite Truck | | | | | | | | |
| | borrow W-314 | | 1.38E+03 | 1.00E+01 | | 1.38E+04 | Total | 1.38E+04 |
| VITRIFICATION | | | | | | | | |
| Construction | | | | | | | | |
| Onsite Truck | | | trips | km/trip | | total | | |
| | borrow | ~~8.4E+04~~ | 2.60E+04 | 1.00E+01 | | 2.60E+05 | Total | 2.60E+05 |
| | | | 6.92E+04 | | | | | |
| Offsite Truck | | 2.47E+04 | trips | km/trip | | total | | |
| | concrete | ~~2.3E+04~~ | 1.45E+04 | 1.40E+02 | | 2.03E+06 | | |
| | steel | 9.0E+03 | 4.75E+03 | 8.00E+02 | | 3.80E+06 | | |
| | | | trips/yr | km/trip | yr | | | |
| ~~1.31E+04~~ | miscellaneous | | ~~2.60~~E+03 | 1.40E+02 | 1.00E+01 | 3.64E+06 | Total | 9.47E+06 |
| | | | ~~3.15~~E+03 | | | | | |
| | | | 2.7 | | | | | |
| Processing | | 5.67E+02 | | | | | | |
| ~~7.30E+03~~ Offsite Truck | | | trips/yr | km/trip | yr | total | | |
| | glassformer/chem | | 1.15E+01 | 8.00E+02 | 1.95E+01 | 1.79E+05 | | |
| | miscellaneous | | ~~2.60~~E+03 | 1.40E+02 | 1.95E+01 | 7.10E+06 | Total | 7.28E+06 |
| | | | 2.96E+03 | | | | | |
| | | | | | | | | |
| Offsite Rail | | | trips/yr | km/trip | yr | total | | |
| | glassformer/chem | | ~~1.30E+02~~ | 8.00E+02 | ~~1.95E+01~~ | 2.03E+06 | Total | 2.03E+06 |
| | | | ~~1.37E+02~~ | | | | | |
| | | | 1.32E+02 | | | | | |
| VITRIFIED HLW TRANSPORT | | | | | | | | |
| Offsite Rail | | | trips | km/trip | | total | | |
| | Yucca Mountain | | ~~8.50E+01~~ | 2.93E+03 | | 2.49E+05 | Total | 2.49E+05 |
| | | 4.15E+02 | | | | | | |
| | | | 415 | | | | | |
| CLOSURE | | | | | | | | |
| Onsite Truck | | | cu yd | trip/cu yd | km/trip | total | | |
| | fill | | 9.36E+05 | 1.00E-01 | 1.00E+01 | 9.36E+05 | | |

No change?



Sheet B-6
RDW 2-15-96

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | PHASE 1 IMPLEMENTATION SUB-ALTERNATIVE | | | | | | | |
| | → | no. Change | | | | | | |
| RETRIEVAL | | | | | | | | |
| WASTE TRANSFER SYSTEM UPGRADE (W-314) | | | | | | | | |
| Onsite Truck | | | trips | km/trip | | total | | |
| | borrow | | 1.38E+03 | 1.00E+00 | | 1.38E+03 | Total | 1.38E+03 |
| Offsite Truck | | | | | | | | |
| | steel | | 5.30E+01 | 8.00E+02 | | 4.24E+04 | | |
| | cement | | 1.00E+02 | 1.40E+02 | | 1.40E+04 | Total | 5.64E+04 |
| VITRIFICATION | | | | | | | | |
| Construction | | | | | | | | |
| Onsite Truck | | | trips | km/trip | | total | | |
| | borrow | | 1.96E+03 | 1.00E+01 | | 1.96E+04 | Total | 1.96E+04 |
| Offsite Truck | | | trips | km/trip | | total | | |
| | concrete | | 1.20E+03 | 1.40E+02 | | 1.68E+05 | | |
| | steel | | 7.32E+03 | 8.00E+02 | | 5.86E+06 | | |
| | miscellaneous | | 3.18E+03 | 1.40E+02 | | 4.45E+05 | Total | 6.47E+06 |
| Processing | | | | | | | | |
| Offsite Truck | | | trips | km/trip | | total | | |
| | glassformer/chem | | 3.50E+03 | 8.00E+02 | | 2.80E+06 | | |
| | glassformer/chem | | 3.57E+03 | 1.40E+02 | | 5.00E+05 | | |
| | miscellaneous | | 5.20E+04 | 1.40E+02 | | 7.28E+06 | Total | 1.06E+07 |
| Offsite Rail | | | trips | km/trip | | total | | |
| | glassformer/chem | | 2.18E+02 | 8.00E+02 | | 1.74E+05 | Total | 1.74E+05 |
| VITRIFIED HLW TRANSPORT | | | | | | | | |
| SITE RESTORATION | | | | | | | | |
| Onsite Truck | | | trips | km/trip | | total | | |
| | contaminated waste | | 1.50E+03 | 1.61E+01 | | 2.42E+04 | | |
| | noncont. waste | | 6.23E+04 | 1.61E+01 | | 1.00E+06 | Total | 1.03E+06 |

phased implementation I + II

Sheet12

Sheet B-7
RDW 2-15-96

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | TOTAL ALTERNATIVE | | | | | | | |
| | | | | | | | | |
| RETRIEVAL | | | | | | | | |
| Waste Transport | | | | | | total | | |
| Onsite Truck | | | | | | 1.25E+04 | Total | 1.25E+04 |
| | | | | | | | | |
| Construction | | | | | | | | |
| Offsite Truck | | | trips/yr | km/trip | yr | total | | |
| | concrete | | 4.80E+02 | 1.40E+02 | 2.00E+01 | 1.34E+06 | | |
| | raw material | | 4.50E+01 | 8.00E+02 | 2.00E+01 | 7.20E+05 | | |
| | equipment | | 2.50E+01 | 1.00E+04 | 2.00E+01 | 5.00E+06 | | |
| | miscellaneous | | 5.20E+03 | 1.40E+02 | 2.00E+01 | 1.46E+07 | | |
| | borrow (W-314) | | 1.38E+03 | 1.00E+01 | | 1.38E+04 | Total | 2.16E+07 |
| | | | | | | | | |
| Offsite Rail | | | trips/yr | km/trip | yr | total | | |
| | raw material | | 1.00E+01 | 8.00E+02 | 2.00E+01 | 1.60E+05 | | |
| | steel (W-314) | | 5.30E+01 | 8.00E+02 | | 4.24E+04 | | |
| | cement (W-314) | | 1.00E+02 | 1.40E+02 | | 1.40E+04 | Total | 2.16E+05 |
| VITRIFICATION | | | | | | | | |
| Construction | | | | | | | | |
| Onsite Truck | | 1.14 | trips | km/trip | | total | | |
| | borrow | ~~1.44~~ E+05 | ~~2.80E+04~~ | 1.00E+01 | | 2.80E+05 | Total | 2.80E+05 |
| | | | | | | | | |
| Offsite Truck | | 3.63 | trips | km/trip | | total | | |
| | concrete | ~~2.61~~ E+04 | 1.57E+04 | 1.40E+02 | | 2.20E+06 | | |
| | steel 9.67 | 9.7E+03 | 1.21E+03 | 8.00E+02 | | 9.68E+05 | | |
| | miscellaneous | | 2.92E+04 | 1.40E+02 | | 4.09E+06 | Total | 7.25E+06 |
| | | ~~3.11~~ E+04 | 3.06+04 | | | | | |
| | | | | | | | | |
| | | | | | | | | |
| Processing | | | | | | | | |
| Offsite Truck | | 2.43E+04 | trips | km/trip | | total | | |
| ~~1.65E+04~~ | glassformer/chem | | ~~3.72E+03~~ | 8.00E+02 | | 2.98E+06 | | |
| | miscellaneous | | 1.03E+05 | 1.40E+02 | | 1.44E+07 | | |
| ~~3.0E+04~~ | process material | | ~~3.57E+03~~ | 1.40E+02 | | 5.00E+05 | Total | 1.79E+07 |
| 1.46E+04 | | | | | | | | |
| Offsite Rail | | | trips | km/trip | | total | | |
| 3.0E+03 | glassformer/chem | | ~~2.75E+03~~ | 8.00E+02 | | 2.20E+06 | Total | 2.20E+06 |
| 2.81E+03 | | | | | | | | |
| | | | | | | | | |
| VITRIFIED HLW TRANSPORT | | | | | | | | |
| Offsite Rail | | | trips | km/trip | | total | | |
| | Yucca Mountain | | 1.70E+02 | 2.93E+03 | | 4.98E+05 | Total | 4.98E+05 |
| | | | 8.35E+02 | | | | | |
| | | | | | | | | |
| CLOSURE | | | | | | | | |
| Onsite Truck | | | cu yd | trip/cu yd | km/trip | total | | |
| | fill | | 9.86E+05 | 1.00E-01 | 1.00E+01 | 9.86E+05 | | |

