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

EDMC NUMBER: 0047100

DOCUMENT NUMBER: NA

SECTION 6 OF

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

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

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

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

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

C 14 TC99 I 129 U 238 TH234 PA234 NP237
PA233

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

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

External Exposure Time: 2.92E+03 hr/yr

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

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

Input Prepared By: _____ Date: _____

Input Checked By: _____ Date: _____

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

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

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

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

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

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

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

---- POPULATION DATA ----

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

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

Lifetime Effective Cumulative Dose Equivalent as a Function of Time

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

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

Lifetime Effective Cumulative Dose Equivalent as a Function of Time

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

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

Cumulative Population Dose Equivalent by Radionuclide

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

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

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

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

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

Lifetime Effective Cumulative
Dose Equivalent 1.8E+01

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

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

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

4.814 E-6

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

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

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

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

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

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

Population Internal Dose To Organ by Exposure Pathway

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

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

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

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

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

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

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

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

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

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

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

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

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

External Exposure Time: 2.92E+03 hr/yr

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

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

Input Prepared By: _____ Date: _____

Input Checked By: _____ Date: _____

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

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

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

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

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

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

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

---- POPULATION DATA ----

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

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

Lifetime Effective Cumulative Dose Equivalent as a Function of Time

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

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

Lifetime Effective Cumulative Dose Equivalent as a Function of Time

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

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

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

Integrated population dose calculated for chronic liquid release
Release from time 1990. A.D. onward for 10,000 years
Case title: DITTY Long-Term Surface Water Release TWRS-EIS (Ex Situ Inter. Sepa.)
Executed on: 06/21/96 at 07:02:01.6 Page 6

Cumulative Population Dose Equivalent by Radionuclide

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

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

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

Integrated population dose calculated for chronic liquid release
Release from time 1990. A.D. onward for 10,000 years
Case title: DITTY Long-Term Surface Water Release TWRS-EIS (Ex Situ Inter. Sepa.)
Executed on: 06/21/96 at 07:02:01.6 Page 7

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

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

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

Lifetime Effective Cumulative
Dose Equivalent 1.8E+01

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

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

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

4.814×10^{-6}

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

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

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

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

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

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

Population Internal Dose To Organ by Exposure Pathway

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

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

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

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

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

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

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

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

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

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

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

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

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

External Exposure Time: 2.92E+03 hr/yr

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

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

Input Prepared By: _____ Date: _____

Input Checked By: _____ Date: _____

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

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

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

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

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

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

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

---- POPULATION DATA ----

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

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

Lifetime Effective Cumulative Dose Equivalent as a Function of Time

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

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

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

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

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

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

Cumulative Population Dose Equivalent by Radionuclide

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

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

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

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

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

Lifetime Effective Cumulative
Dose Equivalent 1.8E+01

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

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

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

4.84×10^{-6}

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

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

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

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

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

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

Population Internal Dose To Organ by Exposure Pathway

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

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

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

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

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TWRS EIS
CALCULATION COVER SHEET

DISCIPLINE & TITLE Engineering / Alternative Schedules For FEIS

ORIGINATOR Colin Henderson DATE 6/25/96

REVISION NO. 0

OBJECTIVE Modify the alternative schedules in the DEIS to move Construction start dates from 1997 to 1998 or 1999 as appropriate, modify operating durations to agree with processing requirements.

METHODOLOGY Using facility sizing data from waste loading Calculations adjust the alternative schedules.

ASSUMPTIONS Construction For Treatment facilities for all ex situ alternatives except Phase 1 Implementation will start No Sooner than 1999. Construction for Retrieval & Transfer would Start no sooner than 1998. Phase 1 construction would start in 1998.

(Continue on another sheet if necessary)

Col Henderson 8/27/96
SIGNATURE/DATE

David J Murray 8/27/96
CHECKED/DATE

CALCULATION & RESULTS
ATTACHED

JACOBS\FORMS\CALCVR.SHT

Pg 2/6

NO ACTION SCHEDULE							**FEIS SCHEDULE**		
	DEIS CHAPTER 3 SCHEDULE			Duration					Duration
Continued Operations	1997-2097			100 yrs			1997-2097		100 yrs
LONG-TERM MANAGEMENT SCHEDULE									
Continued Operations									
Construction									
Waste Retrieval	2033-2037	2083-2087		4 yrs each			2033-2037	2083-2087	4 yrs ea.
New Tanks	2033-2037	2083-2087		4 yrs each			2033-2037	2083-2087	4 yrs ea.
Operations	2037-2042	2087-2092		5 yrs each			2037-2042	2087-2092	5 yrs ea
D&D	2042-2047	2092-2097	42-49,92-99 for WR&T	5 yrs			2042-2047	2092-2097	5 yrs
Monitoring & Maintenance	1997-2097			100 yrs			1997-2097		100 yrs
IN SITU FILL AND CAP SCHEDULE									
Continued Operations	1997-2009			12 yrs			1997-2009		12 yrs
Research and Development	N/A						N/A		
Construction	2003-2005			2 yrs			2003-2005		2 yrs
Operation	2000-2009			9 yrs			2000-2009		9 yrs
D&D	2009-2012			3 yrs			2009-2012		3 yrs
Monitoring and Maintenance	2009-2029			20 yrs			2009-2029		20yrs
Closure	2012-2029			17 yrs			2012-2029		17 yrs
Post Closure Monitoring	2029-2129			100 yrs			2029-2129		100 yrs
IN SITU VITRIFICATION SCHEDULE									
	DEIS CHAPTER 3 SCHEDULE						FEIS		
Continued Operations	1997-2013			16 yrs			1997-2013		16 yrs
Research and Development	1997-2002			5 yrs			1997-2002		5 yrs
Construction	1998-2016			18 yrs			1999-2016		17 yrs
Operation	2005-2016			11 yrs			2005-2016		11 yrs
DST evaporation	2000-2005			5 yrs			2000-2005		5 yrs
ISV strart up	2005-2008			3 yrs			2005-2008		3 yrs
ISV operation	2008-2013			5 yrs			2008-2013		5 yrs
D&D	2013-2016			3 yrs			2013-2016		3 yrs
Monitoring and Maintenance	2016-2033			17 yrs			2016-2033		17 yrs
Closure	2016-2033			17 yrs			2016-2033		17 yrs
Post Closure Monitoring	2033-2133			100 yrs			2033-2133		100 yrs
EX SITU INTERMEDIATE SEPARATIONS SCHEDULE									
	DEIS CHAPTER 3 SCHEDULE								
Continued Operations							1997-2022		25 yrs
Research and Development	1995-2018			23 yrs			1997-2018		21 yrs
Construction									
Waste Retrieval and Transfer	1998-2017			19 yrs			1998-2017		19 yrs
Waste Treatment	1997-2007			10 yrs			1999-2009		10 yrs
HLW							2003-2009		6 yrs
LAW							1999-2004		5 yrs
Operation									
Waste Retrieval	2001-2024			23 yrs			2001-2022		21 yrs
Treatment	2004-2024			20 yrs					
Pretreatment							2004-2022		18 yrs
LLW Vitrification	2004-2024			20 yrs			2005-2022		17 yrs
HLW Vitrification	2011-2024			13 yrs			2011-2022		11 yrs
LLW Disposal							2005-2022		17 yrs
HLW Transportation and Disposal	2019-2029			10 yrs			2022-2040		18 yrs
D&D									
Waste Retrieval facilities	2013-2026			13 yrs			2013-2025		12 yrs
Treatment Facilities	2024-2033			9 yrs			2022-2031		9 yrs
Monitoring and Maintenance									
HLW (assess impacts for 50 yr period)	2024-2029			5 yrs			2022-2040		18 yrs
LLW Disposal									
Closure	2010-2034			24 yrs			2010-2034		24 yrs
Post Closure Monitoring	2034-2134			100 yrs			2034-2134		100 yrs
EX SITU NO SEPARATIONS (VITRIFICATION AND CALCINATION)									
	PDEIS CHAPTER 3 SCHEDULE								

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Continued Operations							1997-2020		23 yrs
Research and Development			1995-2005			10 yrs	1997-2007		10 yrs
Construction									
Waste Retrieval and Transfer			1998-2017			19 yrs	1998-2017		19 yrs
Waste Treatment			1997-2002			5 yrs	1999-2005		6 yrs
Operation									
Waste Retrieval			2001-2019			18 yrs	2003-2020		17 yrs
HLW Vitrification			2004-2019			15 yrs	2006-2020		14 yrs
HLW Transportation and Disposal			2017-2037			20 yrs	2020-2040		20 yrs
D&D									
Waste Retrieval facilities			2013-2021			8 yrs	2015-2023		8 yrs
Treatment Facilities			2019-2024			5 yrs	2020-2025		5 yrs
Monitoring and Maintenance									
HLW (assess impacts for 50 yrs)			2019-2037			18 yrs	2020-2040		20 yrs
Closure			2010-2024			14 yrs	2011-2025		14 yrs
Post Closure Monitoring			2024-2124			100 yrs	2025-2125		100 yrs
EX SITU EXTENSIVE SEPARATIONS SCHEDULE									
			DEIS CHAPTER 3 SCHEDULE						
Continued Operations							1997-2023		26 yrs
Research and Development			1995-2018			23 yrs	1997-2018		21 yrs
Construction									
Waste Retrieval and Transfer			1998-2017			19 yrs	1998-2016		18 yrs
Waste Treatment			1997-2006			9 yrs	1999-2011		12 yrs
HLW							2001-2006		6 yrs
LAW							1999-2004		5 yrs
Operation									
Waste Retrieval			2001-2024			23 yrs	2003-2023		20 yrs
Treatment			2004-2024			20 yrs	2004-2023		19 yrs
Pretreatment							2004-2023		19 yrs
LLW Vitrification							2006-2023		17 yrs
HLW Vitrification							2013-2023		10 yrs
LLW Disposal							2006-2023		17 yrs
HLW Transportation and Disposal			2020-2029			9 yrs	2022-2025		3 yrs
D&D									
Waste Retrieval facilities			2012-2025			13 yrs	2014-2024		10 yrs
Treatment Facilities			2024-2029			5 yrs	2023-2028		5 yrs
Monitoring and Maintenance									
HLW			2024-2029			5 yrs	2023-2025		2 yrs
LLW Disposal									
Closure			2010-2030			20 yrs	2012-2032		20 yrs
Post Closure Monitoring			2030-2130			100 yrs	2032-2132		100 yrs
EX SITU/IN SITU COMBINATION 2									
Continued Operations							1997-2022		25 yrs
Research and Development							1997-2018		21 yrs
Construction									
Waste Retrieval and Transfer							1998-2016		18 yrs
Waste Treatment							1999-2008		9 yrs
HLW							2002-2008		6 yrs
LAW							1999-2004		5 yrs
Fill & Cap							2003-2005		2 yrs
Operation									
Waste Retrieval							2002-2022		20 yrs
Treatment							2004-2022		18 yrs
Pretreatment							2004-2022		18 yrs
LLW Vitrification							2005-2022		17 yrs
HLW Vitrification							2009-2022		13 yrs
LLW Disposal									
HLW Transportation and Disposal							2022-2040		18 yrs
Fill and Cap Operations							2000-2009		9 yrs
D&D									
Waste Retrieval facilities							2013-2024		11 yrs
Treatment Facilities							2022-2031		9 yrs
Fill and Cap Equipment							2022-2025		3 yrs
Monitoring and Maintenance									

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	HLW							2022-2040		18 yrs
Closure								2010-2032		22 yrs
Post Closure Monitoring								2032-2132		100 yrs
EX SITU/IN SITU COMBINATION 1										
				DEIS CHAPTER 3 SCHEDULE						
Continued Operations								1997-2023		26 yrs
Research and Development				1995-2018			23 yrs	1997-2018		21 yrs
Construction										
	Waste Retrieval and Transfer			1998-2017			19 yrs	1998-2016		18 yrs
	Waste Treatment			1997-2007			10 yrs	1999-2009		10 yrs
	HLW							2003-2009		6 yrs
	LAW							1999-2005		6 yrs
	Fill & Cap			2003-2005			2 yrs	2003-2005		2 yrs
Operation										
	Waste Retrieval			2001-2024			23 yrs	2002-2022		20 yrs
	Treatment			2004-2024			20 yrs	2005-2023		18 yrs
	Pretreatment							2005-2023		18 yrs
	LLW Vitrification							2006-2023		17 yrs
	HLW Vitrification							2010-2023		13 yrs
	LLW Disposal							2006-2023		17 yrs
	HLW Transportation and Disposal			2019-2029			10 yrs	2022-2040		18 yrs
	Fill and Cap Operations			2005-2018			13 yrs	2000-2009		9 yrs
D&D				2019-2028			9 yrs			
	Waste Retrieval facilities			2012-2026			14 yrs	2013-2024		11 yrs
	Treatment Facilities			2024-2033			9 yrs	2023-2032		9 yrs
	Fill and Cap Equipment			2018-2021			3 yrs	2022-2025		3 yrs
Monitoring and Maintenance										
	HLW			2024-2029			5 yrs	2023-2040		17 yrs
Closure				2010-2034			24 yrs	2011-2035		24 yrs
Post Closure Monitoring				2034-2134			100 yrs	2035-2135		100 yrs
PHASED IMPLEMENTATION SCHEDULE				Phase 1		Phase 2		Phase 1	Phase 2	
				DEIS CHAPTER 3 SCHEDULE						
Continued Operations								1997-2028		31 yrs
Research and Development										
Construction										
	Phase 1			1997-2002			5 yrs	1998-2002		4 yrs
	Retrieval					2004-2020	16 yrs		2004-2020	16 yrs
	Phase 2					2005-2012	7 yrs		2006-2012	6 yrs
	HLW								2007-2012	5 yrs
	LAW								2006-2011	5 yrs
Operation										
	Phase 1			2002-2012			10 yrs			
	LAW Treatment Plants							2002-2012		10 yrs
	HLW Treatment Plant							2002-2008		6 yrs
	Phase 2									
	Waste Retrieval					2007-2028	21 yrs		2008-2028	20 yrs
	Treatment					2011-2028	17 yrs			
	HLW								2012-2028	16 yrs
	LAW								2011-2024	14 yrs
D&D						2015-2031	16 yrs		2015-2031	16 yrs
Monitoring and Maintenance										
	HLW								2028-2040	12 yrs
HLW Transportation									2022-2040	18 yrs
Closure						2016-2040	24 yrs		2016-2040	24 yrs
Post Closure M&M						2040-2140	100 yrs		2040-2140	100 yrs
	CAPSULES NO ACTION			DEIS CHAPTER 3 SCHEDULE						
Continued Operation				1997-2007			10yrs	1997-2007		10 yrs
Research and Development										
Construction										
Operation										
D&D										

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Monitoring and Maintenance									
CAPSULES ONSITE DISPOSAL									
			DEIS CHAPTER 3 SCHEDULE						
Continued Operation			1997-2028			31 yrs	1997-2028		31 yrs
Research and Development									
Construction			2002-2009			7 yrs	2002-2009		7 yrs
Operation			2010-2029			19 yrs	2010-2029		19 yrs
D&D									
Monitoring and Maintenance			2029-2129			100 yrs	2029-2129		100 yrs
CAPSULES OVERPACK AND SHIP									
			DEIS CHAPTER 3 SCHEDULE						
Continued Operation			1997-2028			31 yrs	1997-2028		31 yrs
Research and Development									
Construction			2002-2009			7 yrs	2002-2009		7 yrs
Operation			2010-2028			18 yrs	2010-2028		18 yrs
HLW Transportation and Disposal			2028-2029			1 yrs	2028-2029		1 yr
D&D									
Monitoring and Maintenance			2010-2029			19 yrs	2010-2029		19 yr
CAPSULES VITRIFY WITH TANK WASTES									
			DEIS CHAPTER 3 SCHEDULE						
Continued Operation			1997-2023			26 yrs	1997-2023		26 yrs
Research and Development									
Construction			2002-2007			5 yrs	2007-2012		5 yrs
Operation			2005-2023			18 yrs	2012-2028		16 yrs
D&D			2024-2029			5 yrs	2028-2033		5 yrs
Monitoring and Maintenance			2023-2029			6 yrs	2028-2040		12 yrs
HLW Transporation to Repository							2022-2040		18 yrs

4-5

PLANT COST ESTIMATE - APPROACH 1
Size exponent fixed at 0.64

CASE	PARAMETER	SEP-A	SEP-B	HLW	LAW-A	LAW-B	CNTR-A	CNTR-B	TOTAL
Intermediate Separation (Base Case)	Cost, $MM	380	None	1,400	1,300	None	520	None	3,600
	Capacity, tpd	200	None	20	200	None	200	None	n/a
	No. Trains	2	None	2	2	None	1	None	n/a
	Cost per Train	190	None	700	650	None	520	None	n/a
Combo 1 (Previous case)	Cost	244	None	898	834	None	334	None	2,310
	Capacity	100	None	10	100	None	100	None	n/a
	No. Trains	1	None	1	1	None	1	None	n/a
	Size Exponent	0.64	None	0.64	0.64	None	0.64	None	n/a
Combo 1 (Current Case)	Cost	214	None	607	730	None	375	None	1,926
	Capacity	120	None	8	120	None	120	None	n/a
	No. Trains	1	None	1	1	None	1	None	n/a
	Size Exponent	0.64	None	0.64	0.64	None	0.64	None	n/a
Combo 2 (Current Case)	Cost	151	None	449	517	None	266	None	1383
	Capacity	70	None	5	70	None	70	None	n/a
	No Trains	1	None	1	1	None	1	None	n/a
	Size Exponent	0.64	None	0.64	0.64	None	0.64	None	0.91
Phased Impl. -Phase I	Cost	None	(2 X 233)	160	232	232	119	119	~~1,095~~ 1,328
	Capacity	None	20	1	20	20	20	20	n/a
	No Trains	None	2 ~~X~~	1	1	1	1	1	n/a
	Size Exponent	None	0.64	0.64	0.64	0.64	0.64	0.64	n/a
Phased Impl. -Phase II	Cost	None	(2 X 652)	700	650	650	334	334	~~3,819~~ 3,972
	Capacity	None	100	10	100	100	100	100	n/a
	No Trains	None	2 ~~X~~	1	1	1	1	1	n/a
	Size Exponent	None	0.64	0.64	0.64	0.64	0.64	0.64	n/a

7/12/96

5-5

PLANT COST ESTIMATE - APPROACH 2

Plant	Analog	Size Exponent	Source
Separations	UF6	0.64	Garrett
HLW	Furnace	0.85	Guthrie
LAW	Furnace	0.85	Guthrie
Central	Cogeneration	0.75	Garrett

CASE	PARAMETER	SEP-A	SEP-B	HLW	LAW-A	LAW-B	CNTR-A	CNTR-B	TOTAL
Intermediate Separation (Base Case)	Cost, $MM	380	None	1,400	1,300	None	520	None	3,600
	Capacity, tpd	200	None	20	200	None	200	None	n/a
	No. Trains	2	None	2	2	None	1	None	n/a
	Cost per Train	190	None	700	650	None	520	None	n/a
Combo 1 (Previous case)	Cost	244	None	777	721	None	309	None	2,051
	Capacity	100	None	10	100	None	100	None	n/a
	No. Trains	1	None	1	1	None	1	None	n/a
	Size Exponent	0.64	None	0.85	0.85	None	0.75	None	n/a
Combo 1 (Current Case)	Cost	214	None	579	759	None	355	None	1,906
	Capacity	120	None	8	120	None	120	None	n/a
	No. Trains	1	None	1	1	None	1	None	n/a
	Size Exponent	0.64	None	0.85	0.85	None	0.75	None	n/a
Combo 2 (Current Case)	Cost	151	None	388	480	None	237	None	1256
	Capacity	70	None	5	70	None	70	None	n/a
	No Trains	1	None	1	1	None	1	None	n/a
	Size Exponent	0.64	None	0.85	0.85	None	0.75	None	1.00
Phased Impl. -Phase I	Cost	None	(2 × 233)	99	165	165	92	92	~~347~~ 1,080
	Capacity	None	20	1	20	20	20	20	n/a
	No Trains	None	2 ×	1	1	1	1	1	n/a
	Size Exponent	None	0.64	0.85	0.85	0.85	0.75	0.75	n/a
Phased Impl. -Phase II	Cost	None	(2 × 652)	700	650	650	309	309	~~3,270~~ 3,922
	Capacity	None	100	10	100	100	100	100	n/a
	No Trains	None	2 ×	1	1	1	1	1	n/a
	Size Exponent	None	0.64	0.85	0.85	0.85	0.75	0.75	n/a

7/12/96

TWRS EIS
CALCULATION COVER SHEET

DISCIPLINE & TITLE ENGR / COST
Preliminary FEIS Operating Treatment Costs

ORIGINATOR D. Stein DATE 7/12/96

REVISION NO. 1

OBJECTIVE Re-estimate operating treatment costs for alternatives based on Preliminary FEIS basis changes (canister size + glass loading)

METHODOLOGY factor from previous cost estimates.

ASSUMPTIONS similar to revision No. 0 of 2/20/96 for draft EIS.

(Continue on another sheet if necessary)

D. Stein
SIGNATURE

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CALCULATION & RESULTS ATTACHED

18 pages total excluding cover sheet

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1.9.2

6.18.2

JACOBS ENGINEERING GROUP INC.

DATE 7/12/96 SUBJECT SHEET NO. 1-2

BY DLS CHKD. JOB NO.

Ex Situ No Separations Vitrification

Preliminary FEIS (PFEIS)

WHC Data Pkg HLW glass - 30% Na_2O loading, 1.0 blend factor

from mass balance info

2.50E+05 MT glass formers

3.57E+05 MT glass product

PFEIS HLW glass - 20% Na_2O loading, 1.2 blend factor

from mass balance info

4.29E+05 MT glass formers

5.36E+05 MT glass product

ratio glass formers

$$\frac{4.29}{2.50} = 1.72$$

ratio glass product

$$\frac{5.36}{3.57} = 1.50$$

Δ cost for glass formers

category	previous $ (thou)	ratio	Δ $ (thou)
SiO_2	8,160	1.72	5,875
Al_2O_3	5,000	1.72	3,600
CaO	2,130	1.72	1,534
Kerosene	7,815	1.50	3,908
electricity	140,700	1.50	70,350
			$85,267

with addition of 2yrs startup time, yrs operation is about same as previous. Assume Δ labor ≈ 0.

JACOBS ENGINEERING GROUP INC.

DATE 7/12/92 SUBJECT SHEET NO. 2-2

BY DLS CHKD. JOB NO.

Δ other op. costs

29,100 canisters (10 m³ each) vs 21,400 canisters (10 m³ each) WHC Data Pkg.

		Δ$ (thou)
Canisters	(29,100 − 21,400) × $20,000/each =	154,000
Casks	(29,100 − 21,400) × $65,000/each =	500,500
		$654,500

Δ op. cost summary

Δ glass formers, etc	$85,267,000
Δ other op. costs	$654,500,000
total Δ op. costs	$739,767,000
previous op. costs	$4,427,000,000
new op. costs	$5,166,767,000

or

$5,167 million
no sep. vitrification

JACOBS ENGINEERING GROUP INC.

DATE 7/12/96 SUBJECT SHEET NO. 1-1

BY DLS CHKD. JOB NO.

Ex Situ No Separations Calcination

preliminary FEIS (PFEIS)

There is no change from original HLW calcination which was 10,300 canisters (10 m^3)

Glass loading and blend factors do not apply to Calcination Alternative.

Original and current op. costs

$3,233,000,000

or

$3,233 million no. sep. calcination

JACOBS ENGINEERING GROUP INC.

DATE 7/12/96 SUBJECT SHEET NO. 1-3

BY DLL CHKD. JOB NO.

Ex Situ Extensive Separations

preliminary FEIS (PFEIS)

WHC Data Pkg HLW glass - 34% waste oxide loading, 1.0 blend factor

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

PFEIS HLW glass - 20% waste oxide, 1.2 blend factor

from mass balance info
1.31 E +03 MT glass formers
1.76 E +03 MT glass product

570 Canisters
(1.17 m^3 each)

ratio glass formers

$$\frac{1.31\,E+03}{8.73\,E+02} = 1.50$$

ratio glass product

$$\frac{1.76\,E+03}{1.32\,E+03} = 1.33$$

WHC Data Pkg LAW glass - 25% Na_2O loading, 1.0 blend factor

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

PFEIS LAW glass - 15% Na_2O loading, 1.0 blend factor

from mass balance info
5.22 E +05 MT glass formers
6.43 E +05 MT glass product

ratio glass formers

$$\frac{5.22}{2.65} = 1.97$$

ratio glass product

$$\frac{6.43}{3.86} = 1.67$$

JACOBS ENGINEERING GROUP INC.

DATE 7/12/96 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 former cost is small compared to LAW glass formers, ratio all glass former cost from LAW ratio only.

Δ cost for glass formers

Category	previous $(Thou)	ratio	Δ $(Thou)
B_2O_3	57,500	1.97	79,323
LiO_2	10,500	1.97	
SiO_2	11,480	1.97	
MgO	2,050	1.97	
CaO	246	1.97	
Kerosene	10,525	1.67	50,113
Sulfur	62,927	1.67	
DCPD	672	1.67	
CPD	672	1.67	
Electricity	498,000	1.4 (same electricity ratio new/prev as used for inter sep)	199,200
			$328,636

With addition of 2yrs startup time and with yrs of operation for LAW vitrification + separations about the same as previous, the reduced yrs of operation for HLW vitrification is very small in labor savings. Assume Δ labor = 0.

JACOBS ENGINEERING GROUP INC.

DATE 7/12/96 SUBJECT SHEET NO. 3-3

BY DLL CHKD. JOB NO.

Δ other op. costs

	previous $(Thou)	ratio	Δ$ (Thou)
vaults	190,000	66/38 = 1.74	140,600
Canisters	4,480	570/448 = 1.27	1,210
Overpacks	6,720	570/448 = 1.27	1,814
			$ 143,624

add containers for LAW glass — Δ$ (Thou)

@ $1000 each (2.6 m³ volume each)

$$\frac{3.51E+05\ m^3\ LAW\ glass}{2.6\ m^3/container} \times \$1000\ each = \$135,000$$

Δ Summary op. costs

LAW/HLW combined op. costs	$328,636,000
other op. costs	$143,624,000
LAW containers	$135,000,000
Δ total	$607,260,000
previous op. cost	$4,556,000,000
new op. cost	$5,163,000,000

or

$5,163 million
ext. separation

JACOBS ENGINEERING GROUP INC.

DATE 7/12/92 SUBJECT SHEET NO. 1-9

BY DLS CHKD. JOB NO.

Ex Situ Intermediate Separations

preliminary FEIS (PFEIS)

WHC Data Pkg 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

PFEIS HLW glass - 20% waste oxide loading, 1.2 blend factor

from mass balance info

2.58 E+04 MT glass formers

3.73 E+04 MT glass product

ratio glass formers

$\frac{2.58}{1.36} = 1.90$

ratio glass product

$\frac{3.73}{2.51} = 1.49$

WHC Data Pkg LAW glass -25% Na_2O loading, 1.0 blend factor

from mass balance info

2.81 E+05 MT glass formers

3.87 E+05 MT glass product

PFEIS LAW glass -15% Na_2O loading, 1.0 blend factor

from mass balance info

5.39 E+05 MT glass formers

6.45 E+05 MT glass product

ratio glass formers

$\frac{5.39}{2.81} = 1.92$

ratio glass product

$\frac{6.45}{3.87} = 1.67$

JACOBS ENGINEERING GROUP INC.

DATE 7/12/96 SUBJECT SHEET NO. 2-9

BY DLS CHKD. JOB NO.

Δ cost for glass formers

HLW

category	previous $ (Thou)	ratio	Δ$ (Thou)
SiO_2	452	1.90	4,232
B_2O_3	1,750	1.90	
Li_2O	2,500	1.90	
electricity	116,700	1.49	54,243
		total HLW Δ	$58,475

LAW

SiO_2	9,160	1.92	24,787
Al_2O_3	6,600	1.92	
CaO	2,322	1.92	
other electricity	159,300 × ½ (estimated)	1.67	94,750
Kerosene	8,670	1.67	
sulfur	46,990	1.67	
DCPD	504	1.67	
CPD	504	1.67	
		total LAW Δ	$119,537

Δ Other costs

vaults	225,000	$\frac{66}{40}$ = 1.65	146,250
canisters	68,200	$\frac{12200}{6800}$ = 1.79	53,878
containers	42,625	1.79	33,674
casks	102,300	1.79	80,817
pads	26,000	1.79	20,540
		total other	$335,159

JACOBS ENGINEERING GROUP INC.

DATE 7/12/96 SUBJECT SHEET NO. 3-9

BY DLS CHKD. JOB NO.

Δ labor costs

total labor per TPA → $1,700,000,000

save 3 yrs on HLW op. (11 vs 14 yrs)

spend 3 yr on LAW op. (17 vs 14 yrs)

PFEIS yrs include 2 yrs of startup.

per Table 9-2 in TPA report

HLW vitr. → 1.1E+07 staff-hrs

LAW vitr. → 1.1E+07 staff-hrs

total staff hrs (everything) → 3.1E+07 staff-hrs

2.2E+07

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

$$\Delta \text{ labor costs} = \left[(1.1E+07)\tfrac{11}{14} + (1.1E+07)\tfrac{17}{14} - 2.2E+07\right] \$55/\text{hr}$$

Δ labor costs ≈ 0

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

add containers for LAW glass @$1000 each (2.6 m³ volume each) — Δ $ (thou)

$$\frac{3.51E+05 \text{ m}^3 \text{ LAW glass}}{2.6 \text{ m}^3/\text{container}} \times \$1000 \text{ each} = \$135,000$$

Δ summary op costs

HLW	$ 58,475,000
LAW	119,537,000
other	335,159,000
LAW containers	135,000,000
total Δ	648,171,000
previous op. cost	3,900,000,000
new op cost	$4,548,171,000

or $\boxed{\$4,548 \text{ million intr. sep.}}$

FORM 91-005-1 (4/81)

JACOBS ENGINEERING GROUP INC.