Sheet B-9
ADW 2-15-96

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | silt | | 6.93E+05 | 1.00E-01 | 3.00E+01 | 2.08E+06 | | |
| | riprap | | 1.05E+06 | 1.00E-01 | 3.20E+01 | 3.36E+06 | | |
| | ag/sand | | 7.93E+05 | 1.00E-01 | 1.00E+01 | 7.93E+05 | | |
| | | | | | | | Total | 7.22E+06 |
| GROUT FILL IMUST | | | | | | | | |
| Onsite Truck sand/gravel | | | 2.20E+03 | 1.00E+01 | | 2.20E+04 | Total | 2.20E+04 |
| Offsite Truck cement | | | 4.63E+02 | 1.40E+02 | | 6.48E+04 | Total | 6.48E+04 |
| Onsite Truck (km) | | 7.79E+06 | | | | | | |
| Onsite Rail (km) | | 0.00E+00 | | | | | | |
| Offsite Truck (km) | | 5.52E+07 | | | | | | |
| Offsite Rail (km) | | 4.71E+06 | | | | | | |
| | | | | | | | | |
| EMPLOYEE VEHICLE | | | | | | | | |
| Retrieval | | person-yr | trip/yr | km/trip | car pool | total | | |
| | Const. | 1.06E+04 | 2.60E+02 | 1.40E+02 | 7.41E-01 | 2.86E+08 | | |
| | Ops/D&D | 3.74E+04 | 2.60E+02 | 1.40E+02 | 7.41E-01 | 1.01E+09 | | |
| Vitrification | | | | | | | | |
| | Const. | 1.98E+04 | 2.60E+02 | 1.40E+02 | 7.41E-01 | 5.34E+08 | | |
| | Ops/D&D | 1.73E+04 | 2.60E+02 | 1.40E+02 | 7.41E-01 | 4.67E+08 | | |
| Closure | | 4.90E+02 | 2.60E+02 | 1.40E+02 | 7.41E-01 | 1.32E+07 | | |
| | | | | | | | Total | 2.31E+09 |
| | | | | | | | | |
| | | | | | | | | |
| | | | | | | | | |
| | | | | | | | | |
| | | | | | | | | |
| | | | | | | | | |
| Distance traveled in population zones | | | | | | | | |
| | | | | | | | | |
| Urban | | Offsite km | zone fraction | | Onsite | TOTALS | | |
| | Truck | 5.52E+07 | 5.00E-02 | | | 2.76E+06 | | |
| | Rail | 4.71E+06 | 5.00E-02 | | | 2.36E+05 | | |
| Suburban | | | | | | | | |
| | Truck | 5.52E+07 | 5.00E-02 | | 7.79E+06 | 1.05E+07 | | |
| | Rail | 4.71E+06 | 5.00E-02 | | | 2.36E+05 | | |
| Rural | | | | | | | | |
| | Truck | 5.52E+07 | 9.00E-01 | | | 4.97E+07 | | |
| | Rail | 4.71E+06 | 9.00E-01 | | | 4.24E+06 | | |
| | | | | | | | | |
| | | | | | | | | |
| | | | | | | | | |
| | | | | | | | | |
| | | | | | | | | |
| Fatalities/Injuries resulting from Truck and Rail transportation accidents | | | | | | | | |
| | | | urban km | | suburban km | | rural km | |
| | | | truck | rail | truck | rail | truck | rail |
| | | | 2.76E+06 | 2.36E+05 | 1.05E+07 | 2.36E+05 | 4.97E+07 | 4.24E+06 |
| urban truck fat/km | | 7.50E-09 | 2.07E-02 | | | | | |

Sheet B-10
RJW 2-15-96

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| urban truck inj/km | | 3.70E-07 | 1.02E+00 | | | | | |
| urban rail fat/km | | 1.70E-08 | | 4.01E-03 | | | | |
| urban rail inj/km | | 3.30E-08 | | 7.78E-03 | | | | |
| sub truck fat.km | | 1.30E-08 | | | 1.37E-01 | | | |
| sub truck inj/km | | 3.80E-07 | | | 4.01E+00 | | | |
| sub rail fat/km | | 1.70E-08 | | | | 4.01E-03 | | |
| sub rail inj/km | | 3.30E-08 | | | | 7.78E-03 | | |
| rural truck fat/km | | 5.30E-08 | | | | | 2.63E+00 | |
| rural truck inj/km | | 8.00E-07 | | | | | 3.98E+01 | |
| rural rail fat/km | | 1.70E-08 | | | | | | 7.21E-02 |
| rural rail inj/km | | 3.30E-08 | | | | | | 1.40E-01 |
| | | | | | | | | |
| | | | | | | | | |
| | TOTAL FATALITIES | | 2.87E+00 | | | | | |
| | TOTAL INJURIES | | 4.50E+01 | | | | | |
| | | | | | | | | |
| Fatalities/Injuries resulting from Employee vehicle accidents | | | | | | | | |
| | | | | | | | | |
| | | km | rate/km | TOTAL | | | | |
| | fatalities | 2.31E+09 | 8.98E-09 | 2.07E+01 | | | | |
| | injuries | 2.31E+09 | 7.14E-07 | 1.65E+03 | | | | |
| | | | | | | | | |
| | | | | | | | | |
| Cumulative fatalities/injuries from traffic impacts | | | | | | | | |
| | | | | | | | | |
| | | | transport | employee | TOTAL | | | |
| | FATALITIES | | 2.87E+00 | 2.07E+01 | 2.36E+01 | | | |
| | INJURIES | | 4.50E+01 | 1.65E+03 | 1.69E+03 | | | |
| | | | | | | | | |
| CONSTRUCTION ACCIDENTS | | | | | | | | |
| | | rate | person-yr | | | | | |
| | TRC = | 9.75E-02 | 3.09E+04 | = | 3011.775 | | | |
| | LWC = | 2.45E-02 | 3.09E+04 | = | 756.805 | | | |
| | Fatality = | 3.20E-05 | 3.09E+04 | = | 0.98848 | | | |
| | | | | | | | | |
| OPERATION ACCIDENTS | | | | | | | | |
| | | rate | person-yr | | | | | |
| | TRC = | 2.20E-02 | 5.47E+04 | = | 1203.4 | | | |
| | LWC = | 1.10E-02 | 5.47E+04 | = | 601.7 | | | |
| | Fatality = | 3.20E-05 | 5.47E+04 | = | 1.7504 | | | |
| | | | | | | | | |
| | | | | | | | | |
| TOTALS | | | | | | | | |

Sheet B-11
RDW 2-15-96

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | INJUR | 5.91E+03 | | | | | | |
| | FATAL | 2.63E+01 | | | | | | |

Sheet B-12
RDW-2-15-96

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | | EX SITU NO SEPARATIONS ALTERNATIVE | | | | | |
| RETRIEVAL | | | | | | | | |
| Waste Transport | | | | | | total | | |
| Onsite Truck | | | | | | 1.25E+04 | Total | 1.25E+04 |
| | | | | | | | | |
| Construction | | | | | | | | |
| Offsite Truck | | | trips/yr | km/trip | yr | total | | |
| | concrete | | 4.80E+02 | 1.40E+02 | 2.00E+01 | 1.34E+06 | | |
| | raw material | | 4.50E+01 | 8.00E+02 | 2.00E+01 | 7.20E+05 | | |
| | equipment | | 2.50E+01 | 1.00E+04 | 2.00E+01 | 5.00E+06 | | |
| | miscellaneous | | 5.20E+03 | 1.40E+02 | 2.00E+01 | 1.46E+07 | | |
| | steel W-314 | | 5.30E+01 | 8.00E+02 | | 4.24E+04 | | |
| | cement/misc W-314 | | 1.53E+02 | 1.40E+02 | | 2.14E+04 | Total | 2.17E+07 |
| Offsite Rail | | | trips/yr | km/trip | yr | total | | |
| | raw material | | 1.00E+01 | 8.00E+02 | 2.00E+01 | 1.60E+05 | Total | 1.60E+05 |
| Onsite Truck | | | | | | | | |
| | borrow W-314 | | 1.38E+03 | 1.00E+01 | | 1.38E+04 | Total | 1.38E+04 |
| VITRIFICATION | | | | | | | | |
| Construction | | | | | | | | |
| Onsite Truck | | | trips | km/trip | | total | | |
| | borrow | 1.18E+05 | ~~2.02E+04~~ | 1.00E+01 | | 2.02E+05 | Total | 2.02E+05 |
| | | | | | | | | |
| Offsite Truck | | 4.38 | trips | km/trip | | total | | |
| | Try Cities | ~~2.6~~ | ~~1.30E+04~~ | 1.40E+02 | | 1.82E+06 | | |
| | Portland/Seattle | ~~1.76E+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
~~[illegible]~~
~~[illegible]~~
Connected 20 Trips
8.47E+05 trips
steel
7.3E+03
SS
5.2E+03
2710

Sheet B-13
REW-2-15-96

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | silt | | 4.93E+05 | 1.00E-01 | 3.00E+01 | 1.48E+06 | | |
| | riprap | | 8.35E+05 | 1.00E-01 | 3.20E+01 | 2.67E+06 | | |
| | ag/sand | | 5.43E+05 | 1.00E-01 | 1.00E+01 | 5.43E+05 | Total | 5.68E+06 |
| GROUT FILL IMUST | | | | | | | | |
| Onsite Truck sand/gravel | | | 2.20E+03 | 1.00E+01 | | 2.20E+04 | Total | 2.20E+04 |
| Offsite Truick cement | | | 4.63E+02 | 1.40E+02 | | 6.48E+04 | Total | 6.48E+04 |
| | | | | | | | | |
| Onsite Truck (km) | | 5.93E+06 | | | | | | |
| Onsite Rail (km) | | 0.00E+00 | | | | | | |
| Offsite Truck (km) | | 4.23E+07 | | | | | | |
| Offsite Rail (km) | | 7.58E+06 | | | | | | |
| | | | | | | | | |
| EMPLOYEE VEHICLE | | | | | | | | |
| Retrieval | | person-yr | trip/yr | km/trip | car pool | total | | |
| | Const. | 1.06E+04 | 2.60E+02 | 1.40E+02 | 7.41E-01 | 2.86E+08 | | |
| | Ops | 3.15E+04 | 2.60E+02 | 1.40E+02 | 7.41E-01 | 8.50E+08 | | |
| Vitrification | | | | | | | | |
| | Const. | 1.48E+04 | 2.60E+02 | 1.40E+02 | 7.41E-01 | 3.99E+08 | | |
| | Ops | 9.78E+03 | 2.60E+02 | 1.40E+02 | 7.41E-01 | 2.64E+08 | | |
| Closure | | 4.62E+02 | 2.60E+02 | 1.40E+02 | 7.41E-01 | 1.25E+07 | | |
| | total | 6.71E+04 | | | | | Total | 1.81E+09 |
| | | | | | | | | |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Distance traveled in population zones | | | | | | | | |
| | | | | | | | | |
| Urban | | Offsite km | zone fraction | | Onsite | TOTALS | | |
| | Truck | 4.23E+07 | 5.00E-02 | | | 2.12E+06 | | |
| | Rail | 7.58E+06 | 5.00E-02 | | | 3.79E+05 | | |
| Suburban | | | | | | | | |
| | Truck | 4.23E+07 | 5.00E-02 | | 5.93E+06 | 8.05E+06 | | |
| | Rail | 7.58E+06 | 5.00E-02 | | | 3.79E+05 | | |
| Rural | | | | | | | | |
| | Truck | 4.23E+07 | 9.00E-01 | | | 3.81E+07 | | |
| | Rail | 7.58E+06 | 9.00E-01 | | | 6.83E+06 | | |
| | | | | | | | | |
| | | | | | | | | |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Fatalities/Injuries resulting from Truck and Rail transportation accidents | | | | | | | | |
| | | | urban km | | suburban km | | rural km | |
| | | | truck | rail | truck | rail | truck | rail |
| | | | 2.12E+06 | 3.79E+05 | 8.05E+06 | 3.79E+05 | 3.81E+07 | 6.83E+06 |
| urban truck fat/km | | 7.50E-09 | 1.59E-02 | | | | | |
| urban truck inj/km | | 3.70E-07 | 7.83E-01 | | | | | |
| urban rail fat/km | | 1.70E-08 | | 6.45E-03 | | | | |
| urban rail inj/km | | 3.30E-08 | | 1.25E-02 | | | | |

Sheet B-14
RAW 2-15-96

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| sub truck fat.km | | 1.30E-08 | | | 1.05E-01 | | | |
| sub truck inj/km | | 3.80E-07 | | | 3.06E+00 | | | |
| sub rail fat/km | | 1.70E-08 | | | | 6.45E-03 | | |
| sub rail inj/km | | 3.30E-08 | | | | 1.25E-02 | | |
| rural truck fat/km | | 5.30E-08 | | | | | 2.02E+00 | |
| rural truck inj/km | | 8.00E-07 | | | | | 3.05E+01 | |
| rural rail fat/km | | 1.70E-08 | | | | | | 1.16E-01 |
| rural rail inj/km | | 3.30E-08 | | | | | | 2.25E-01 |
| | | | | | | | | |
| | | | | | | | | |
| | TOTAL FATALITIES | | 2.27E+00 | | | | | |
| | TOTAL INJURIES | | 3.46E+01 | | | | | |
| | | | | | | | | |
| Fatalities/Injuries resulting from Employee vehicle accidents | | | | | | | | |
| | | | | | | | | |
| | | km | rate/km | TOTAL | | | | |
| | fatalities | 1.81E+09 | 8.98E-09 | 1.63E+01 | | | | |
| | injuries | 1.81E+09 | 7.14E-07 | 1.29E+03 | | | | |
| | | | | | | | | |
| | | | | | | | | |
| Cumulative fatalities/injuries from traffic impacts | | | | | | | | |
| | | | | | | | | |
| | | | transport | employee | TOTAL | | | |
| | FATALITIES | | 2.27E+00 | 1.63E+01 | 1.85E+01 | | | |
| | INJURIES | | 3.46E+01 | 1.29E+03 | 1.33E+03 | | | |
| | | | | | | | | |
| | | | | | | | | |
| CONSTRUCTION ACCIDENTS | | | | | | | | |
| | | rate | person-yr | | | | | |
| | TRC = | 9.75E-02 | 2.59E+04 | = | 2521.545 | | | |
| | LWC = | 2.45E-02 | 2.59E+04 | = | 633.619 | | | |
| | Fatality = | 3.20E-05 | 2.59E+04 | = | 0.827584 | | | |
| | | | | | | | | |
| OPERATION ACCIDENTS | | | | | | | | |
| | | rate | person-yr | | | | | |
| | TRC = | 2.20E-02 | 4.13E+04 | = | 908.16 | | | |
| | LWC = | 1.10E-02 | 4.13E+04 | = | 454.08 | | | |
| | Fatality = | 3.20E-05 | 4.13E+04 | = | 1.32096 | | | |
| | | | | | | | | |
| TOTALS | | | | | | | | |
| | INJUR | 4.76E+03 | | | | | | |
| | FATAL | 2.07E+01 | | | | | | |

Sheet B-15
~~DBW~~ 2-15-96

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | EX SITU EXTENSIVE SEPARATIONS ALTERNATIVE | | | | | | |
| | | | | | | | | |
| RETRIEVAL | | | | | | | | |
| Waste Transport | | | | | | total | | |
| Onsite Truck | | | | | | 1.25E+04 | Total | 1.25E+04 |
| | | | | | | | | |
| Construction | | | | | | | | |
| Offsite Truck | | | trips/yr | km/trip | yr | total | | |
| | concrete | | 4.80E+02 | 1.40E+02 | 2.00E+01 | 1.34E+06 | | |
| | raw material | | 4.50E+01 | 8.00E+02 | 2.00E+01 | 7.20E+05 | | |
| | equipment | | 2.50E+01 | 1.00E+04 | 2.00E+01 | 5.00E+06 | | |
| | miscellaneous | | 5.20E+03 | 1.40E+02 | 2.00E+01 | 1.46E+07 | | |
| | steel W-314 | | 5.30E+01 | 8.00E+02 | | 4.24E+04 | | |
| | cement/misc W-314 | | 1.53E+02 | 1.40E+02 | | 2.14E+04 | Total | 2.17E+07 |
| Offsite Rail | | | trips/yr | km/trip | yr | total | | |
| | raw material | | 1.00E+01 | 8.00E+02 | 2.00E+01 | 1.60E+05 | Total | 1.60E+05 |
| Onsite Truck | | | | | | | | |
| | borrow | | ~~1.38E+03~~ | 1.00E+01 | | 1.38E+04 | Total | 1.38E+04 |
| VITRIFICATION | | | | | | | | |
| Construction | | | | | | | | |
| Onsite Truck | | | trips | km/trip | | total | | |
| | borrow | 2.12E+05 | ~~6.10E+04~~ | 1.00E+01 | | 6.10E+05 | Total | 6.10E+05 |
| | | | | | | | | |
| Offsite Truck | | | trips | km/trip | | total | | |
| 35640 | 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 | | |
| 32E+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 | | |