DATE ~~2/15/96~~ 7/12/96 rev. SUBJECT revisions for PFEIS 7/12/96

BY DLS CHKD. _____

SHEET NO. 4-9

JOB NO. _____

Intermediate Separations
Low Bounding Case

HLW @ 15%, ~~1.5~~ 1.2 blend factor
LAW @ 10%, ~~1.25~~ 1.0 blend factor

Low Bounding Case HLW glass – 15% waste oxide, ~~1.5~~ 1.2 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) (total waste, total prev., formers prev.)
7.26E +04 MT glass product

ratio glass formers: ~~$\frac{6.11 E+04}{1.36 E+04} = 4.49$~~ $\frac{.6 \times 6.11}{1.36} = 2.70$

ratio glass product: ~~$\frac{7.26 E+04}{2.51 E+04} = 2.89$~~ $\frac{.69 \times 7.26}{2.51} = 2.0$

Low Bounding Case LAW glass – 10% sodium oxide loading, ~~1.25~~ 1.0 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) (total waste, total prev, formers prev)
1.21E +06 MT glass product

ratio glass formers: ~~$\frac{11.0}{2.81} = 3.91$~~ $\frac{.77 \times 11}{2.81} = 3.01$

ratio glass product: ~~$\frac{12.1}{3.87} = 3.13$~~ $\frac{.50 \times 12.1}{3.87} = 2.50$

FORM 91-005-1 (4/81)

JACOBS ENGINEERING GROUP INC.

DATE ~~2/13/91~~ 7/12/96 rev. SUBJECT

SHEET NO. 5 - ~~10~~ 9

JOB NO.

BY DLS CHKD.

Δ cost for glass formers

HLW

category	$ (thousands) previous	ratio used	Δ $ (thousands)	
SiO_2	452	~~4.49~~ 2.70	~~1,577~~	1,993
B_2O_3	1,750	~~4.49~~ 2.70	~~6,107~~	
Li_2O	2,500	~~4.49~~ 2.70	~~8,725~~	
electricity	110,700	~~2.89~~ 2.00	~~209,223~~	110,700

17 yrs operation

total HLW Δ ~~$225,632~~ 118,693

LAW

SiO_2	9,160	~~3.91~~ 3.01	~~20,655~~		
Al_2O_3	6,600	~~3.91~~ 3.01	~~19,206~~		36,345
CaO	2,322	~~3.91~~ 3.01	~~6,757~~		
other electricity	159,300 × ½	~~3.13~~ 2.5	~~169,655~~ *		
Kerosene	8,670	~~3.13~~ 2.5	~~18,467~~		204,47
Sulfur	46,990	~~3.13~~ 2.5	~~100,089~~		
DCPD	504	~~3.13~~ 2.5	~~1,074~~		
CPD	504	~~3.13~~ 2.5	~~1,074~~		

total LAW Δ ~~$342,977~~ 240,822

26 yrs operation

* previously calculated in error @ $90,005

Δ Other Op. Cost

	$ (thousands) previous	HLW ratio	LAW ratio	Δ $ (thousands)	
vaults	225,000		$\frac{124}{40} = 3.10$ $\frac{94}{40} = 2.48$	~~472,500~~	333,000
canisters	66,200	$\frac{44500}{6800} = 6.54$	— $\frac{18900}{6800} = 2.78$	~~—,230~~	121,396
containers	42,625	6.54	— 2.78	~~236,140~~	
casks	102,300	6.54	— 2.78	~~566,740~~	304,24
pads	26,000	6.54	— 2.78	~~144,040~~	

total Δ other op costs ~~$1,197,250~~ 758,64

FORM 91-005-1 (4/81)

JACOBS ENGINEERING GROUP INC.

DATE ~~2/15/96~~ 7/12/96 rev. SUBJECT

BY DLS CHKD.

SHEET NO. 6- ~~8~~ 9

JOB NO.

Δ labor costs

new HLW hrs = (1.1E+07) × $\frac{17}{14}$ = 1.34E+07

new LAW hrs = (1.1E+07) × $\frac{24}{14}$ = 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~~

$522,500,000

Δ Summary on op. costs

Δ HLW	~~$225,632,000~~	115,693
Δ LAW	~~342,977,000~~	240,822
Δ other	~~1,797,250,000~~	758,642
Δ labor	~~649,000,000~~	522,500,000
Δ total	~~$3,014,859,000~~	202,500,000
previous op. cost	3,900,000,000	3,900,000,000
new op. cost	$6,914,859,000	$5,743,157,000

LAW canisters

repository fee for ~~44,500~~ 18,900 canisters = ~~$7.8 billion~~ $7.190

LAW canisters

$\frac{99}{66}$ × 135,000,000 = $202,500,000

low loading op cost for treatment

FORM 91-005-1 (4/81)

JACOBS ENGINEERING GROUP INC.

DATE ~~2/13/96~~ 7/12/96 SUBJECT rev

BY DLS CHKD. _____

SHEET NO. 7 - 9

JOB NO. _____

Intermediate Separations
High Bounding Case

HLW @ 40%, ~~1.5~~ 1.2 blend
LAW @ 25%, ~~1.25~~ 1.0 blend

High Bounding Case HLW glass – 40%, ~~1.5~~ 1.2 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 prod, total pre, formers pre)
2.72E +04 MT glass product

ratio glass formers: $\frac{.6 \times 1.57}{1.36} = .69$ ~~$\frac{1.57}{1.36} = 1.15$~~

ratio glass product: $\frac{.69 \times 2.72}{2.51} = .75$ ~~$\frac{2.72}{2.51} = 1.08$~~

High Bounding Case LAW glass – 25%, ~~1.25~~ 1.0 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: $\frac{.77 \times 3.78}{2.81} = 1.04$ ~~$\frac{3.78}{2.81} = 1.35$~~

ratio glass product: $\frac{.80 \times 4.84}{3.87} = 1.00$ ~~$\frac{4.84}{3.87} = 1.25$~~

FORM 91-005-1 (4/81)

JACOBS ENGINEERING GROUP INC.

DATE ~~2/23/96~~ 7/12/96 rev. SUBJECT

BY DCS CHKD. _____

SHEET NO. 8-~~10~~9

JOB NO. _____

Δ cost for glass formers

HLW category	$ (Thousand) previous	ratio used	$ (Thousands) Δ	
SiO_2	452	~~1.15~~ .69	~~68~~	−1458
B_2O_3	1,750	~~1.15~~ .69	~~262~~	
Li_2O	2,500	~~1.15~~ .69	~~375~~	
electricity	110,700	~~1.08~~ .75	~~8856~~	−27,675

7 yrs operation — total HLW Δ $ ~~9,561~~ −29,133

LAW

SiO_2	9,160	~~1.35~~		~~3206~~	+723
Al_2O_3	6,600	~~1.35~~	1.04	~~2310~~	
CaO	2,322	~~1.35~~		~~813~~	
other electricity	159,300 × 1/2	~~1.25~~		~~19913~~	+0
Kerosene	8,670	~~1.25~~	1.00	~~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~~ +723

Δ other Op. Costs

	$ previous (thou)	HLW ratio	LAW ratio	$ (Thousands) Δ	
vaults	225,000	—	$\frac{50}{40}=1.25$ $\frac{40}{40}=1$	~~56,250~~	0
Canisters	68,200	$\frac{16,700}{6600}=2.46$	— $\frac{7080}{6800}=1.04$	~~99,572~~	
Containers	42,625	2.46	— 1.04	~~62,232~~	956
Casks	102,300	2.46	— 1.04	~~149,358~~	
pots	26,000	2.46	— 1.04	~~37,960~~	

total Δ other $ ~~405,372~~ +956

FORM 91-005-1 (4/81)

JACOBS ENGINEERING GROUP INC.

DATE ~~2/23/96~~ 7/12/96 rev. SUBJECT

SHEET NO. 9 - ~~10~~ 9

JOB NO.

BY DLL CHKD.

Δ labor cost

new HLW hrs = $(1.1E+07) \times \frac{\cancel{7}\,6}{14} = 0.\cancel{55}\,.47\,E+7$

new LAW hrs = $(1.1E+07) \times \frac{\cancel{7}\,9}{14} = \underline{0.\cancel{86}\,.71\,E+7}$

$1.\cancel{4}\,1.18\,1.41\,E+7$ vs $2.2E+7$

Δ labor cost = $(\cancel{1.41}\,1.18\,E+7) - (2.2E+7) \times \$55/hr$

Δ labor costs = $-\$\cancel{434,500,000}$

$-561,000,000$

Δ Summary on op. costs

Δ HLW	$ ~~9,561,000~~	$-29,133,000$
Δ LAW	~~40,413,000~~	$+723,000$
Δ other	~~405,372,000~~	$+9,565,000$
Δ labor	~~-434,500,000~~	$-561,000,000$
Δ total	$ ~~20,843,000~~ LAW contain	$+81,818,000$
previous op. cost	$ 3,900,000,010	$+3,900,000,000$
new op. cost	$ ~~3,920,843,000~~	$3,401,973

repository fee for ~~11,700~~ canisters = $ ~~5 billion~~ $2,967

7080

LAW contains

$\frac{40}{66} \times 135,000,000 = \$81,818,182$

high level op. cost for now

FORM 91-005-1 (4/81)

JACOBS ENGINEERING GROUP INC.

DATE 7/12/96 SUBJECT SHEET NO. 1-1

BY DLS CHKD. JOB NO.

Ex Situ / In Situ Combos

preliminary FEIS (PFEIS)

Category	Inter Sep.	Combo 1	(% of Inter)	Combo 2	(% of Inter)
vaults (LAW)	66	40	(61%)	24	(36%)
canisters (HLW)	12,200	8,540	(70%)	4,940	(40%)
op. costs	$4,548 million				
LAW	200 T/D	120 T/D		70 T/D	
HLW	20 T/D	8 T/D		5 T/D	
yr. op incl. startup	11 HLW / 17 LAW	13 HLW / 17 LAW		18 HLW / 17 LAW	

avg 46%

avg 30

if we assume about same manpower to operate each facility then Δ labor for op. yrs & factor other op. costs based on above percentages

Δ labor for combo 1 $\left[\frac{13}{11}(1.1E+07) - (1.1E+07)\right] \times \$55/hr = \$110{,}000$ million

Δ labor for combo 2 $\left[\frac{18}{11}(1.1E+07) - (1.1E+07)\right] \times \$55/hr = \$385{,}000$ million

Total op. costs

ΔHLW	58,475	.7(58,475)	.4(58,475)
ΔLAW	119,537	.61(119,537)	.36(119,537)
Δ other	335,159	.66(335,159)	.38(335,159)
LAW containers	135,000	.61(135,000)	.36(135,000)
Δ labor	—	110,000	385,000
prev. op cost	3,900,000	.66(3,900,000)	.38(3,900,000)
total op. cost	$4,548 million inter. sep.	$3,101 million combo 1	$2,109 million combo 2

JACOBS ENGINEERING GROUP INC.

DATE 7/12/96 SUBJECT SHEET NO. 1-2

BY DLS CHKD. JOB NO.

Phased Implementation

preliminary FEIS (PFEIS)

for phase 1 (which has not changed), keep op. costs for treatment the same at $1,500 million. Add $20 million for WR+T operating which was neglected previously.

Assign all extra op. costs due to changes in canister size, # canisters, containers, casks, vaults, extra glass, electricity, kerosene, etc to phase 2. Δ op. cost will therefore be about the same as inter. separations, except extra labor will have to be added to account for 2 plants now operating in phase 2.

Phase 2 - Δ Labor Estimate

per WHC data pkg for Inter. Sep - labor for LAW plant is 1.1E+07 hrs at $55/hr for 14 yrs operation but phase 2 LAW to operate 13 yrs. Therefore labor Δ will be ~ 1.1E+07 hrs × $\frac{13}{14}$ × $55/hr = $560,000,000

Phase 2 op. costs

Δ labor costs	$560,000,000
inter Sep op. costs	$4,548,000,000
	$5,108,000,000

or $5,108 million phase 2

FORM 91-005-1 (4/81)

JACOBS ENGINEERING GROUP INC.

DATE 7/12/96 SUBJECT SHEET NO. 2-2

BY DLS CHKD. JOB NO.

Phased Implementation Summary

	Phase 1	Phase 2	Total
Current Op.	4900	3700	8600
R&D	0	190	190
Capital			
WR&T	—	2280	2280
Treatment	1328	3972	5300
Closure	41	170	211
total	1369	6422	7791
Operating			
WR&T	20	3990	4010
Treatment	1500	5108	6608
total	1520	9098	10618
Repository fee	—	5280	5280
Total Cost	7789	24690	32479

AR
1.7.2

TWRS EIS
CALCULATION COVER SHEET

DISCIPLINE & TITLE Socioeconomics - School Enrollment Increases resulting from TWRS Alternatives 4/12/96

ORIGINATOR A. Bachrach DATE ~~10/5/95~~

REVISION NO. ~~2~~ 3

OBJECTIVE Estimate increased enrollment in major Tri-Cities School District (Richland, Kennewick, Pasco, Kiona-Benton) in peak year of TWRS alternative impact

METHODOLOGY 1) Estimate % of population increase that is school age (use 1994 Population + School District Enrollment data as basis) 2) Allocate Peak Year Growth in Enrollment for each Alternative to each District based on 1994 share of Total Enrollment of all 4 Districts.

ASSUMPTIONS

1) Ratio of School Enrollment to Population will remain same as 1994

2) Ratio of each District's share of Tri-Cities enrollment total will remain the same as 1994)

(Continue on another sheet if necessary)

Anni Bachrach
SIGNATURE

CALCULATION & RESULTS ATTACHED

JACOBS\FORMS\CALCVR.SHT

JACOBS ENGINEERING GROUP INC.

DATE _____ SUBJECT _____ SHEET NO. 10/5/95 (1)

BY _____ CHKD. _____ JOB NO. _____

SCHOOL ENROLLMENT IMPACTS

(% of Peak Year Population Growth Allocated to Primary Tri-Cities School Districts)

1) % of Total Population Growth Enrolled in School)

$$\frac{\text{1994 School District Population}}{\text{1994 Community Population}}$$

Pasco	Kennewick	Richland	Tri-Cities Average
7,700 / 22,170	13,125 / 46,960	8686 / 35,430	25,581 / 104,560

TRI-CITIES AVERAGE = 28.3% of Population enrolled in K-12

2) Allocation of Peak Year Population Growth is by Each District's Percentage of 1994 Total of All Relevant Districts

Kennewick	Richland	Pasco	Kiona-Benton
$\frac{13,125}{31,105} = 42.2\%$	$\frac{8,686}{31,105} = 27.9\%$	$\frac{7,770}{31,105} = 25.0\%$	$\frac{1,524}{31,105} = 4.9\%$

FORM 91-005-1 (4/81)

JACOBS ENGINEERING GROUP INC.