Sheet B-16
BDW 2-15-96

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | silt | | 6.93E+05 | 1.00E-01 | 3.00E+01 | 2.08E+06 | | |
| | riprap | | 1.05E+06 | 1.00E-01 | 3.20E+01 | 3.36E+06 | | |
| | ag/sand | | 7.93E+05 | 1.00E-01 | 1.00E+01 | 7.93E+05 | Total | 7.22E+06 |
| GROUT FILL IMUST | | | | | | | | |
| Onsite Truck sand/gravel | | | 2.20E+03 | 1.00E+01 | | 2.20E+04 | Total | 2.20E+04 |
| Offsite Truck cement | | | 4.63E+02 | 1.40E+02 | | 6.48E+04 | Total | 6.48E+04 |
| | | | | | | | | |
| Onsite Truck (km) | | 7.88E+06 | | | | | | |
| Onsite Rail (km) | | 0 | | | | | | |
| Offsite Truck (km) | | 5.91E+07 | | | | | | |
| Offsite Rail (km) | | 8.34E+06 | | | | | | |
| | | | | | | | | |
| EMPLOYEE VEHICLE | | | | | | | | |
| Retrieval | | person-yr | trip/yr | km/trip | car pool | total | | |
| | Const. | 1.06E+04 | 2.60E+02 | 1.40E+02 | 7.41E-01 | 2.86E+08 | | |
| | Ops/D&D | 3.74E+04 | 2.60E+02 | 1.40E+02 | 7.41E-01 | 1.01E+09 | | |
| Vitrification | | | | | | | | |
| | Const. | 2.58E+04 | 2.60E+02 | 1.40E+02 | 7.41E-01 | 6.96E+08 | | |
| | Ops/D&D | 6.95E+03 | 2.60E+02 | 1.40E+02 | 7.41E-01 | 1.87E+08 | | |
| Closure | | 4.90E+02 | 2.60E+02 | 1.40E+02 | 7.41E-01 | 1.32E+07 | | |
| | total | 8.12E+04 | | | | | Total | 2.19E+09 |
| | | | | | | | | |
| | | | | | | | | |
| | | | | | | | | |
| | | | | | | | | |
| Distance traveled in population zones | | | | | | | | |
| | | | | | | | | |
| Urban | | Offsite km | zone fraction | | Onsite | TOTALS | | |
| | Truck | 5.91E+07 | 5.00E-02 | | | 2.95E+06 | | |
| | Rail | 8.34E+06 | 5.00E-02 | | | 4.17E+05 | | |
| Suburban | | | | | | | | |
| | Truck | 5.91E+07 | 5.00E-02 | | 7.88E+06 | 1.08E+07 | | |
| | Rail | 8.34E+06 | 5.00E-02 | | | 4.17E+05 | | |
| Rural | | | | | | | | |
| | Truck | 5.91E+07 | 9.00E-01 | | | 5.32E+07 | | |
| | Rail | 8.34E+06 | 9.00E-01 | | | 7.51E+06 | | |
| | | | | | | | | |
| | | | | | | | | |
| | | | | | | | | |
| | | | | | | | | |
| Fatalities/Injuries resulting from Truck and Rail transportation accidents | | | | | | | | |
| | | | urban km | | suburban km | | rural km | |
| | | | truck | rail | truck | rail | truck | rail |
| | | | 2.95E+06 | 4.17E+05 | 1.08E+07 | 4.17E+05 | 5.32E+07 | 7.51E+06 |
| urban truck fat/km | | 7.50E-09 | 2.22E-02 | | | | | |
| urban truck inj/km | | 3.70E-07 | 1.09E+00 | | | | | |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| urban rail fat/km | | 1.70E-08 | | 7.09E-03 | | | | |
| urban rail inj/km | | 3.30E-08 | | 1.38E-02 | | | | |
| sub truck fat.km | | 1.30E-08 | | | 1.41E-01 | | | |
| sub truck inj/km | | 3.80E-07 | | | 4.12E+00 | | | |
| sub rail fat/km | | 1.70E-08 | | | | 7.09E-03 | | |
| sub rail inj/km | | 3.30E-08 | | | | 1.38E-02 | | |
| rural truck fat/km | | 5.30E-08 | | | | | 2.82E+00 | |
| rural truck inj/km | | 8.00E-07 | | | | | 4.26E+01 | |
| rural rail fat/km | | 1.70E-08 | | | | | | 1.28E-01 |
| rural rail inj/km | | 3.30E-08 | | | | | | 2.48E-01 |
| | | | | | | | | |
| | | | | | | | | |
| | TOTAL FATALITIES | | 3.12E+00 | | | | | |
| | TOTAL INJURIES | | 4.80E+01 | | | | | |
| | | | | | | | | |
| Fatalities/Injuries resulting from Employee vehicle accidents | | | | | | | | |
| | | | | | | | | |
| | | km | rate/km | TOTAL | | | | |
| | fatalities | 2.19E+09 | 8.98E-09 | 1.97E+01 | | | | |
| | injuries | 2.19E+09 | 7.14E-07 | 1.56E+03 | | | | |
| | | | | | | | | |
| | | | | | | | | |
| Cumulative fatalities/injuries from traffic impacts | | | | | | | | |
| | | | | | | | | |
| | | | transport | employee | TOTAL | | | |
| | FATALITIES | | 3.12E+00 | 1.97E+01 | 2.28E+01 | | | |
| | INJURIES | | 4.80E+01 | 1.56E+03 | 1.61E+03 | | | |
| | | | | | | | | |
| | | | | | | | | |
| | | | | | | | | |
| CONSTRUCTION ACCIDENTS | | | | | | | | |
| | | rate | person-yr | | | | | |
| | TRC = | 9.75E-02 | 3.69E+04 | = | 3596.775 | | | |
| | LWC = | 2.45E-02 | 3.69E+04 | = | 903.805 | | | |
| | Fatality = | 3.20E-05 | 3.69E+04 | = | 1.18048 | | | |
| | | | | | | | | |
| OPERATION ACCIDENTS | | | | | | | | |
| | | rate | person-yr | | | | | |
| | TRC = | 2.20E-02 | 4.44E+04 | = | 975.7 | | | |
| | LWC = | 1.10E-02 | 4.44E+04 | = | 487.85 | | | |
| | Fatality = | 3.20E-05 | 4.44E+04 | = | 1.4192 | | | |
| | | | | | | | | |
| TOTALS | | | | | | | | |

Sheet B-18
RDW 2-15-96

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| | INJUR | 6.19E+03 | | | | | |
| | FATAL | 2.54E+01 | | | | | |

Sheet B-19
RDW 2-15-96

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | | EX SITU COMBINATION | | | | | |
| | | | | | | | | |
| RETRIEVAL | | | | | | | | |
| Waste Transport | | | | | | total | | |
| Onsite Truck | | | | | | 0.00E+00 | | |
| | | | | | | | | |
| Construction | | | | | | | | |
| Offsite Truck | | | trips/yr | km/trip | yr | total | | |
| | concrete | | 2.40E+02 | 1.40E+02 | 2.00E+01 | 6.72E+05 | | |
| | raw material | | 2.25E+01 | 8.00E+02 | 2.00E+01 | 3.60E+05 | | |
| | equipment | | 1.25E+01 | 1.00E+04 | 2.00E+01 | 2.50E+06 | | |
| | miscellaneous | | 2.60E+03 | 1.40E+02 | 2.00E+01 | 7.28E+06 | | |
| | steel W-314 | | 5.30E+01 | 8.00E+02 | | 4.24E+04 | | |
| | cement/misc W-314 | | 1.53E+02 | 1.40E+02 | | 2.14E+04 | Total | 1.09E+07 |
| Offsite Rail | | | trips/yr | km/trip | yr | total | | |
| | raw material | | 5.00E+00 | 8.00E+02 | 2.00E+01 | 8.00E+04 | Total | 8.00E+04 |
| Onsite Truck | | | | | | | | |
| | borrow W-314 | | 1.38E+03 | 1.00E+01 | | 1.38E+04 | Total | 1.38E+04 |
| VITRIFICATION | | | | | | | | |
| Construction | | | | | | | | |
| Onsite Truck | | | trips | km/trip | | total | | |
| | borrow P.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 | | |

Sheet B-2D
RDW 2-15-96

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | silt | | 5.76E+05 | 1.00E-01 | 3.00E+01 | 1.73E+06 | | |
| | riprap | | 9.21E+05 | 1.00E-01 | 3.20E+01 | 2.95E+06 | | |
| | ag/sand | | 6.43E+05 | 1.00E-01 | 1.00E+01 | 6.43E+05 | Total | 6.25E+06 |
| GROUT FILL IMUST | | | | | | | | |
| Onsite Truck sand/gravel | | | 2.20E+03 | 1.00E+01 | | 2.20E+04 | Total | 2.20E+04 |
| Offsite Truck cement | | | 4.63E+02 | 1.40E+02 | | 6.48E+04 | Total | 6.48E+04 |
| | | | | | | | | |
| Onsite Truck (km) | | 6.55E+06 | | | | | | |
| Onsite Rail (km) | | 0.00E+00 | | | | | | |
| Offsite Truck (km) | | 2.77E+07 | | | | | | |
| Offsite Rail (km) | | 2.36E+06 | | | | | | |
| | | | | | | | | |
| EMPLOYEE VEHICLE | | | | | | | | |
| Retrieval | | person-yr | trip/yr | km/trip | car pool | total | | |
| | Const. | 6.36E+03 | 2.60E+02 | 1.40E+02 | 7.41E-01 | 1.72E+08 | | |
| | Ops/D&D | 2.24E+04 | 2.60E+02 | 1.40E+02 | 7.41E-01 | 6.04E+08 | | |
| Vitrification | | | | | | | | |
| | Const. | 1.19E+04 | 2.60E+02 | 1.40E+02 | 7.41E-01 | 3.21E+08 | | |
| | Ops/D&D | 1.04E+04 | 2.60E+02 | 1.40E+02 | 7.41E-01 | 2.81E+08 | | |
| Fill tank | | | | | | | | |
| | Const. | 5.70E+01 | 2.60E+02 | 1.40E+02 | 7.41E-01 | 1.54E+06 | | |
| | Ops/D&D | 1.80E+03 | 2.60E+02 | 1.40E+02 | 7.41E-01 | 4.86E+07 | | |
| Closure | | 5.74E+02 | 2.60E+02 | 1.40E+02 | 7.41E-01 | 1.55E+07 | | |
| | | | | | | | Total | 1.44E+09 |
| | | | | | | | | |
| | | | | | | | | |
| | | | | | | | | |
| Distance traveled in population zones | | | | | | | | |
| | | | | | | | | |
| Urban | | Offsite km | zone fraction | | Onsite | TOTALS | | |
| | Truck | 2.77E+07 | 5.00E-02 | | | 1.38E+06 | | |
| | Rail | 2.36E+06 | 5.00E-02 | | | 1.18E+05 | | |
| Suburban | | | | | | | | |
| | Truck | 2.77E+07 | 5.00E-02 | | 6.55E+06 | 7.93E+06 | | |
| | Rail | 2.36E+06 | 5.00E-02 | | | 1.18E+05 | | |
| Rural | | | | | | | | |
| | Truck | 2.77E+07 | 9.00E-01 | | | 2.49E+07 | | |
| | Rail | 2.36E+06 | 9.00E-01 | | | 2.12E+06 | | |
| | | | | | | | | |
| | | | | | | | | |
| | | | | | | | | |
| Fatalities/Injuries resulting from Truck and Rail transportation accidents | | | | | | | | |
| | | | urban km | | suburban km | | rural km | |
| | | | truck | rail | truck | rail | truck | rail |
| | | | 1.38E+06 | 1.18E+05 | 7.93E+06 | 1.18E+05 | 2.49E+07 | 2.12E+06 |
| urban truck fat/km | | 7.50E-09 | 1.04E-02 | | | | | |

Sheet B-21
RDW 2-15-96

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| urban truck inj/km | | 3.70E-07 | 5.12E-01 | | | | | |
| urban rail fat/km | | 1.70E-08 | | 2.00E-03 | | | | |
| urban rail inj/km | | 3.30E-08 | | 3.89E-03 | | | | |
| sub truck fat.km | | 1.30E-08 | | | 1.03E-01 | | | |
| sub truck inj/km | | 3.80E-07 | | | 3.02E+00 | | | |
| sub rail fat/km | | 1.70E-08 | | | | 2.00E-03 | | |
| sub rail inj/km | | 3.30E-08 | | | | 3.89E-03 | | |
| rural truck fat/km | | 5.30E-08 | | | | | 1.32E+00 | |
| rural truck inj/km | | 8.00E-07 | | | | | 1.99E+01 | |
| rural rail fat/km | | 1.70E-08 | | | | | | 3.61E-02 |
| rural rail inj/km | | 3.30E-08 | | | | | | 7.00E-02 |
| | | | | | | | | |
| | | | | | | | | |
| | TOTAL FATALITIES | | 1.47E+00 | | | | | |
| | TOTAL INJURIES | | 2.35E+01 | | | | | |
| | | | | | | | | |
| Fatalities/Injuries resulting from Employee vehicle accidents | | | | | | | | |
| | | | | | | | | |
| | | km | rate/km | TOTAL | | | | |
| | fatalities | 1.44E+09 | 8.98E-09 | 1.30E+01 | | | | |
| | injuries | 1.44E+09 | 7.14E-07 | 1.03E+03 | | | | |
| | | | | | | | | |
| | | | | | | | | |
| Cumulative fatalities/injuries from traffic impacts | | | | | | | | |
| | | | | | | | | |
| | | | transport | employee | TOTAL | | | |
| | FATALITIES | | 1.47E+00 | 1.30E+01 | 1.44E+01 | | | |
| | INJURIES | | 2.35E+01 | 1.03E+03 | 1.05E+03 | | | |
| | | | | | | | | |
| | | | | | | | | |
| CONSTRUCTION ACCIDENTS | | | | | | | | |
| | | rate | person-yr | | | | | |
| | TRC = | 9.75E-02 | 1.89E+04 | = | 1841.873 | | | |
| | LWC = | 2.45E-02 | 1.89E+04 | = | 462.8295 | | | |
| | Fatality = | 3.20E-05 | 1.89E+04 | = | 0.604512 | | | |
| | | | | | | | | |
| OPERATION ACCIDENTS | | | | | | | | |
| | | rate | person-yr | | | | | |
| | TRC = | 2.20E-02 | 3.46E+04 | = | 761.2 | | | |
| | LWC = | 1.10E-02 | 3.46E+04 | = | 380.6 | | | |
| | Fatality = | 3.20E-05 | 3.46E+04 | = | 1.1072 | | | |
| | | | | | | | | |
| TOTALS | | | | | | | | |

Sheet B-22
RDW 2-15-96

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | INJUR | 3.66E+03 | | | | | | |
| | FATAL | 1.61E+01 | | | | | | |

No Change?



Sheet B-23
RDW 2-15-96

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | PHASE 1 IMPLEMENTATION SUB-ALTERNATIVE | | | | | | | |
| RETRIEVAL | | | | | | | | |
| WASTE TRANSFER SYSTEM UPGRADE (W-314) | | | | | | | | |
| | Onsite Truck | | trips | km/trip | | total | | |
| | borrow | | 1.38E+03 | 1.00E+00 | | 1.38E+03 | Total | 1.38E+03 |
| | Offsite Truck | | | | | | | |
| | steel | | 5.30E+01 | 8.00E+02 | | 4.24E+04 | | |
| | cement | | 1.00E+02 | 1.40E+02 | | 1.40E+04 | Total | 5.64E+04 |
| VITRIFICATION | | | | | | | | |
| | Construction | | | | | | | |
| | Onsite Truck | | trips | km/trip | | total | | |
| | borrow | | 1.96E+03 | 1.00E+01 | | 1.96E+04 | Total | 1.96E+04 |
| | Offsite Truck | | trips | km/trip | | total | | |
| | concrete | | 1.20E+03 | 1.40E+02 | | 1.68E+05 | | |
| | steel | | 7.32E+03 | 8.00E+02 | | 5.86E+06 | | |
| | miscellaneous | | 3.18E+03 | 1.40E+02 | | 4.45E+05 | Total | 6.47E+06 |
| | Processing | | | | | | | |
| | Offsite Truck | | trips | km/trip | | total | | |
| | glassformer/chem | | 3.50E+03 | 8.00E+02 | | 2.80E+06 | | |
| | glassformer/chem | | 3.57E+03 | 1.40E+02 | | 5.00E+05 | | |
| | miscellaneous | | 5.20E+04 | 1.40E+02 | | 7.28E+06 | Total | 1.06E+07 |
| | Offsite Rail | | trips | km/trip | | total | | |
| | glassformer/chem | | 2.18E+02 | 8.00E+02 | | 1.74E+05 | Total | 1.74E+05 |
| VITRIFIED HLW TRANSPORT | | | | | | | | |
| SITE RESTORATION | | | | | | | | |
| | Onsite Truck | | trips | km/trip | | total | | |
| | contaminated waste | | 1.50E+03 | 1.61E+01 | | 2.42E+04 | | |
| | noncont. waste | | 6.23E+04 | 1.61E+01 | | 1.00E+06 | Total | 1.03E+06 |