DATE _____ SUBJECT _____ SHEET NO. 2

BY _____ CHKD. _____ JOB NO. _____

Alternative/ (Peak Year)	Peak Population △ / Peak Total School Pop. △	Kennewick	Richland	Pasco	Kiona-Benton
No Action (2025)	2350 / 6700	280	190	170	30
Long-Term Management (2035)	3200 / 9000	380	250	230	40
In Situ Filled Cap (2001)	460 / 1300	60	40	30	10
In Situ Vitrification (2001)	6350 / 1800	760	500	450	90
Ex Situ Intermediate Vitrification (2002)	9900 / 2800	1200	780	700	140
Ex Situ Extensive Separations (2004)	17,800 / 5050	2100	1400	1300	250
Ex Situ No Separations (2000)	11700 / 3350	1400	920	830	160
Ex Situ/In Situ Combination (2000)	6000 / 1700	720	470	430	80
Phased Implementation (Phase 1 only) (1994)	8600 / 2400	1030	680	610	120
*Totals Rounded to 2 Significant Digits					
Phased Implementation (Total) (2011)	16,100 / 4,600	1940	1280	1200	230

FORM 71-005-1 (4/81)

A.K
1.7.2

TWRS EIS
CALCULATION COVER SHEET

DISCIPLINE & TITLE Natural Resources. Transportation (Vehicular Traffic Impacts)

ORIGINATOR A. Bachrach DATE ~~11/10/95~~ 7/12/96

REVISION NO. ~~3~~ 4

OBJECTIVE Estimate Impact of Vehicular Traffic Associated with TWRS alternatives on Baseline Traffic Conditions in Alternative Peak Year. Roadways are Stevens Rd at 1100 Area and Route 4 West of Wye Barricade.

METHODOLOGY 1) Estimate Future Baseline Traffic Volumes. 2) Estimate Peak Year Traffic Volume for each TWRS alternative and Sum 1)+2). Use Sum to evaluate level of traffic congestion

ASSUMPTIONS (attached)

(Continue on another sheet if necessary)

Carmi Bachrach
SIGNATURE

CALCULATION & RESULTS ATTACHED

JACOBS\FORMS\CALCVR.SHT

JACOBS ENGINEERING GROUP INC.

DATE _____ SUBJECT TRAFFIC IMPACTS ASSUMPTIONS SHEET NO. 1

BY _____ CHKD. _____ JOB NO. _____

1) Future Baseline Traffic Volume (Average Daily Traffic or ADT) and Future Baseline AM Peak Hour volume will follow historical patterns. Ratio of Total Site Employment to ADT on Stevens Rd. at 1100 Area is 1.725 (Benton Franklin Regional Commission 1993). Ratio of Total Site Employment to ADT on Route 4 West of Wye Barricade is .50 (WHC 1994) Above values used for all alternatives.

2) Use of alternate routes to 200 Areas (versus. Stevens Road and Route 4) based on Benton Franklin Regional Commission SR 240 Corridor Study of 1993). 11% of Site employees commute from Benton City/Yakima (West) and would use SR 24 and Route 11A. 6% of Site employees commute from West Richland and would use Route 10. 700 Vehicles would use State Route 240/240 Access Road. Above values used for all alternatives.

3) TWRS Peak Year employment obtained from Jacobs 1995 and are same values used in Economic Impact analysis

4) All TWRS Construction employment would work M-F day shift and would all be in peak hour.

FORM 91-005-1 (4/81)

JACOBS ENGINEERING GROUP INC.

DATE _____ SUBJECT _____ SHEET NO. 2

BY _____ CHKD. _____ JOB NO. _____

5) TWRS Operations phase employment would include some workers not working M-F, day shift because of 7 day operating work schedule. 50% of non-exempt workers only assumed to work M-F day shift. All

6) exempt employees would work M-F day shift.

7) Per WHC Site planning factor, TWRS employees would have 1.35 person/vehicle to account for carpools and vanpools. (1/1.35 = .74 Factor). Value used for all TWRS alternatives.

FORM 91-005-1 (4/81)

JACOBS ENGINEERING GROUP INC.

DATE _____ SUBJECT _____ SHEET NO. 3

BY _____ CHKD. _____ JOB NO. _____

Peak Year Employment (M-F Day Shift)

Alternative	# of Total Employees	M-F day	Year
No Action	760 (Routine Ops. only)	760	2001
Long-Term Mgmt.	760 (Routine Ops. only)	760	2001
[No analysis of impacts in 2030's during retaining. Analysis of Traffic Impacts 40 years in future of no value]			
In Situ Fill + Cap	<150	(No analysis)	
In Situ Vitrification	2600	2600	2004
Ex Situ Intermediate Separations	4100	4000	2001
Ex Situ No Separations	4400	4100	2000
Ex Situ Extensive Separations	7000	6700	2003
Ex Situ/In Situ Combination	2500	2400	2001
Phased Implementation (Phase I)	3300	3300	1999
Capsules (all alts.)	<100	(No Analysis)	

FORM 91-005-1 (4/61)

JACOBS ENGINEERING GROUP INC.

DATE _____ SUBJECT _____ SHEET NO. 4

BY _____ CHKD. _____ JOB NO. _____

Stevens Road Future Baseline Volumes

1992 ADT = 28,231 Site Employment (1992) = 16,364
1992 Peak Hour 3,362

Employment: ADT = 1.725

Peak Hour: ADT = .119 (11.9%)

	Site Employment	ADT	Peak Hour
1999	14,758	25,460	3030 (3000)
2000	14,580	25,150	2990 (3000)
2001	14,366	24,780	2949 (2900)
2002	13,976	24,110	2870 (2900)
2003	13,527	23,330	2780 (2800)
2004	13,120	22,630	2690 (2700)
2010	10,182	17,560	2090 (2100)

FORM 91-005-1 (4/81)

JACOBS ENGINEERING GROUP INC.

DATE _____ SUBJECT _____ SHEET NO. 5

BY _____ CHKD. _____ JOB NO. _____

Route 4 Future Baseline

ADT 1994 (July) = 9201 Site Employment - 18,436 = (50%)

AM Peak Hour ~~2389~~ 1994 (July) 2389 Employment: ADT = 50%

ADT/Peak Hour Ratio = 26%

	Site Employ.	Route 4 ADT	Route 4 Peak Hour
1999 =	14,758 X .5 =	7380 X .26	1920 (1900)
2000 =	14,580 X "	7290 X "	1890 (1900)
2001 =	14,366 X "	7180 X "	1860 (1900)
2002 =	13,976 X "	6990 X "	1820 (1800)
2003 =	13,527 X "	6760 X "	1760 (1800)
2004 =	12,795 X "	6400 X "	1660 (1700)
2010 =	10182 X .5	5190 X .26	1329 (1300)

FORM 91-005-1 (4/81)

JACOBS ENGINEERING GROUP INC.

DATE _____ SUBJECT _____ SHEET NO. 6

BY _____ CHKD. _____ JOB NO. _____

No Action + Long Term Management (2001 – all employment is Routine Tank Farm Operations)

Stevens Road at 1100 Area

Baseline ADT = 24,780

Baseline AM Peak = 2900

TWRS Employment = 760 X .741 (Occupancy Factor) = 560

- 280 Vehicles (50%) use SR 240/240 Access Road
- 62 Vehicles (11%) use Route 11A (West – Benton City)
- 34 vehicles (6%) use Route 10 (West Richland)

-376 (380) use alternates

-AM Peak Hour Volume = 2900 (Baseline) + 180 (TWRS) = (3100)

Route 4 West of Wye Barricade

Baseline ADT = 7380

Baseline AM Peak = 1920

TWRS Volum = 180 (-50% using alternate: Rt 2/11A) = 90

AM Peak Hour Volume = 1920 + 90 = 2010 (2000)

FORM 91-005-1 (4/81)

JACOBS ENGINEERING GROUP INC.

DATE _____ SUBJECT _____ SHEET NO. 7

BY _____ CHKD. _____ JOB NO. _____

In Situ Vitrification (Peak Year = 2004)

Stevens Rd. at 1100 Area

Baseline ADT = 22,630

Baseline AM Peak = 2700

TWRS Employees = 2600 X .74 (Occupancy Factor) = 1920

- 700 vehicles using SR 240/240 Access
- 210 vehicles (11%) using Route 11A (Benton City)
- 120 vehicles (6%) using Route 10 (West Richland)

-1030 vehicles using alternates

AM Peak Hour Volume = 2700 (Baseline) + 900 (TWRS) = 3600

Route 4 ~~patt~~ Wye Barricade

Baseline ADT = 6,400

Baseline AM Peak = 1660

TWRS Volume = 900 - 500 vehicles using Rt 2/11A = ~~500~~ 400

AM Peak Hour Volume = 1,660 (Baseline) + ~~900~~ (TWRS) = ~~2060~~ (2100)

FORM 91-005-1 (4/81)

JACOBS ENGINEERING GROUP INC.

DATE _____ SUBJECT _____ SHEET NO. 8

BY _____ CHKD. _____ JOB NO. _____

Ex Situ Intermediate Separations (Peak Year = 2001)

Stevens Road at 1100 Area

Baseline ADT = 24,780

Baseline AM Peak = 2900

TWRS Employees = 4000 X .74 (Occupancy Factor) = 2960

- 700 Vehicles using SR 240/240 Access Road
- 330 vehicles using Route 11A
- 180 vehicles using Route 10
- 1210 using alternates

AM Peak Hour Volume = 2900 (Baseline) + 1750 (TWRS) = 4650 (4700)

Route 4 West of Wye Barricade

Baseline ADT = 7180

Baseline AM Peak = 1860

TWRS Volume = 1750 - 500 using Rt 2/11A alternate = 1250

AM Peak Hour Volume = 1860 (Baseline) + 1250 (TWRS) = 3110 (3100)

(20% trucks)

FORM 91-005-1 (4/81)

JACOBS ENGINEERING GROUP INC.

DATE _____ SUBJECT _____ SHEET NO. 9

BY _____ CHKD. _____ JOB NO. _____

Ex Situ No Separations (Peak Year = 2000)

Stevens Road

Baseline ADT = 25,150

Baseline AM Peak = 3000

TWRS Employment = 4100 X .74 (Occupancy Factor) = 3030

- 700 Vehicles using SR 240/240 Access Road
- 330 vehicles using Route 11A
- 180 vehicles using Route 10

1210 using alternates

AM Peak Hour = 3000 (Baseline) + 1800 (TWRS) = 4,800

Route 4

Baseline ADT = 7290

Baseline AM Peak = 1890

TWRS Volume = 1800 − 500 vehicles using Route 2/11A) = 1300

AM Peak Hour Volume = 1890 (~~+ 1300~~ Baseline) + 1300 (TWRS) = 3200

FORM 91-005-1 (4/81)

JACOBS ENGINEERING GROUP INC.

DATE _____ SUBJECT _____ SHEET NO. 10

BY _____ CHKD. _____ JOB NO. _____

Ex Situ Extensive Separations (Peak Year = 2003)

Stevens Road

Baseline ADT = 23,330

Baseline AM Peak = 2800

TWRS Employment = 6700 X .74 (Occupancy Factor) = 4960

- 700 Vehicles using SR 240/240 Access Rd.
- 550 Vehicles using Rt. 11A
- 300 Vehicles using Rt. 10

1550 vehicles using alternate

AM Peak Hour Volume = 2800 (Baseline) + 3400 (TWRS) = 6200

Route 4

Baseline ADT = 6760

AM Peak Hour = 1760

TWRS Volume = 3400 - 500 using Rt. 2/11A alternate

AM Peak Hour Volume = 1760 (Baseline) + 2900 (TWRS) = 4700

FORM 1-005-1 (4/81)

JACOBS ENGINEERING GROUP INC.

DATE _____ SUBJECT _____ SHEET NO. 11

BY _____ CHKD. _____ JOB NO. _____

Ex Situ / In Situ Combination (1) (Peak Year = 2001)

Stevens Road

Baseline ADT = 24,780

Baseline AM Peak = 2900

TWRS Employment = 2400 X .74 (Occupancy Factor) = 1780

- 700 vehicles using SR/240/240 Access
- 200 vehicles using Route 11A
- 110 vehicles using Route 10

1010 vehicles using alternates

AM Peak Hour Volume = 2900 (Baseline) + 770 (TWRS) = 3670 (3700)

Route 4

Baseline ADT = 7180

Baseline AM Peak = 1860

TWRS Volume = 770 - 400 using Rt. 2/11A alternate = 370

AM Peak Hour Volume = 1860 (Baseline) + 370 (TWRS) = 2230 (2200)

FORM 91-005-1 (4/81)

Phased Implementation (Phase 1) Peak Year = ~~2000~~ 1999

Stevens Rd

Baseline ADT = 25,460

Baseline AM Peak = 3000

TWRS Employment = 3300 X .74 (Occupancy Factor) = 2440

- 700 vehicles using SR 240/240 Access Rd.
- 270 vehicles using Route 11A
- 150 vehicles using Route 10
- 1120 vehicles using alternates

AM Peak Hour Volume = 3000 (Baseline) + 1300 (TWRS) = 4300

Route 4

Baseline ADT = 7380

Baseline AM Peak = 1920

TWRS Volume = 1300 - 500 using Rt. 2/11A alternate = 800

AM Peak Hour Volume = 1920 + 800 = 2720 (2700)

Revision 7/10/96

Phased Implementation (Total Alternative)

Stevens Road at 1100 Area (Peak Year = 2010)

Baseline Employment = 10,182

Baseline ADT = 17,560. Baseline AM Peak = 2100

TWRS Employment = ~~6,600~~ 6,700 X .74 Occupancy Factor = ~~4,884~~ 4,958 (~~5,000~~)

- 700 Vehicles using SR 240/240 Access Road
- 540 Vehicles (11%) using Route 11A (West - Benton City)
- 300 Vehicles (6%) using Route 10 (West Richland)

1540 (1500) Vehicles use alternates

AM Peak Hour Volume = 2,100 (Baseline) + 3,500 (TWRS) = 5,600

8' Route 4 West of Wye Barricade

Baseline ADT = 5190 Baseline AM Peak = 1,300

TWRS Volume = 3,400 - 500 using Rt 2/11A alternate = 2,900

AM Peak Hour Volume = 1,300 + 2,900 = 4,200

Ex Situ / In Situ Combination 2 (Peak Year = 2001)

Stevens Road at 1100 Area

Baseline ADT = 24,780

Baseline AM Peak = 2900

TWRS Employees = 2800 X .74 (Occupancy Factor) = 2100

- 700 Vehicles using SR240/240 Access Road
- 330 Vehicles (11%) using Route 11A (West – Benton City)
- 130 Vehicles (6%) using Route 10 (West Richland)

1060 (1100) Vehicles use alternates

AM Peak Hour Volume = 2,900 (Baseline) + 1000 (TWRS) = 3900

Route 4 West of Wye Barricade

Baseline ADT = 7,180

Baseline AM Peak = 1,860

TWRS Volume = 1000 - 500 using Rt 2/11A Alternate = 500

AM Peak Hour Volume = 1,860 + 500 = 2300

The probability for the seismic event was based upon WHC-SD-W364-TI-002 Rev 1 (WHC-1996)

TWRS EIS
CALCULATION COVER SHEET

DISCIPLINE & TITLE Safety: Latent cancer fatality point-estimate risks resulting from radiological accidents. Includes bounding and nominal scenarios.