Sheet B-24
RDW 2-15-96

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| GROUT FILL IMUST | | | | | | | | |
| Onsite Truck (km) | | 1.05E+06 | | | | | | |
| Onsite Rail (km) | | 0.00E+00 | | | | | | |
| Offsite Truck (km) | | 1.71E+07 | | | | | | |
| Offsite Rail (km) | | 1.74E+05 | | | | | | |
| EMPLOYEE VEHICLE | | | | | | | | |
| | | person-yr | trip/yr | km/trip | car pool | total | | |
| | Const. | 1.07E+04 | 2.60E+02 | 1.40E+02 | 7.41E-01 | 2.89E+08 | | |
| | Ops/D&D | 6.93E+03 | 2.60E+02 | 1.40E+02 | 7.41E-01 | 1.87E+08 | Total | 4.76E+08 |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Distance traveled in population zones | | | | | | | | |
| Urban | | Offsite km | zone fraction | | Onsite | TOTALS | | |
| | Truck | 1.71E+07 | 5.00E-02 | | | 8.55E+05 | | |
| | Rail | 1.74E+05 | 5.00E-02 | | | 8.72E+03 | | |
| Suburban | | | | | | | | |
| | Truck | 1.71E+07 | 5.00E-02 | | 1.05E+06 | 1.90E+06 | | |
| | Rail | 1.74E+05 | 5.00E-02 | | | 8.72E+03 | | |
| Rural | | | | | | | | |
| | Truck | 1.71E+07 | 9.00E-01 | | | 1.54E+07 | | |
| | Rail | 1.74E+05 | 9.00E-01 | | | 1.57E+05 | | |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Fatalities/Injuries resulting from Truck and Rail transportation accidents | | | | | | | | |
| | | | urban km | | suburban km | | rural km | |
| | | | truck | rail | truck | rail | truck | rail |
| | | | 8.55E+05 | 8.72E+03 | 1.90E+06 | 8.72E+03 | 1.54E+07 | 1.57E+05 |
| urban truck fat/km | | 7.50E-09 | 6.41E-03 | | | | | |

Sheet B-25
RDW 2-15-96

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| urban truck inj/km | | 3.70E-07 | 3.16E-01 | | | | | |
| urban rail fat/km | | 1.70E-08 | | 1.48E-04 | | | | |
| urban rail inj/km | | 3.30E-08 | | 2.88E-04 | | | | |
| sub truck fat.km | | 1.30E-08 | | | 2.47E-02 | | | |
| sub truck inj/km | | 3.80E-07 | | | 7.23E-01 | | | |
| sub rail fat/km | | 1.70E-08 | | | | 1.48E-04 | | |
| sub rail inj/km | | 3.30E-08 | | | | 2.88E-04 | | |
| rural truck fat/km | | 5.30E-08 | | | | | 8.16E-01 | |
| rural truck inj/km | | 8.00E-07 | | | | | 1.23E+01 | |
| rural rail fat/km | | 1.70E-08 | | | | | | 2.67E-03 |
| rural rail inj/km | | 3.30E-08 | | | | | | 5.18E-03 |
| | | | | | | | | |
| | | | | | | | | |
| | TOTAL FATALITIES | | 8.50E-01 | | | | | |
| | TOTAL INJURIES | | 1.34E+01 | | | | | |
| | | | | | | | | |
| Fatalities/Injuries resulting from Employee vehicle accidents | | | | | | | | |
| | | | | | | | | |
| | | km | rate/km | TOTAL | | | | |
| | fatalities | 4.76E+08 | 8.98E-09 | 4.27E+00 | | | | |
| | injuries | 4.76E+08 | 7.14E-07 | 3.40E+02 | | | | |
| | | | | | | | | |
| | | | | | | | | |
| | | | | | | | | |
| Cumulative fatalities/injuries from traffic impacts | | | | | | | | |
| | | | | | | | | |
| | | | transport | employee | TOTAL | | | |
| | FATALITIES | | 8.50E-01 | 4.27E+00 | 5.12E+00 | | | |
| | INJURIES | | 1.34E+01 | 3.40E+02 | 3.53E+02 | | | |
| | | | | | | | | |
| CONSTRUCTION ACCIDENTS | | | | | | | | |
| | | rate | person-yr | | | | | |
| | TRC = | 9.75E-02 | 1.07E+04 | = | 1043.25 | | | |
| | LWC = | 2.45E-02 | 1.07E+04 | = | 262.15 | | | |
| | Fatality = | 3.20E-05 | 1.07E+04 | = | 0.3424 | | | |
| | | | | | | | | |
| OPERATION ACCIDENTS | | | | | | | | |
| | | rate | person-yr | | | | | |
| | TRC = | 2.20E-02 | 6.93E+03 | = | 152.46 | | | |
| | LWC = | 1.10E-02 | 6.93E+03 | = | 76.23 | | | |
| | Fatality = | 3.20E-05 | 6.93E+03 | = | 0.22176 | | | |
| | | | | | | | | |
| | | | | | | | | |
| TOTALS | | | | | | | | |

Sheet B-26
RDW 2-15-96

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | INJUR | 1.55E+03 | | | | | | |
| | FATAL | 5.68E+00 | | | | | | |

Phased Implementation I + II



Sheet B-27
RDW 2-15-96

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | TOTAL ALTERNATIVE | | | | | | | |
| | | | | | | | | |
| RETRIEVAL | | | | | | | | |
| Waste Transport | | | | | | total | | |
| Onsite Truck | | | | | | 1.25E+04 | Total | 1.25E+04 |
| | | | | | | | | |
| Construction | | | | | | | | |
| Offsite Truck | | | trips/yr | km/trip | yr | total | | |
| | concrete | | 4.80E+02 | 1.40E+02 | 2.00E+01 | 1.34E+06 | | |
| | raw material | | 4.50E+01 | 8.00E+02 | 2.00E+01 | 7.20E+05 | | |
| | equipment | | 2.50E+01 | 1.00E+04 | 2.00E+01 | 5.00E+06 | | |
| | miscellaneous | | 5.20E+03 | 1.40E+02 | 2.00E+01 | 1.46E+07 | | |
| | borrow (W-314) | | 1.38E+03 | 1.00E+01 | | 1.38E+04 | Total | 2.16E+07 |
| | | | | | | | | |
| Offsite Rail | | | trips/yr | km/trip | yr | total | | |
| | raw material | | 1.00E+01 | 8.00E+02 | 2.00E+01 | 1.60E+05 | | |
| | steel (W-314) | | 5.30E+01 | 8.00E+02 | | 4.24E+04 | | |
| | cement (W-314) | | 1.00E+02 | 1.40E+02 | | 1.40E+04 | Total | 2.16E+05 |
| VITRIFICATION | | | | | | | | |
| Construction | | | | | | | | |
| Onsite Truck | | 1.44E+05 | trips | km/trip | | total | | |
| | borrow p-30 | | ~~2.80E+04~~ | 1.00E+01 | | 2.80E+05 | Total | 2.80E+05 |
| | | | | | | | | |
| Offsite Truck | | | trips | km/trip | | total | | |
| | concrete | 2.61E4 | ~~1.57E+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 | | |

Sheet B-28
RJD 2-15-96

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | silt | | 6.93E+05 | 1.00E-01 | 3.00E+01 | 2.08E+06 | | |
| | riprap | | 1.05E+06 | 1.00E-01 | 3.20E+01 | 3.36E+06 | | |
| | ag/sand | | 7.93E+05 | 1.00E-01 | 1.00E+01 | 7.93E+05 | | |
| | grout fill sand IMUST | | 2.20E+03 | 1.00E+01 | | 2.20E+04 | Total | 7.24E+06 |
| Offsite Truck | | | trips | km/trip | | total | | |
| | groutfill cement IMUS | | 4.63E+02 | 1.40E+02 | | 6.48E+04 | Total | 6.48E+04 |
| | | | | | | | | |
| Onsite Truck (km) | | 7.53E+06 | | | | | | |
| Onsite Rail (km) | | 0.00E+00 | | | | | | |
| Offsite Truck (km) | | 4.69E+07 | | | | | | |
| Offsite Rail (km) | | 2.91E+06 | | | | | | |
| | | | | | | | | |
| EMPLOYEE VEHICLE | | | | | | | | |
| Phase 1 | | person-yr | trip/yr | km/trip | car pool | total | | |
| | Const. | 1.16E+04 | 2.60E+02 | 1.40E+02 | 7.41E-01 | 3.13E+08 | | |
| | Ops/D&D | 6.77E+03 | 2.60E+02 | 1.40E+02 | 7.41E-01 | 1.83E+08 | | |
| Phase 2 | | | | | | | | |
| | Const. | 1.98E+04 | 2.60E+02 | 1.40E+02 | 7.41E-01 | 5.34E+08 | | |
| | Ops/D&D | 4.91E+04 | 2.60E+02 | 1.40E+02 | 7.41E-01 | 1.32E+09 | | |
| | | | | | | | | |
| | | | | | | | Total | 2.35E+09 |
| | | | | | | | | |
| | | | | | | | | |
| | | | | | | | | |
| | | | | | | | | |
| Distance traveled in population zones | | | | | | | | |
| | | | | | | | | |
| Urban | | Offsite km | zone fraction | | Onsite | TOTALS | | |
| | Truck | 4.69E+07 | 5.00E-02 | | | 2.34E+06 | | |
| | Rail | 2.91E+06 | 5.00E-02 | | | 1.46E+05 | | |
| Suburban | | | | | | | | |
| | Truck | 4.69E+07 | 5.00E-02 | | 7.53E+06 | 9.88E+06 | | |
| | Rail | 2.91E+06 | 5.00E-02 | | | 1.46E+05 | | |
| Rural | | | | | | | | |
| | Truck | 4.69E+07 | 9.00E-01 | | | 4.22E+07 | | |
| | Rail | 2.91E+06 | 9.00E-01 | | | 2.62E+06 | | |
| | | | | | | | | |
| | | | | | | | | |
| | | | | | | | | |
| | | | | | | | | |
| Fatalities/Injuries resulting from Truck and Rail transportation accidents | | | | | | | | |
| | | | urban km | | suburban km | | rural km | |
| | | | truck | rail | truck | rail | truck | rail |
| | | | 2.34E+06 | 1.46E+05 | 9.88E+06 | 1.46E+05 | 4.22E+07 | 2.62E+06 |
| urban truck fat/km | | 7.50E-09 | 1.76E-02 | | | | | |

Sheet B-29
RDW 2-15-96

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| urban truck inj/km | | 3.70E-07 | 8.67E-01 | | | | | |
| urban rail fat/km | | 1.70E-08 | | 2.48E-03 | | | | |
| urban rail inj/km | | 3.30E-08 | | 4.81E-03 | | | | |
| sub truck fat.km | | 1.30E-08 | | | 1.28E-01 | | | |
| sub truck inj/km | | 3.80E-07 | | | 3.75E+00 | | | |
| sub rail fat/km | | 1.70E-08 | | | | 2.48E-03 | | |
| sub rail inj/km | | 3.30E-08 | | | | 4.81E-03 | | |
| rural truck fat/km | | 5.30E-08 | | | | | 2.23E+00 | |
| rural truck inj/km | | 8.00E-07 | | | | | 3.37E+01 | |
| rural rail fat/km | | 1.70E-08 | | | | | | 4.46E-02 |
| rural rail inj/km | | 3.30E-08 | | | | | | 8.66E-02 |
| | | | | | | | | |
| | | | | | | | | |
| | TOTAL FATALITIES | | 2.43E+00 | | | | | |
| | TOTAL INJURIES | | 3.84E+01 | | | | | |
| | | | | | | | | |
| Fatalities/Injuries resulting from Employee vehicle accidents | | | | | | | | |
| | | | | | | | | |
| | | km | rate/km | TOTAL | | | | |
| | fatalities | 2.35E+09 | 8.98E-09 | 2.11E+01 | | | | |
| | injuries | 2.35E+09 | 7.14E-07 | 1.68E+03 | | | | |
| | | | | | | | | |
| | | | | | | | | |
| | | | | | | | | |
| Cumulative fatalities/injuries from traffic impacts | | | | | | | | |
| | | | | | | | | |
| | | | transport | employee | TOTAL | | | |
| | FATALITIES | | 2.43E+00 | 2.11E+01 | 2.36E+01 | | | |
| | INJURIES | | 3.84E+01 | 1.68E+03 | 1.72E+03 | | | |
| | | | | | | | | |
| CONSTRUCTION ACCIDENTS | | | | | | | | |
| | | rate | person-yr | | | | | |
| | TRC = | 9.75E-02 | 3.14E+04 | = | 3061.5 | | | |
| | LWC = | 2.45E-02 | 3.14E+04 | = | 769.3 | | | |
| | Fatality = | 3.20E-05 | 3.14E+04 | = | 1.0048 | | | |
| | | | | | | | | |
| OPERATION ACCIDENTS | | | | | | | | |
| | | rate | person-yr | | | | | |
| | TRC = | 2.20E-02 | 5.59E+04 | = | 1229.14 | | | |
| | LWC = | 1.10E-02 | 5.59E+04 | = | 614.57 | | | |
| | Fatality = | 3.20E-05 | 5.59E+04 | = | 1.78784 | | | |
| | | | | | | | | |
| | | | | | | | | |
| TOTALS | | | | | | | | |

Sheet B-30
RDW 2-15-96

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | INJUR | 6.01E+03 | | | | | | |
| | FATAL | 2.64E+01 | | | | | | |

| | 1 | 2 | 3 | 4 | 5 | 6 |
|---|---|---|---|---|---|---|
| | | | | Sheet | B-31 | 2-15-96 |
| Gasoline ($m^3$) | 54.6 ~~$m^3$~~ | NA | NA | 54.6 | 20 | 75.5 |
| (gals) | 26454.6 galls | | | 26454.6 gals | 5280 gallons | 19884.8 galls |
| Diesel ($m^3$) | 3.51E+03 ~~$m^3$~~ | 1.4E+04 | 6.044E+04 | 2.3E+04 | 5.05 ~~9.22~~ 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 | 28050 | 24480 | | Sand + 71400 | 13770 | 26214 |
| Mg oxide 0.1837 | 4.24E4 | 4.4E4 | | 1.08E5 | 2.08E4 | 3.96 ~~5.19~~ E4 |
| Boron | | | | | | |
| 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 | 5.4E+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)

Sheet B-32
RDW 2-15-96

Items for Trucking/Railcar

~~[illegible]~~

| | | | % |
|---|---|---|---|
| Gasoline | | | |
| Diesel fuel | Silica | 1760 | 0.816 |
| Kerosene | Boron | 14 | 0.0065 |
| Concrete: cement (tons) | Calcium | 286 | 0.1327 |
| (cu yds) Sand | aluminum | 96 | 0.0445 |
| (cu yds) gravel | | 2156 | |

Concrete prefab materials
Carbon Steel Prefab
Stainless Steel prefab
Carbon Steel Rebar
glass formers
process chemicals:
Oxygen ? $m^3$

0.1837

1327
0445
0065
0.1837

Sulfer
dicyclopentadine
Oligmer

$$\text{Tons} = m^3 \left(\frac{Mg}{m^3}\right)\left(\frac{mT}{Mg}\right)\left(\frac{\overset{1.1}{\text{Tons}}}{mT}\right)$$

$$\text{Tons} = (m^3)(1.6)(1.1) = m^3(1.76)$$

alternatives
1 Ex Situ Intermediate Seps.
2 Ex Situ no Seps vitri.
3 Ex Situ no Seps Calcin
4 Ex Situ Extensive Seps.
5 Ex Situ/In Situ Combo.
6 Phased 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 ~~90T~~ | PORT/Sand ~~TK~~ | 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

SAW 25%, 1.25 HLW 40%, 1.5
Sheet B-34
RDW 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
RDW 2-15-96