ORIGINATOR Michael Harkov DATE 7-28-96

REVISION NO. ~~0~~

OBJECTIVE Show LCF point-estimate risk resulting from radiological accidents evaluated in the TWRS EIS

METHODOLOGY See attachments

~~Doses,~~

ASSUMPTIONS Doses, are based on WHC data package WHC-SD-WM-ANAL-041 Rev 0. Probability for hydrogen deflagration was based on LANL 1995-LA-UR-95-1800. All other probabilities were based on WHC data package WHC-SD-WM-ANAL-041 Rev 0.

(Continue on another sheet if necessary)

SIGNATURE/DATE

Loretta Cion 8/28

CHECKED/DATE

CALCULATION & RESULTS
ATTACHED

JACOBS\FORMS\CALCVR.SHT

NO ACTION ALTERNATIVE

Table E.2.2.3 Latent Cancer Fatality Risk from Mispositioned Jumper

Receptor	Dose pers - rem	LCF/rem	LCF	Probability	LCF Risk point-est	
Nominal Scenario						
MEI Worker	5.88E+01	8.00E-04	4.70E-02	1.10E-01	5.17E-03	
Workers	5.88E+02	8.00E-04	4.70E-01	1.10E-01	5.17E-02	
MEI noninvolved worker	1.92E+01	4.00E-04	7.68E-03	1.10E-01	8.45E-04	
Noninvolved workers	7.23E+02	4.00E-04	2.89E-01	1.10E-01	3.18E-02	
MEI general public	8.44E-02	5.00E-04	4.22E-05	1.10E-01	4.64E-06	
General public	1.77E+02	5.00E-04	8.85E-02	1.10E-01	9.74E-03	9.33E-02
Bounding Scenario						
MEI Worker	1.33E+03	lethal	1.00E+00	1.10E-01	1.10E-01	
Workers	1.33E+04	lethal	1.00E+01	1.10E-01	1.10E+00	
MEI noninvolved worker	4.35E+02	lethal	1.00E+00	1.10E-01	1.10E-01	
Noninvolved workers	1.64E+04	4.00E-04	6.56E+00	1.10E-01	7.22E-01	
MEI general public	1.91E+00	5.00E-04	9.55E-04	1.10E-01	1.05E-04	
General public	4.01E+03	5.00E-04	2.01E+00	1.10E-01	2.21E-01	2.04E+00

Table E.2.2.9 Latent Cancer Fatality Risk from Hydrogen Deflagration in Waste Storage Tank

Receptor	Dose pers - rem	LCF/rem	LCF	Probability	LCF Risk point-est	
Nominal Scenario						
MEI Worker	3.91E+01	8.00E-04	3.13E-02	7.20E-01	2.25E-02	
Workers	3.91E+02	8.00E-04	3.13E-01	7.20E-01	2.25E-01	
MEI noninvolved worker	9.40E+00	4.00E-04	3.76E-03	7.20E-01	2.71E-03	
Noninvolved workers	1.32E+02	4.00E-04	5.28E-02	7.20E-01	3.80E-02	
MEI general public	2.28E-02	5.00E-04	1.14E-05	7.20E-01	8.21E-06	
General public	1.99E+01	5.00E-04	9.95E-03	7.20E-01	7.16E-03	2.70E-01
Bounding Scenario						
MEI Worker	7.31E+03	lethal	1.00E+00	7.20E-01	7.20E-01	
Workers	7.31E+04	lethal	1.00E+01	7.20E-01	7.20E+00	
MEI noninvolved worker	1.76E+03	lethal	1.00E+00	7.20E-01	7.20E-01	
Noninvolved workers	2.47E+04	4.00E-04	9.88E+00	7.20E-01	7.11E+00	
MEI general public	4.26E+00	5.00E-04	2.13E-03	7.20E-01	1.53E-03	
General public	3.72E+03	5.00E-04	1.86E+00	7.20E-01	1.34E+00	1.57E+01

Table E.2.2.15 Latent Cancer Fatality Risk from Seismic Event

Receptor	Dose pers - rem	LCF/rem	LCF	Probability	LCF Risk point-est	
Nominal Scenario						
MEI Worker	1.21E+02	8.00E-04	9.68E-02	1.40E-02	1.36E-03	
Workers	1.21E+03	8.00E-04	9.68E-01	1.40E-02	1.36E-02	
MEI noninvolved worker	2.90E+01	8.00E-04	2.32E-02	1.40E-02	3.25E-04	
Noninvolved workers	4.07E+02	4.00E-04	1.63E-01	1.40E-02	2.28E-03	
MEI general public	7.03E-02	5.00E-04	3.52E-05	1.40E-02	4.92E-07	
General public	6.14E+01	5.00E-04	3.07E-02	1.40E-02	4.30E-04	1.63E-02
Bounding Scenario						
MEI Worker	8.04E+03	lethal	1.00E+00	1.40E-02	1.40E-02	
Workers	8.04E+04	lethal	1.00E+01	1.40E-02	1.40E-01	
MEI noninvolved worker	1.93E+03	lethal	1.00E+00	1.40E-02	1.40E-02	
Noninvolved workers	2.71E+04	4.00E-04	1.08E+01	1.40E-02	1.52E-01	
MEI general public	4.68E+00	5.00E-04	2.34E-03	1.40E-02	3.28E-05	
General public	4.09E+03	5.00E-04	2.05E+00	1.40E-02	2.86E-02	
						3.20E-01

LONG TERM MANAGEMENT ALTERNATIVE

Table E.3.3.2 Latent Cancer Fatality Risk from Mispositioned Jumper

Receptor	Dose pers - rem	LCF/rem	LCF	Probability	LCF Risk point-est	
Nominal Scenario						
MEI Worker	5.88E+01	8.00E-04	4.70E-02	2.20E-01	1.03E-02	
Workers	5.88E+02	8.00E-04	4.70E-01	2.20E-01	1.03E-01	
MEI noninvolved worker	1.92E+01	4.00E-04	7.68E-03	2.20E-01	1.69E-03	
Noninvolved workers	7.23E+02	4.00E-04	2.89E-01	2.20E-01	6.36E-02	
MEI general public	8.44E-02	5.00E-04	4.22E-05	2.20E-01	9.28E-06	
General public	1.77E+02	5.00E-04	8.85E-02	2.20E-01	1.95E-02	1.87E-01
Bounding Scenario						
MEI Worker	1.33E+03	lethal	1.00E+00	2.20E-01	2.20E-01	
Workers	1.33E+04	lethal	1.00E+01	2.20E-01	2.20E+00	
MEI noninvolved worker	4.35E+02	lethal	1.00E+00	2.20E-01	2.20E-01	
Noninvolved workers	1.64E+04	4.00E-04	6.56E+00	2.20E-01	1.44E+00	
MEI general public	1.91E+00	5.00E-04	9.55E-04	2.20E-01	2.10E-04	
General public	4.01E+03	5.00E-04	2.01E+00	2.20E-01	4.41E-01	4.08E+00

Table E.3.3.4 Latent Cancer Fatality Risk from Hydrogen Deflagration in Waste Storage Tank

Receptor	Dose pers - rem	LCF/rem	LCF	Probability	LCF Risk point-est	
Nominal Scenario						
MEI Worker	3.91E+01	8.00E-04	3.13E-02	7.20E-01	2.25E-02	
Workers	3.91E+02	8.00E-04	3.13E-01	7.20E-01	2.25E-01	
MEI noninvolved worker	9.40E+00	4.00E-04	3.76E-03	7.20E-01	2.71E-03	
Noninvolved workers	1.32E+02	4.00E-04	5.28E-02	7.20E-01	3.80E-02	
MEI general public	2.28E-02	5.00E-04	1.14E-05	7.20E-01	8.21E-06	
General public	1.99E+01	5.00E-04	9.95E-03	7.20E-01	7.16E-03	2.70E-01
Bounding Scenario						
MEI Worker	7.31E+03	lethal	1.00E+00	7.20E-01	7.20E-01	
Workers	7.31E+04	lethal	1.00E+01	7.20E-01	7.20E+00	
MEI noninvolved worker	1.76E+03	lethal	1.00E+00	7.20E-01	7.20E-01	
Noninvolved workers	2.47E+04	4.00E-04	9.88E+00	7.20E-01	7.11E+00	
MEI general public	4.26E+00	5.00E-04	2.13E-03	7.20E-01	1.53E-03	
General public	3.72E+03	5.00E-04	1.86E+00	7.20E-01	1.34E+00	1.57E+01

Table E.3.3.6 Latent Cancer Fatality Risk from Seismic Event

Receptor	Dose pers - rem	LCF/rem	LCF	Probability	LCF Risk point-est	
Nominal Scenario						
MEI Worker	1.21E+02	8.00E-04	9.68E-02	1.40E-02	1.36E-03	
Workers	1.21E+03	8.00E-04	9.68E-01	1.40E-02	1.36E-02	
MEI noninvolved worker	2.90E+01	8.00E-04	2.32E-02	1.40E-02	3.25E-04	
Noninvolved workers	4.07E+02	4.00E-04	1.63E-01	1.40E-02	2.28E-03	
MEI general public	7.03E-02	5.00E-04	3.52E-05	1.40E-02	4.92E-07	
General public	6.14E+01	5.00E-04	3.07E-02	1.40E-02	4.30E-04	1.63E-02
Bounding Scenario						
MEI Worker	8.04E+03	lethal	1.00E+00	1.40E-02	1.40E-02	
Workers	8.04E+04	lethal	1.00E+01	1.40E-02	1.40E-01	
MEI noninvolved worker	1.93E+03	lethal	1.00E+00	1.40E-02	1.40E-02	
Noninvolved workers	2.71E+04	4.00E-04	1.08E+01	1.40E-02	1.52E-01	
MEI general public	4.68E+00	5.00E-04	2.34E-03	1.40E-02	3.28E-05	
General public	4.09E+03	5.00E-04	2.05E+00	1.40E-02	2.86E-02	3.20E-01

FILL AND CAP ALTERNATIVE

Table E.4.3.3 Latent Cancer Fatality Risk from Mispositioned Jumper

Receptor	Dose pers - rem	LCF/rem	LCF	Probability	LCF Risk point-est	
Nominal Scenario						
MEI Worker	5.88E+01	8.00E-04	4.70E-02	1.32E-01	6.21E-03	
Workers	5.88E+02	8.00E-04	4.70E-01	1.32E-01	6.21E-02	
MEI noninvolved worker	1.92E+01	4.00E-04	7.68E-03	1.32E-01	1.01E-03	
Noninvolved workers	7.23E+02	4.00E-04	2.89E-01	1.32E-01	3.82E-02	
MEI general public	8.44E-02	5.00E-04	4.22E-05	1.32E-01	5.57E-06	
General public	1.77E+02	5.00E-04	8.85E-02	1.32E-01	1.17E-02	1.12E-01
Bounding Scenario						
MEI Worker	1.33E+03	lethal	1.00E+00	1.32E-01	1.32E-01	
Workers	1.33E+04	lethal	1.00E+01	1.32E-01	1.32E+00	
MEI noninvolved worker	4.35E+02	lethal	1.00E+00	1.32E-01	1.32E-01	
Noninvolved workers	1.64E+04	4.00E-04	6.56E+00	1.32E-01	8.66E-01	
MEI general public	1.91E+00	5.00E-04	9.55E-04	1.32E-01	1.26E-04	
General public	4.01E+03	5.00E-04	2.01E+00	1.32E-01	2.65E-01	2.45E+00

Table E.4.3.5 Latent Cancer Fatality Risk from Hydrogen Deflagration in Waste Storage Tank

Receptor	Dose pers - rem	LCF/rem	LCF	Probability	LCF Risk point-est	
Nominal Scenario						
MEI Worker	3.91E+01	8.00E-04	3.13E-02	8.64E-02	2.70E-03	
Workers	3.91E+02	8.00E-04	3.13E-01	8.64E-02	2.70E-02	
MEI noninvolved worker	9.40E+00	4.00E-04	3.76E-03	8.64E-02	3.25E-04	
Noninvolved workers	1.32E+02	4.00E-04	5.28E-02	8.64E-02	4.56E-03	
MEI general public	2.28E-02	5.00E-04	1.14E-05	8.64E-02	9.85E-07	
General public	1.99E+01	5.00E-04	9.95E-03	8.64E-02	8.60E-04	3.24E-02
Bounding Scenario						
MEI Worker	7.31E+03	lethal	1.00E+00	8.64E-02	8.64E-02	
Workers	7.31E+04	lethal	1.00E+01	8.64E-02	8.64E-01	
MEI noninvolved worker	1.76E+03	lethal	1.00E+00	8.64E-02	8.64E-02	
Noninvolved workers	2.47E+04	4.00E-04	9.88E+00	8.64E-02	8.54E-01	
MEI general public	4.26E+00	5.00E-04	2.13E-03	8.64E-02	1.84E-04	
General public	3.72E+03	5.00E-04	1.86E+00	8.64E-02	1.61E-01	1.88E+00

Table E.4.3.7 Latent Cancer Fatality Risk from Tank Dome Collapse

Receptor	Dose pers - rem	LCF/rem	LCF	Probability	LCF Risk point-est	
Nominal Scenario						
MEI Worker	1.22E+02	8.00E-04	9.76E-02	1.00E-04	9.76E-06	
Workers	1.22E+03	8.00E-04	9.76E-01	1.00E-04	9.76E-05	
MEI noninvolved worker	2.93E+01	8.00E-04	2.34E-02	1.00E-04	2.34E-06	
Noninvolved workers	4.11E+02	4.00E-04	1.64E-01	1.00E-04	1.64E-05	
MEI general public	7.09E-02	5.00E-04	3.55E-05	1.00E-04	3.55E-09	
General public	6.20E+01	5.00E-04	3.10E-02	1.00E-04	3.10E-06	1.17E-04
Bounding Scenario						
MEI Worker	8.11E+03	lethal	1.00E+00	1.00E-04	1.00E-04	
Workers	8.11E+04	lethal	1.00E+01	1.00E-04	1.00E-03	
MEI noninvolved worker	1.95E+03	lethal	1.00E+00	1.00E-04	1.00E-04	
Noninvolved workers	2.74E+04	4.00E-04	1.10E+01	1.00E-04	1.10E-03	
MEI general public	4.73E+00	5.00E-04	2.37E-03	1.00E-04	2.37E-07	
General public	4.13E+03	5.00E-04	2.07E+00	1.00E-04	2.07E-04	2.30E-03

Table E.4.3.13 Latent Cancer Fatality Risk from Seismic Event

Receptor	Dose pers - rem	LCF/rem	LCF	Probability	LCF Risk point-est	
Nominal Scenario						
MEI Worker	1.21E+02	8.00E-04	9.68E-02	1.68E-03	1.63E-04	
Workers	1.21E+03	8.00E-04	9.68E-01	1.68E-03	1.63E-03	
MEI noninvolved worker	2.90E+01	8.00E-04	2.32E-02	1.68E-03	3.90E-05	
Noninvolved workers	4.07E+02	4.00E-04	1.63E-01	1.68E-03	2.74E-04	
MEI general public	7.03E-02	5.00E-04	3.52E-05	1.68E-03	5.91E-08	
General public	6.14E+01	5.00E-04	3.07E-02	1.68E-03	5.16E-05	1.95E-03
Bounding Scenario						
MEI Worker	8.04E+03	lethal	1.00E+00	1.68E-03	1.68E-03	
Workers	8.04E+04	lethal	1.00E+01	1.68E-03	1.68E-02	
MEI noninvolved worker	1.93E+03	lethal	1.00E+00	1.68E-03	1.68E-03	
Noninvolved workers	2.71E+04	4.00E-04	1.08E+01	1.68E-03	1.82E-02	
MEI general public	4.68E+00	5.00E-04	2.34E-03	1.68E-03	3.93E-06	
General public	4.09E+03	5.00E-04	2.05E+00	1.68E-03	3.44E-03	3.84E-02