Sensitivity Case 2

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

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

Sensitivity Case 3

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

Sheet B-37
RDW 2-15-96

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | EX SITU INTERMEDIATE SEPARATIONS ALTERNATIVE | | | | | | | |
| RETRIEVAL | | | | | | | | |
| Waste Transport | | | | | | total | | |
| Onsite Truck | | | | | | 1.25E+04 | | |
| | | | | | | | Total | 1.25E+04 |
| Construction | | | | | | | | |
| Offsite Truck | | | trips/yr | km/trip | yr | total | | |
| | concrete | | 4.80E+02 | 1.40E+02 | 2.00E+01 | 1.34E+06 | | |
| | raw material | | 4.50E+01 | 8.00E+02 | 2.00E+01 | 7.20E+05 | | |
| | equipment | | 2.50E+01 | 1.00E+04 | 2.00E+01 | 5.00E+06 | | |
| | miscellaneous | | 5.20E+03 | 1.40E+02 | 2.00E+01 | 1.46E+07 | | |
| | steel W-314 | | 5.30E+01 | 8.00E+02 | | 4.24E+04 | | |
| | cement W-314 | | 1.00E+02 | 1.40E+02 | | 1.40E+04 | Total | 2.17E+07 |
| Offsite Rail | | | trips/yr | km/trip | yr | total | | |
| | raw material | | 1.00E+01 | 8.00E+02 | 2.00E+01 | 1.60E+05 | Total | 1.60E+05 |
| Onsite Truck | | | | | | | | |
| | borrow W-314 | | 1.38E+03 | 1.00E+01 | | 1.38E+04 | Total | 1.38E+04 |
| VITRIFICATION | | | | | | | | |
| Construction | | | | | | | | |
| Onsite Truck | | | trips | km/trip | | total | | |
| | borrow | 1.67E+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 | 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 | | |
| ~~4.11E+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 | | |
| | | | 5.35E+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 material 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 |
| | SAW - 25% $Na_2O$ loading | SAW - 15% $Na_2O$ loading | SAW - 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 Case.

(2) based on Casting shield Covers on Site.

(3) based on Casting Shield covers off Site.

| | | |
|---|---|---|
| LAW - 25% | LAW - 15% | LAW - 10% |
| $Na_2O$ Loading | $Na_2O$ Loading | Loading $Na_2O$ |
| HLW - 45% | 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 Action Alternative | 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% $Na_2O$ loading Blend 1.25 HLW-15% loading Blend 1.5 | R = 1.25 LAW-25% $Na_2O$ Loading Blend 1.25 HLW-40% loading Blend 1.5 |
|---|---|---|---|---|---|---|
| Land, permanently committed (hectares) (Long-term commitment of radiologically contaminated area) | Total | 17 | 40 | | | |
| | Construction/ Operation | 0 | 7 | | | |
| | Closure | 17 | 33 | | | |
| Land, incremental temporarily committed (hectares) (area disturbed during construction and operations) | Total | 0 | 108 | | | |
| | Construction/ Operation | 0 | 84 | | | |
| | Closure | 0 | 24 | | | |
| Borrow Pit Disturbed Area (hectares) based on an excavation depth of 3 meters | McGee Ranch | N/A | 21 | | | |
| | Pit 30 | N/A | 57 | | | |
| | Vernita Quarry | N/A | 27 | | | |
| Water, Total (cubic meters) | Sanitary plus Raw Water | 1.52E+06 | 1.47E+07 | 2.40 E+07 | 3.5 E+07 | 1.77E+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 | 2.78E+07 | 1.33E+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 | 1.92E+04 | 1.12 E+04 |
| | Closure | N/A | N/R | | | |
| Gasoline (cubic meters) | Total | N/A | 8.0E+03 | 8.0 E+03 | 8.07E+03 | 8.00 E+03 |
| | Construction | N/A | 7.6E+03 | | | |
| | Operation | N/R | N/R | 5.46 E+01 | 77.3E+00 | 9.1E+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 3.13 | R = 1.25 |
|---|---|---|---|---|---|---|
| Diesel (cubic meters) | Total | 2.2E+04 | 3.32E+04 | 9.47E+04 | 1.01E+05 | 8.9E+04 |
| | Construction | N/A | 2.1E+04 | | | |
| | Operation | 2.2E+04 | 1.02E+03 | 7.53E+03 | 1.39E+04 | 2.24E+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+06~~ 1.11E+06 ~~3.06E+05~~ | 1.07E+06 | 3.53E+05 |
| | Closure | N/A | 1.9E+04 | | | |
| Carbon Steel (metric tons) | Total | 1E+03 | 1.64E+05 | 1.78E+05 | 3.27E+05 | 1.95E+05 |
| | Construction | N/A | 1.07E+05 | 1.07E+05 | 1.07E+05 | 1.07E+05 |
| | Operation | 1E+03 | N/R | 5.16E+04 | 2.01E+05 | 6.87E+04 |
| | Closure | N/R | 1.9E+04 ? | ?? | ?? | ?? |
| Stainless Steel (mt) TOTAL | Construction | N/A | ~~1.9E+04~~ ~~1.9E+04~~ NR | ~~4.41E+04~~ 1.4E+04 ~~2.51E+04~~ | ~~5.24E+04~~ 1.9E+04 ~~3.34E+04~~ | ~~3.2E+04~~ ~~1.9E+04~~ ~~1.3E+04~~ |
| Hastelloy/Inconel (mt) | Construction | N/R | 2.3E+03 | | | |
| Glass Formers (mt) | Operation | N/A | 2.94E+05 | 5.0E+05 | 6.26E+05 | 3.65E+05 |
| Process Chemicals (mt) | Operation | N/A | ~~1.90E+05~~ 3.81E+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 | | | |

deis\appendb\appendb.dll

* 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~~ 1199650 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 | | | | |
| Boronoxide | | | | |
| 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 | 145000 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) | 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~~ 5.77E+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 | 147 ~~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] | — |

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.

Sheet B-47
AGW 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).

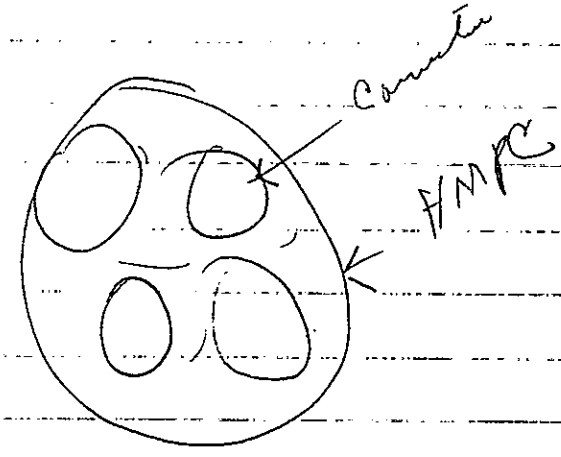
Phased Implementation (Phase I) would involve 20 rail shipments per year to bring materials onto the Site, but no offsite shipments of HLW. The total Phased Implementation alternative would require 108 rail shipments per year during construction and operations, 83 rail shipments per year to the HLW repository, 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
BN 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 | | | | | |



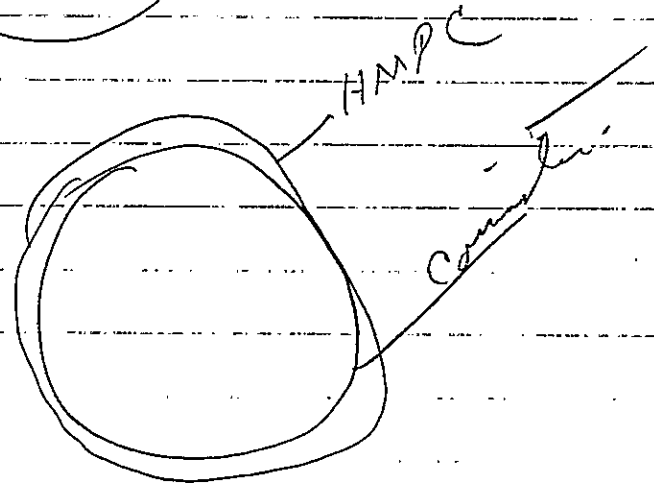



Table 9-7. Transportation in Support of Processing (Units as Indicated).

| Item | Extensive Separation Alternative |
|---|---|
| Normal Operation<br>Route location<br>(State mileage) | Portland/Seattle<br>(400 kilometers) |
| Roadtype<br>(gravel or asphalt) | Asphalt |
| Number of trips per year [1]<br>Truck<br>Train [2] | <br>513<br>637 |
| High-level waste transportation<br>Route location<br>(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.