IN SITU VITRIFICATION

Table E.5.3.3 Latent Cancer Fatality Risk from Mispositioned Jumper

Receptor	Dose pers - rem	LCF/rem	LCF	Probability	LCF Risk point-est	
Nominal Scenario						
MEI Worker	5.88E+01	8.00E-04	4.70E-02	1.76E-01	8.28E-03	
Workers	5.88E+02	8.00E-04	4.70E-01	1.76E-01	8.28E-02	
MEI noninvolved worker	1.92E+01	4.00E-04	7.68E-03	1.76E-01	1.35E-03	
Noninvolved workers	7.23E+02	4.00E-04	2.89E-01	1.76E-01	5.09E-02	
MEI general public	8.44E-02	5.00E-04	4.22E-05	1.76E-01	7.43E-06	
General public	1.77E+02	5.00E-04	8.85E-02	1.76E-01	1.56E-02	1.49E-01
Bounding Scenario						
MEI Worker	1.33E+03	lethal	1.00E+00	1.76E-01	1.76E-01	
Workers	1.33E+04	lethal	1.00E+01	1.76E-01	1.76E+00	
MEI noninvolved worker	4.35E+02	lethal	1.00E+00	1.76E-01	1.76E-01	
Noninvolved workers	1.64E+04	4.00E-04	6.56E+00	1.76E-01	1.15E+00	
MEI general public	1.91E+00	5.00E-04	9.55E-04	1.76E-01	1.68E-04	
General public	4.01E+03	5.00E-04	2.01E+00	1.76E-01	3.53E-01	3.27E+00

Table E.5.3.5 Latent Cancer Fatality Risk from Hydrogen Deflagration in Waste Storage Tank

Receptor	Dose pers - rem	LCF/rem	LCF	Probability	LCF Risk point-est	
Nominal Scenario						
MEI Worker	3.91E+01	8.00E-04	3.13E-02	1.15E-01	3.60E-03	
Workers	3.91E+02	8.00E-04	3.13E-01	1.15E-01	3.60E-02	
MEI noninvolved worker	9.40E+00	4.00E-04	3.76E-03	1.15E-01	4.32E-04	
Noninvolved workers	1.32E+02	4.00E-04	5.28E-02	1.15E-01	6.07E-03	
MEI general public	2.28E-02	5.00E-04	1.14E-05	1.15E-01	1.31E-06	
General public	1.99E+01	5.00E-04	9.95E-03	1.15E-01	1.14E-03	4.32E-02
Bounding Scenario						
MEI Worker	7.31E+03	lethal	1.00E+00	1.15E-01	1.15E-01	
Workers	7.31E+04	lethal	1.00E+01	1.15E-01	1.15E+00	
MEI noninvolved worker	1.76E+03	lethal	1.00E+00	1.15E-01	1.15E-01	
Noninvolved workers	2.47E+04	4.00E-04	9.88E+00	1.15E-01	1.14E+00	
MEI general public	4.26E+00	5.00E-04	2.13E-03	1.15E-01	2.45E-04	
General public	3.72E+03	5.00E-04	1.86E+00	1.15E-01	2.14E-01	2.50E+00

Table E.5.3.7 Latent Cancer Fatality Risk from Off-gas Duct Rupture

Receptor	Dose pers - rem	LCF/rem	LCF	Probability	LCF Risk point-est	
Nominal Scenario						
MEI Worker	1.97E+01	4.00E-04	7.88E-03	1.60E-02	1.26E-04	
Workers	1.97E+02	4.00E-04	7.88E-02	1.60E-02	1.26E-03	
MEI noninvolved worker	6.45E+00	4.00E-04	2.58E-03	1.60E-02	4.13E-05	
Noninvolved workers	2.43E+02	4.00E-04	9.72E-02	1.60E-02	1.56E-03	
MEI general public	2.82E-02	5.00E-04	1.41E-05	1.60E-02	2.26E-07	
General public	5.91E+01	5.00E-04	2.96E-02	1.60E-02	4.73E-04	3.29E-03
Bounding Scenario						
MEI Worker	3.69E+03	lethal	1.00E+00	1.60E-02	1.60E-02	
Workers	3.69E+04	lethal	1.00E+01	1.60E-02	1.60E-01	
MEI noninvolved worker	1.21E+03	lethal	1.00E+00	1.60E-02	1.60E-02	
Noninvolved workers	4.54E+04	8.00E-04	3.63E+01	1.60E-02	5.81E-01	
MEI general public	5.27E+00	5.00E-04	2.64E-03	1.60E-02	4.22E-05	
General public	1.10E+04	5.00E-04	5.50E+00	1.60E-02	8.80E-02	8.29E-01

Table E.5.3.13 Latent Cancer Fatality Risk from Seismic Event

Receptor	Dose pers - rem	LCF/rem	LCF	Probability	LCF Risk point-est	
Nominal Scenario						
MEI Worker	1.21E+02	8.00E-04	9.68E-02	2.24E-03	2.17E-04	
Workers	1.21E+03	8.00E-04	9.68E-01	2.24E-03	2.17E-03	
MEI noninvolved worker	2.90E+01	8.00E-04	2.32E-02	2.24E-03	5.20E-05	
Noninvolved workers	4.07E+02	4.00E-04	1.63E-01	2.24E-03	3.65E-04	
MEI general public	7.03E-02	5.00E-04	3.52E-05	2.24E-03	7.87E-08	
General public	6.14E+01	5.00E-04	3.07E-02	2.24E-03	6.88E-05	2.60E-03
Bounding Scenario						
MEI Worker	8.04E+03	lethal	1.00E+00	2.24E-03	2.24E-03	
Workers	8.04E+04	lethal	1.00E+01	2.24E-03	2.24E-02	
MEI noninvolved worker	1.93E+03	lethal	1.00E+00	2.24E-03	2.24E-03	
Noninvolved workers	2.71E+04	4.00E-04	1.08E+01	2.24E-03	2.43E-02	
MEI general public	4.68E+00	5.00E-04	2.34E-03	2.24E-03	5.24E-06	
General public	4.09E+03	5.00E-04	2.05E+00	2.24E-03	4.58E-03	5.13E-02

INTERMEDIATE SEPARATIONS

Table E.6.3.3 Latent Cancer Fatality Risk from Mispositioned Jumper

Receptor	Dose pers - rem	LCF/rem	LCF	Probability	LCF Risk point-est	
Nominal Scenario						
MEI Worker	5.88E+01	8.00E-04	4.70E-02	2.75E-01	1.29E-02	
Workers	5.88E+02	8.00E-04	4.70E-01	2.75E-01	1.29E-01	
MEI noninvolved worker	1.92E+01	4.00E-04	7.68E-03	2.75E-01	2.11E-03	
Noninvolved workers	7.23E+02	4.00E-04	2.89E-01	2.75E-01	7.95E-02	
MEI general public	8.44E-02	5.00E-04	4.22E-05	2.75E-01	1.16E-05	
General public	1.77E+02	5.00E-04	8.85E-02	2.75E-01	2.43E-02	2.33E-01
Bounding Scenario						
MEI Worker	1.33E+03	lethal	1.00E+00	2.75E-01	2.75E-01	
Workers	1.33E+04	lethal	1.00E+01	2.75E-01	2.75E+00	
MEI noninvolved worker	4.35E+02	lethal	1.00E+00	2.75E-01	2.75E-01	
Noninvolved workers	1.64E+04	4.00E-04	6.56E+00	2.75E-01	1.80E+00	
MEI general public	1.91E+00	5.00E-04	9.55E-04	2.75E-01	2.63E-04	
General public	4.01E+03	5.00E-04	2.01E+00	2.75E-01	5.51E-01	5.11E+00

Table E.6.3.5 Latent Cancer Fatality Risk from Hydrogen Deflagration in Waste Storage Tank

Receptor	Dose pers - rem	LCF/rem	LCF	Probability	LCF Risk point-est	
Nominal Scenario						
MEI Worker	3.91E+01	8.00E-04	3.13E-02	1.80E-01	5.63E-03	
Workers	3.91E+02	8.00E-04	3.13E-01	1.80E-01	5.63E-02	
MEI noninvolved worker	9.40E+00	4.00E-04	3.76E-03	1.80E-01	6.77E-04	
Noninvolved workers	1.32E+02	4.00E-04	5.28E-02	1.80E-01	9.50E-03	
MEI general public	2.28E-02	5.00E-04	1.14E-05	1.80E-01	2.05E-06	
General public	1.99E+01	5.00E-04	9.95E-03	1.80E-01	1.79E-03	6.76E-02
Bounding Scenario						
MEI Worker	7.31E+03	lethal	1.00E+00	1.80E-01	1.80E-01	
Workers	7.31E+04	lethal	1.00E+01	1.80E-01	1.80E+00	
MEI noninvolved worker	1.76E+03	lethal	1.00E+00	1.80E-01	1.80E-01	
Noninvolved workers	2.47E+04	4.00E-04	9.88E+00	1.80E-01	1.78E+00	
MEI general public	4.26E+00	5.00E-04	2.13E-03	1.80E-01	3.83E-04	
General public	3.72E+03	5.00E-04	1.86E+00	1.80E-01	3.35E-01	3.91E+00

Table E.6.3.7 Latent Cancer Fatality Risk from Loss of Filtration

Receptor	Dose pers - rem	LCF/rem	LCF	Probability	LCF Risk point-est	
Nominal Scenario						
MEI Worker	4.89E+01	8.00E-04	3.91E-02	2.20E-04	8.61E-06	
Workers	4.89E+02	8.00E-04	3.91E-01	2.20E-04	8.61E-05	
MEI noninvolved worker	3.22E-01	4.00E-04	1.29E-04	2.20E-04	2.83E-08	
Noninvolved workers	1.37E+01	4.00E-04	5.48E-03	2.20E-04	1.21E-06	
MEI general public	1.38E-03	5.00E-04	6.90E-07	2.20E-04	1.52E-10	
General public	2.07E+00	5.00E-04	1.04E-03	2.20E-04	2.28E-07	8.75E-05
Bounding Scenario						
MEI Worker	3.26E+03	lethal	1.00E+00	2.20E-04	2.20E-04	
Workers	3.26E+04	lethal	1.00E+01	2.20E-04	2.20E-03	
MEI noninvolved worker	2.14E+01	8.00E-04	1.71E-02	2.20E-04	3.77E-06	
Noninvolved workers	9.16E+02	4.00E-04	3.66E-01	2.20E-04	8.06E-05	
MEI general public	9.22E-02	5.00E-04	4.61E-05	2.20E-04	1.01E-08	
General public	1.38E+02	5.00E-04	6.90E-02	2.20E-04	1.52E-05	2.30E-03

Table E.6.3.13 Latent Cancer Fatality Risk from Seismic Induced Line Break in Vault

Receptor	Dose pers - rem	LCF/rem	LCF	Probability	LCF Risk point-est	
Nominal Scenario						
MEI Worker	1.84E+00	4.00E-04	7.36E-04	1.63E-02	1.20E-05	
Workers	1.84E+01	4.00E-04	7.36E-03	1.63E-02	1.20E-04	
MEI noninvolved worker	2.74E-02	4.00E-04	1.10E-05	1.63E-02	1.79E-07	
Noninvolved workers	1.03E+00	4.00E-04	4.12E-04	1.63E-02	6.72E-06	
MEI general public	1.20E-04	5.00E-04	6.00E-08	1.63E-02	9.78E-10	
General public	2.53E-01	5.00E-04	1.27E-04	1.63E-02	2.06E-06	1.29E-04
Bounding Scenario						
MEI Worker	6.97E+00	4.00E-04	2.79E-03	1.63E-02	4.54E-05	
Workers	6.97E+01	4.00E-04	2.79E-02	1.63E-02	4.54E-04	
MEI noninvolved worker	1.04E-01	4.00E-04	4.16E-05	1.63E-02	6.78E-07	
Noninvolved workers	3.92E+00	4.00E-04	1.57E-03	1.63E-02	2.56E-05	
MEI general public	4.57E-04	5.00E-04	2.29E-07	1.63E-02	3.72E-09	
General public	9.60E-01	5.00E-04	4.80E-04	1.63E-02	7.82E-06	4.88E-04

Table E.6.3.19 Latent Cancer Fatality Risk from Breached Canister

Receptor	Dose pers - rem	LCF/rem	LCF	Probability	LCF Risk point-est	
Nominal Scenario						
MEI Worker	4.53E-08	4.00E-04	1.81E-11	1.00E+00	1.81E-11	
Workers	4.53E-07	4.00E-04	1.81E-10	1.00E+00	1.81E-10	
MEI noninvolved worker	6.77E-10	4.00E-04	2.71E-13	1.00E+00	2.71E-13	
Noninvolved workers	2.55E-08	4.00E-04	1.02E-11	1.00E+00	1.02E-11	
MEI general public	1.00E-12	5.00E-04	5.00E-16	1.00E+00	5.00E-16	
General public	2.23E-09	5.00E-04	1.12E-12	1.00E+00	1.12E-12	1.93E-10
Bounding Scenario						
MEI Worker	2.72E-05	4.00E-04	1.09E-08	1.00E+00	1.09E-08	
Workers	2.72E-04	4.00E-04	1.09E-07	1.00E+00	1.09E-07	
MEI noninvolved worker	4.06E-07	4.00E-04	1.62E-10	1.00E+00	1.62E-10	
Noninvolved workers	1.53E-05	4.00E-04	6.12E-09	1.00E+00	6.12E-09	
MEI general public	6.01E-10	5.00E-04	3.01E-13	1.00E+00	3.01E-13	
General public	1.34E-06	5.00E-04	6.70E-10	1.00E+00	6.70E-10	1.16E-07

Table E.6.3.21 Latent Cancer Fatality Risk from Seismic Event

Receptor	Dose pers - rem	LCF/rem	LCF	Probability	LCF Risk point-est	
Nominal Scenario						
MEI Worker	1.21E+02	8.00E-04	9.68E-02	3.50E-03	3.39E-04	
Workers	1.21E+03	8.00E-04	9.68E-01	3.50E-03	3.39E-03	
MEI noninvolved worker	2.90E+01	8.00E-04	2.32E-02	3.50E-03	8.12E-05	
Noninvolved workers	4.07E+02	4.00E-04	1.63E-01	3.50E-03	5.70E-04	
MEI general public	7.03E-02	5.00E-04	3.52E-05	3.50E-03	1.23E-07	
General public	6.14E+01	5.00E-04	3.07E-02	3.50E-03	1.07E-04	4.07E-03
Bounding Scenario						
MEI Worker	8.04E+03	lethal	1.00E+00	3.50E-03	3.50E-03	
Workers	8.04E+04	lethal	1.00E+01	3.50E-03	3.50E-02	
MEI noninvolved worker	1.93E+03	lethal	1.00E+00	3.50E-03	3.50E-03	
Noninvolved workers	2.71E+04	4.00E-04	1.08E+01	3.50E-03	3.79E-02	
MEI general public	4.68E+00	5.00E-04	2.34E-03	3.50E-03	8.19E-06	
General public	4.09E+03	5.00E-04	2.05E+00	3.50E-03	7.16E-03	8.01E-02

NO SEPARATIONS ALTERNATIVE

Table E.7.3.2 Latent Cancer Fatality Risk from Mispositioned Jumper

Receptor	Dose pers - rem	LCF/rem	LCF	Probability	LCF Risk point-est	
Nominal Scenario						
MEI Worker	5.88E+01	8.00E-04	4.70E-02	2.48E-01	1.17E-02	
Workers	5.88E+02	8.00E-04	4.70E-01	2.48E-01	1.17E-01	
MEI noninvolved worker	1.92E+01	4.00E-04	7.68E-03	2.48E-01	1.90E-03	
Noninvolved workers	7.23E+02	4.00E-04	2.89E-01	2.48E-01	7.17E-02	
MEI general public	8.44E-02	5.00E-04	4.22E-05	2.48E-01	1.05E-05	
General public	1.77E+02	5.00E-04	8.85E-02	2.48E-01	2.19E-02	2.10E-01
Bounding Scenario						
MEI Worker	1.33E+03	lethal	1.00E+00	2.48E-01	2.48E-01	
Workers	1.33E+04	lethal	1.00E+01	2.48E-01	2.48E+00	
MEI noninvolved worker	4.35E+02	lethal	1.00E+00	2.48E-01	2.48E-01	
Noninvolved workers	1.64E+04	4.00E-04	6.56E+00	2.48E-01	1.63E+00	
MEI general public	1.91E+00	5.00E-04	9.55E-04	2.48E-01	2.37E-04	
General public	4.01E+03	5.00E-04	2.01E+00	2.48E-01	4.97E-01	4.60E+00

Table E.7.3.4 Latent Cancer Fatality Risk from Hydrogen Deflagration in Waste Storage Tank

Receptor	Dose pers - rem	LCF/rem	LCF	Probability	LCF Risk point-est	
Nominal Scenario						
MEI Worker	3.91E+01	8.00E-04	3.13E-02	1.66E-01	5.19E-03	
Workers	3.91E+02	8.00E-04	3.13E-01	1.66E-01	5.19E-02	
MEI noninvolved worker	9.40E+00	4.00E-04	3.76E-03	1.66E-01	6.24E-04	
Noninvolved workers	1.32E+02	4.00E-04	5.28E-02	1.66E-01	8.76E-03	
MEI general public	2.28E-02	5.00E-04	1.14E-05	1.66E-01	1.89E-06	
General public	1.99E+01	5.00E-04	9.95E-03	1.66E-01	1.65E-03	6.23E-02
Bounding Scenario						
MEI Worker	7.31E+03	lethal	1.00E+00	1.66E-01	1.66E-01	
Workers	7.31E+04	lethal	1.00E+01	1.66E-01	1.66E+00	
MEI noninvolved worker	1.76E+03	lethal	1.00E+00	1.66E-01	1.66E-01	
Noninvolved workers	2.47E+04	4.00E-04	9.88E+00	1.66E-01	1.64E+00	
MEI general public	4.26E+00	5.00E-04	2.13E-03	1.66E-01	3.54E-04	
General public	3.72E+03	5.00E-04	1.86E+00	1.66E-01	3.09E-01	3.61E+00

Table E.7.3.6 Latent Cancer Fatality Risk from Loss of Filtration

Receptor	Dose	LCF/rem	LCF	Probability	LCF Risk	
	pers - rem				point-est	
Nominal Scenario						
MEI Worker	4.89E+01	8.00E-04	3.91E-02	2.02E-04	7.90E-06	
Workers	4.89E+02	8.00E-04	3.91E-01	2.02E-04	7.90E-05	
MEI noninvolved worker	3.22E-01	4.00E-04	1.29E-04	2.02E-04	2.60E-08	
Noninvolved workers	1.37E+01	4.00E-04	5.48E-03	2.02E-04	1.11E-06	
MEI general public	1.38E-03	5.00E-04	6.90E-07	2.02E-04	1.39E-10	
General public	2.07E+00	5.00E-04	1.04E-03	2.02E-04	2.09E-07	8.03E-05
Bounding Scenario						
MEI Worker	3.26E+03	lethal	1.00E+00	2.02E-04	2.02E-04	
Workers	3.26E+04	lethal	1.00E+01	2.02E-04	2.02E-03	
MEI noninvolved worker	2.14E+01	8.00E-04	1.71E-02	2.02E-04	3.46E-06	
Noninvolved workers	9.16E+02	4.00E-04	3.66E-01	2.02E-04	7.40E-05	
MEI general public	9.22E-02	5.00E-04	4.61E-05	2.02E-04	9.31E-09	
General public	1.38E+02	5.00E-04	6.90E-02	2.02E-04	1.39E-05	2.11E-03

Table E.7.3.8 Latent Cancer Fatality Risk from Breached Canister

Receptor	Dose	LCF/rem	LCF	Probability	LCF Risk	
	pers - rem				point-est	
Nominal Scenario						
MEI Worker	9.06E-08	4.00E-04	3.62E-11	1.00E+00	3.62E-11	
Workers	9.06E-07	4.00E-04	3.62E-10	1.00E+00	3.62E-10	
MEI noninvolved worker	1.35E-09	4.00E-04	5.40E-13	1.00E+00	5.40E-13	
Noninvolved workers	5.10E-08	4.00E-04	2.04E-11	1.00E+00	2.04E-11	
MEI general public	2.00E-12	5.00E-04	1.00E-15	1.00E+00	1.00E-15	
General public	4.46E-09	5.00E-04	2.23E-12	1.00E+00	2.23E-12	3.85E-10
Bounding Scenario						
MEI Worker	5.44E-05	4.00E-04	2.18E-08	1.00E+00	2.18E-08	
Workers	5.44E-04	4.00E-04	2.18E-07	1.00E+00	2.18E-07	
MEI noninvolved worker	8.12E-07	4.00E-04	3.25E-10	1.00E+00	3.25E-10	
Noninvolved workers	3.06E-05	4.00E-04	1.22E-08	1.00E+00	1.22E-08	
MEI general public	1.20E-09	5.00E-04	6.00E-13	1.00E+00	6.00E-13	
General public	2.68E-06	5.00E-04	1.34E-09	1.00E+00	1.34E-09	2.31E-07

Table E.7.3.10 Latent Cancer Fatality Risk from Seismic Event

Receptor	Dose	LCF/rem	LCF	Probability	LCF Risk	
	pers - rem				point-est	
Nominal Scenario						
MEI Worker	1.21E+02	8.00E-04	9.68E-02	3.22E-03	3.12E-04	
Workers	1.21E+03	8.00E-04	9.68E-01	3.22E-03	3.12E-03	
MEI noninvolved worker	2.90E+01	8.00E-04	2.32E-02	3.22E-03	7.47E-05	
Noninvolved workers	4.07E+02	4.00E-04	1.63E-01	3.22E-03	5.24E-04	
MEI general public	7.03E-02	5.00E-04	3.52E-05	3.22E-03	1.13E-07	
General public	6.14E+01	5.00E-04	3.07E-02	3.22E-03	9.89E-05	3.74E-03
Bounding Scenario						
MEI Worker	8.04E+03	lethal	1.00E+00	3.22E-03	3.22E-03	
Workers	8.04E+04	lethal	1.00E+01	3.22E-03	3.22E-02	
MEI noninvolved worker	1.93E+03	lethal	1.00E+00	3.22E-03	3.22E-03	
Noninvolved workers	2.71E+04	4.00E-04	1.08E+01	3.22E-03	3.49E-02	
MEI general public	4.68E+00	5.00E-04	2.34E-03	3.22E-03	7.53E-06	
General public	4.09E+03	5.00E-04	2.05E+00	3.22E-03	6.58E-03	7.37E-02

EXTENSIVE SEPARATIONS ALTERNATIVE

Table E.8.3.2 Latent Cancer Fatality Risk from Mispositioned Jumper

Receptor	Dose	LCF/rem	LCF	Probability	LCF Risk	
	pers - rem				point-est	
Nominal Scenario						
MEI Worker	5.88E+01	8.00E-04	4.70E-02	2.86E-01	1.35E-02	
Workers	5.88E+02	8.00E-04	4.70E-01	2.86E-01	1.35E-01	
MEI noninvolved worker	1.92E+01	4.00E-04	7.68E-03	2.86E-01	2.20E-03	
Noninvolved workers	7.23E+02	4.00E-04	2.89E-01	2.86E-01	8.27E-02	
MEI general public	8.44E-02	5.00E-04	4.22E-05	2.86E-01	1.21E-05	
General public	1.77E+02	5.00E-04	8.85E-02	2.86E-01	2.53E-02	2.43E-01
Bounding Scenario						
MEI Worker	1.33E+03	lethal	1.00E+00	2.86E-01	2.86E-01	
Workers	1.33E+04	lethal	1.00E+01	2.86E-01	2.86E+00	
MEI noninvolved worker	4.35E+02	lethal	1.00E+00	2.86E-01	2.86E-01	
Noninvolved workers	1.64E+04	4.00E-04	6.56E+00	2.86E-01	1.88E+00	
MEI general public	1.91E+00	5.00E-04	9.55E-04	2.86E-01	2.73E-04	
General public	4.01E+03	5.00E-04	2.01E+00	2.86E-01	5.73E-01	5.31E+00

Table E.8.3.4 Latent Cancer Fatality Risk from Hydrogen Deflagration in Waste Storage Tank

Receptor	Dose	LCF/rem	LCF	Probability	LCF Risk	
	pers - rem				point-est	
Nominal Scenario						
MEI Worker	3.91E+01	8.00E-04	3.13E-02	1.87E-01	5.85E-03	
Workers	3.91E+02	8.00E-04	3.13E-01	1.87E-01	5.85E-02	
MEI noninvolved worker	9.40E+00	4.00E-04	3.76E-03	1.87E-01	7.03E-04	
Noninvolved workers	1.32E+02	4.00E-04	5.28E-02	1.87E-01	9.87E-03	
MEI general public	2.28E-02	5.00E-04	1.14E-05	1.87E-01	2.13E-06	
General public	1.99E+01	5.00E-04	9.95E-03	1.87E-01	1.86E-03	7.02E-02
Bounding Scenario						
MEI Worker	7.31E+03	lethal	1.00E+00	1.87E-01	1.87E-01	
Workers	7.31E+04	lethal	1.00E+01	1.87E-01	1.87E+00	
MEI noninvolved worker	1.76E+03	lethal	1.00E+00	1.87E-01	1.87E-01	
Noninvolved workers	2.47E+04	4.00E-04	9.88E+00	1.87E-01	1.85E+00	
MEI general public	4.26E+00	5.00E-04	2.13E-03	1.87E-01	3.98E-04	
General public	3.72E+03	5.00E-04	1.86E+00	1.87E-01	3.48E-01	4.07E+00

Table E.8.3.6 Latent Cancer Fatality Risk from Loss of Filtration

Receptor	Dose	LCF/rem	LCF	Probability	LCF Risk	
	pers - rem				point-est	
Nominal Scenario						
MEI Worker	4.89E+01	8.00E-04	3.91E-02	2.29E-04	8.96E-06	
Workers	4.89E+02	8.00E-04	3.91E-01	2.29E-04	8.96E-05	
MEI noninvolved worker	3.22E-01	4.00E-04	1.29E-04	2.29E-04	2.95E-08	
Noninvolved workers	1.37E+01	4.00E-04	5.48E-03	2.29E-04	1.25E-06	
MEI general public	1.38E-03	5.00E-04	6.90E-07	2.29E-04	1.58E-10	
General public	2.07E+00	5.00E-04	1.04E-03	2.29E-04	2.37E-07	9.11E-05
Bounding Scenario						
MEI Worker	3.26E+03	lethal	1.00E+00	2.29E-04	2.29E-04	
Workers	3.26E+04	lethal	1.00E+01	2.29E-04	2.29E-03	
MEI noninvolved worker	2.14E+01	8.00E-04	1.71E-02	2.29E-04	3.92E-06	
Noninvolved workers	9.16E+02	4.00E-04	3.66E-01	2.29E-04	8.39E-05	
MEI general public	9.22E-02	5.00E-04	4.61E-05	2.29E-04	1.06E-08	
General public	1.38E+02	5.00E-04	6.90E-02	2.29E-04	1.58E-05	2.39E-03

Table E.8.3.8 Latent Cancer Fatality Risk from Seismic Induced Line Break in Vault

Receptor	Dose pers - rem	LCF/rem	LCF	Probability	LCF Risk point-est	
Nominal Scenario						
MEI Worker	1.84E+00	4.00E-04	7.36E-04	1.69E-02	1.24E-05	
Workers	1.84E+01	4.00E-04	7.36E-03	1.69E-02	1.24E-04	
MEI noninvolved worker	2.74E-02	4.00E-04	1.10E-05	1.69E-02	1.85E-07	
Noninvolved workers	1.03E+00	4.00E-04	4.12E-04	1.69E-02	6.96E-06	
MEI general public	1.20E-04	5.00E-04	6.00E-08	1.69E-02	1.01E-09	
General public	2.53E-01	5.00E-04	1.27E-04	1.69E-02	2.14E-06	1.33E-04
Bounding Scenario						
MEI Worker	6.97E+00	4.00E-04	2.79E-03	1.69E-02	4.71E-05	
Workers	6.97E+01	4.00E-04	2.79E-02	1.69E-02	4.71E-04	
MEI noninvolved worker	1.04E-01	4.00E-04	4.16E-05	1.69E-02	7.03E-07	
Noninvolved workers	3.92E+00	4.00E-04	1.57E-03	1.69E-02	2.65E-05	
MEI general public	4.57E-04	5.00E-04	2.29E-07	1.69E-02	3.86E-09	
General public	9.60E-01	5.00E-04	4.80E-04	1.69E-02	8.11E-06	5.06E-04

Table E.8.3.10 Latent Cancer Fatality Risk from Breached Canister

Receptor	Dose pers - rem	LCF/rem	LCF	Probability	LCF Risk point-est	
Nominal Scenario						
MEI Worker	4.53E-08	4.00E-04	1.81E-11	1.00E+00	1.81E-11	
Workers	4.53E-07	4.00E-04	1.81E-10	1.00E+00	1.81E-10	
MEI noninvolved worker	6.77E-10	4.00E-04	2.71E-13	1.00E+00	2.71E-13	
Noninvolved workers	2.55E-08	4.00E-04	1.02E-11	1.00E+00	1.02E-11	
MEI general public	1.00E-12	5.00E-04	5.00E-16	1.00E+00	5.00E-16	
General public	2.23E-09	5.00E-04	1.12E-12	1.00E+00	1.12E-12	1.93E-10
Bounding Scenario						
MEI Worker	2.72E-05	4.00E-04	1.09E-08	1.00E+00	1.09E-08	
Workers	2.72E-04	4.00E-04	1.09E-07	1.00E+00	1.09E-07	
MEI noninvolved worker	4.06E-07	4.00E-04	1.62E-10	1.00E+00	1.62E-10	
Noninvolved workers	1.53E-05	4.00E-04	6.12E-09	1.00E+00	6.12E-09	
MEI general public	6.01E-10	5.00E-04	3.01E-13	1.00E+00	3.01E-13	
General public	1.34E-06	5.00E-04	6.70E-10	1.00E+00	6.70E-10	1.16E-07

Table E.8.3.12 Latent Cancer Fatality Risk from Seismic Event

Receptor	Dose pers - rem	LCF/rem	LCF	Probability	LCF Risk point-est	
Nominal Scenario						
MEI Worker	1.21E+02	8.00E-04	9.68E-02	3.64E-03	3.52E-04	
Workers	1.21E+03	8.00E-04	9.68E-01	3.64E-03	3.52E-03	
MEI noninvolved worker	2.90E+01	8.00E-04	2.32E-02	3.64E-03	8.44E-05	
Noninvolved workers	4.07E+02	4.00E-04	1.63E-01	3.64E-03	5.93E-04	
MEI general public	7.03E-02	5.00E-04	3.52E-05	3.64E-03	1.28E-07	
General public	6.14E+01	5.00E-04	3.07E-02	3.64E-03	1.12E-04	4.23E-03
Bounding Scenario						
MEI Worker	8.04E+03	lethal	1.00E+00	3.64E-03	3.64E-03	
Workers	8.04E+04	lethal	1.00E+01	3.64E-03	3.64E-02	
MEI noninvolved worker	1.93E+03	lethal	1.00E+00	3.64E-03	3.64E-03	
Noninvolved workers	2.71E+04	4.00E-04	1.08E+01	3.64E-03	3.95E-02	
MEI general public	4.68E+00	5.00E-04	2.34E-03	3.64E-03	8.52E-06	
General public	4.09E+03	5.00E-04	2.05E+00	3.64E-03	7.44E-03	8.33E-02

EX SITU/ IN SITU COMBINATION 1 ALTERNATIVE

Table E.9.3.2 Latent Cancer Fatality Risk from Mispositioned Jumper

Receptor	Dose pers - rem	LCF/rem	LCF	Probability	LCF Risk point-est	
Nominal Scenario						
MEI Worker	5.88E+01	8.00E-04	4.70E-02	2.04E-01	9.60E-03	
Workers	5.88E+02	8.00E-04	4.70E-01	2.04E-01	9.60E-02	
MEI noninvolved worker	1.92E+01	4.00E-04	7.68E-03	2.04E-01	1.57E-03	
Noninvolved workers	7.23E+02	4.00E-04	2.89E-01	2.04E-01	5.90E-02	
MEI general public	8.44E-02	5.00E-04	4.22E-05	2.04E-01	8.61E-06	
General public	1.77E+02	5.00E-04	8.85E-02	2.04E-01	1.81E-02	1.73E-01
Bounding Scenario						
MEI Worker	1.33E+03	lethal	1.00E+00	2.04E-01	2.04E-01	
Workers	1.33E+04	lethal	1.00E+01	2.04E-01	2.04E+00	
MEI noninvolved worker	4.35E+02	lethal	1.00E+00	2.04E-01	2.04E-01	
Noninvolved workers	1.64E+04	4.00E-04	6.56E+00	2.04E-01	1.34E+00	
MEI general public	1.91E+00	5.00E-04	9.55E-04	2.04E-01	1.95E-04	
General public	4.01E+03	5.00E-04	2.01E+00	2.04E-01	4.09E-01	3.79E+00

Table E.9.3.4 Latent Cancer Fatality Risk from Hydrogen Deflagration in Waste Storage Tank

Receptor	Dose pers - rem	LCF/rem	LCF	Probability	LCF Risk point-est	
Nominal Scenario						
MEI Worker	3.91E+01	8.00E-04	3.13E-02	1.87E-01	5.85E-03	
Workers	3.91E+02	8.00E-04	3.13E-01	1.87E-01	5.85E-02	
MEI noninvolved worker	9.40E+00	4.00E-04	3.76E-03	1.87E-01	7.03E-04	
Noninvolved workers	1.32E+02	4.00E-04	5.28E-02	1.87E-01	9.87E-03	
MEI general public	2.28E-02	5.00E-04	1.14E-05	1.87E-01	2.13E-06	
General public	1.99E+01	5.00E-04	9.95E-03	1.87E-01	1.86E-03	7.02E-02
Bounding Scenario						
MEI Worker	7.31E+03	lethal	1.00E+00	1.87E-01	1.87E-01	
Workers	7.31E+04	lethal	1.00E+01	1.87E-01	1.87E+00	
MEI noninvolved worker	1.76E+03	lethal	1.00E+00	1.87E-01	1.87E-01	
Noninvolved workers	2.47E+04	4.00E-04	9.88E+00	1.87E-01	1.85E+00	
MEI general public	4.26E+00	5.00E-04	2.13E-03	1.87E-01	3.98E-04	
General public	3.72E+03	5.00E-04	1.86E+00	1.87E-01	3.48E-01	4.07E+00

Table E.9.3.6 Latent Cancer Fatality Risk from Loss of Filtration

Receptor	Dose pers - rem	LCF/rem	LCF	Probability	LCF Risk point-est	
Nominal Scenario						
MEI Worker	4.89E+01	8.00E-04	3.91E-02	2.29E-04	8.96E-06	
Workers	4.89E+02	8.00E-04	3.91E-01	2.29E-04	8.96E-05	
MEI noninvolved worker	3.22E-01	4.00E-04	1.29E-04	2.29E-04	2.95E-08	
Noninvolved workers	1.37E+01	4.00E-04	5.48E-03	2.29E-04	1.25E-06	
MEI general public	1.38E-03	5.00E-04	6.90E-07	2.29E-04	1.58E-10	
General public	2.07E+00	5.00E-04	1.04E-03	2.29E-04	2.37E-07	9.11E-05
Bounding Scenario						
MEI Worker	3.26E+03	lethal	1.00E+00	2.29E-04	2.29E-04	
Workers	3.26E+04	lethal	1.00E+01	2.29E-04	2.29E-03	
MEI noninvolved worker	2.14E+01	8.00E-04	1.71E-02	2.29E-04	3.92E-06	
Noninvolved workers	9.16E+02	4.00E-04	3.66E-01	2.29E-04	8.39E-05	
MEI general public	9.22E-02	5.00E-04	4.61E-05	2.29E-04	1.06E-08	
General public	1.38E+02	5.00E-04	6.90E-02	2.29E-04	1.58E-05	2.39E-03

Table E.9.3.8 Latent Cancer Fatality Risk from Seismic Induced Line Break in Vault

Receptor	Dose	LCF/rem	LCF	Probability	LCF Risk	
	pers - rem				point-est	
Nominal Scenario						
MEI Worker	1.84E+00	4.00E-04	7.36E-04	1.69E-02	1.24E-05	
Workers	1.84E+01	4.00E-04	7.36E-03	1.69E-02	1.24E-04	
MEI noninvolved worker	2.74E-02	4.00E-04	1.10E-05	1.69E-02	1.85E-07	
Noninvolved workers	1.03E+00	4.00E-04	4.12E-04	1.69E-02	6.96E-06	
MEI general public	1.20E-04	5.00E-04	6.00E-08	1.69E-02	1.01E-09	
General public	2.53E-01	5.00E-04	1.27E-04	1.69E-02	2.14E-06	1.33E-04
Bounding Scenario						
MEI Worker	6.97E+00	4.00E-04	2.79E-03	1.69E-02	4.71E-05	
Workers	6.97E+01	4.00E-04	2.79E-02	1.69E-02	4.71E-04	
MEI noninvolved worker	1.04E-01	4.00E-04	4.16E-05	1.69E-02	7.03E-07	
Noninvolved workers	3.92E+00	4.00E-04	1.57E-03	1.69E-02	2.65E-05	
MEI general public	4.57E-04	5.00E-04	2.29E-07	1.69E-02	3.86E-09	
General public	9.60E-01	5.00E-04	4.80E-04	1.69E-02	8.11E-06	5.06E-04

Table E.9.3.10 Latent Cancer Fatality Risk from Breached Canister

Receptor	Dose	LCF/rem	LCF	Probability	LCF Risk	
	pers - rem				point-est	
Nominal Scenario						
MEI Worker	4.53E-08	4.00E-04	1.81E-11	1.00E+00	1.81E-11	
Workers	4.53E-07	4.00E-04	1.81E-10	1.00E+00	1.81E-10	
MEI noninvolved worker	6.77E-10	4.00E-04	2.71E-13	1.00E+00	2.71E-13	
Noninvolved workers	2.55E-08	4.00E-04	1.02E-11	1.00E+00	1.02E-11	
MEI general public	1.00E-12	5.00E-04	5.00E-16	1.00E+00	5.00E-16	
General public	2.23E-09	5.00E-04	1.12E-12	1.00E+00	1.12E-12	1.93E-10
Bounding Scenario						
MEI Worker	2.72E-05	4.00E-04	1.09E-08	1.00E+00	1.09E-08	
Workers	2.72E-04	4.00E-04	1.09E-07	1.00E+00	1.09E-07	
MEI noninvolved worker	4.06E-07	4.00E-04	1.62E-10	1.00E+00	1.62E-10	
Noninvolved workers	1.53E-05	4.00E-04	6.12E-09	1.00E+00	6.12E-09	
MEI general public	6.01E-10	5.00E-04	3.01E-13	1.00E+00	3.01E-13	
General public	1.34E-06	5.00E-04	6.70E-10	1.00E+00	6.70E-10	1.16E-07

Table E.9.3.12 Latent Cancer Fatality Risk from Tank Dome Collapse

Receptor	Dose	LCF/rem	LCF	Probability	LCF Risk	
	pers - rem				point-est	
Nominal Scenario						
MEI Worker	1.22E+02	8.00E-04	9.76E-02	1.00E-04	9.76E-06	
Workers	1.22E+03	8.00E-04	9.76E-01	1.00E-04	9.76E-05	
MEI noninvolved worker	2.93E+01	8.00E-04	2.34E-02	1.00E-04	2.34E-06	
Noninvolved workers	4.11E+02	4.00E-04	1.64E-01	1.00E-04	1.64E-05	
MEI general public	7.09E-02	5.00E-04	3.55E-05	1.00E-04	3.55E-09	
General public	6.20E+01	5.00E-04	3.10E-02	1.00E-04	3.10E-06	1.17E-04
Bounding Scenario						
MEI Worker	8.11E+03	lethal	1.00E+00	1.00E-04	1.00E-04	
Workers	8.11E+04	lethal	1.00E+01	1.00E-04	1.00E-03	
MEI noninvolved worker	1.95E+03	lethal	1.00E+00	1.00E-04	1.00E-04	
Noninvolved workers	2.74E+04	4.00E-04	1.10E+01	1.00E-04	1.10E-03	
MEI general public	4.73E+00	5.00E-04	2.37E-03	1.00E-04	2.37E-07	
General public	4.13E+03	5.00E-04	2.07E+00	1.00E-04	2.07E-04	2.30E-03

Table E.9.3.14 Latent Cancer Fatality Risk from Seismic Event

Receptor	Dose	LCF/rem	LCF	Probability	LCF Risk	
	pers - rem				point-est	
Nominal Scenario						
MEI Worker	1.21E+02	8.00E-04	9.68E-02	3.64E-03	3.52E-04	
Workers	1.21E+03	8.00E-04	9.68E-01	3.64E-03	3.52E-03	
MEI noninvolved worker	2.90E+01	8.00E-04	2.32E-02	3.64E-03	8.44E-05	
Noninvolved workers	4.07E+02	4.00E-04	1.63E-01	3.64E-03	5.93E-04	
MEI general public	7.03E-02	5.00E-04	3.52E-05	3.64E-03	1.28E-07	
General public	6.14E+01	5.00E-04	3.07E-02	3.64E-03	1.12E-04	4.23E-03
Bounding Scenario						
MEI Worker	8.04E+03	lethal	1.00E+00	3.64E-03	3.64E-03	
Workers	8.04E+04	lethal	1.00E+01	3.64E-03	3.64E-02	
MEI noninvolved worker	1.93E+03	lethal	1.00E+00	3.64E-03	3.64E-03	
Noninvolved workers	2.71E+04	4.00E-04	1.08E+01	3.64E-03	3.95E-02	
MEI general public	4.68E+00	5.00E-04	2.34E-03	3.64E-03	8.52E-06	
General public	4.09E+03	5.00E-04	2.05E+00	3.64E-03	7.44E-03	8.33E-02

EX SITU/ IN SITU COMBINATION 2 ALTERNATIVE

Table E.10.3.2 Latent Cancer Fatality Risk from Mispositioned Jumper

Receptor	Dose pers - rem	LCF/rem	LCF	Probability	LCF Risk point-est	
Nominal Scenario						
MEI Worker	5.88E+01	8.00E-04	4.70E-02	1.75E-01	8.23E-03	
Workers	5.88E+02	8.00E-04	4.70E-01	1.75E-01	8.23E-02	
MEI noninvolved worker	1.92E+01	4.00E-04	7.68E-03	1.75E-01	1.34E-03	
Noninvolved workers	7.23E+02	4.00E-04	2.89E-01	1.75E-01	5.06E-02	
MEI general public	8.44E-02	5.00E-04	4.22E-05	1.75E-01	7.39E-06	
General public	1.77E+02	5.00E-04	8.85E-02	1.75E-01	1.55E-02	1.48E-01
Bounding Scenario						
MEI Worker	1.33E+03	lethal	1.00E+00	1.75E-01	1.75E-01	
Workers	1.33E+04	lethal	1.00E+01	1.75E-01	1.75E+00	
MEI noninvolved worker	4.35E+02	lethal	1.00E+00	1.75E-01	1.75E-01	
Noninvolved workers	1.64E+04	4.00E-04	6.56E+00	1.75E-01	1.15E+00	
MEI general public	1.91E+00	5.00E-04	9.55E-04	1.75E-01	1.67E-04	
General public	4.01E+03	5.00E-04	2.01E+00	1.75E-01	3.51E-01	3.25E+00

Table E.10.3.4 Latent Cancer Fatality Risk from Hydrogen Deflagration in Waste Storage Tank

Receptor	Dose pers - rem	LCF/rem	LCF	Probability	LCF Risk point-est	
Nominal Scenario						
MEI Worker	3.91E+01	8.00E-04	3.13E-02	1.80E-01	5.63E-03	
Workers	3.91E+02	8.00E-04	3.13E-01	1.80E-01	5.63E-02	
MEI noninvolved worker	9.40E+00	4.00E-04	3.76E-03	1.80E-01	6.77E-04	
Noninvolved workers	1.32E+02	4.00E-04	5.28E-02	1.80E-01	9.50E-03	
MEI general public	2.28E-02	5.00E-04	1.14E-05	1.80E-01	2.05E-06	
General public	1.99E+01	5.00E-04	9.95E-03	1.80E-01	1.79E-03	6.76E-02
Bounding Scenario						
MEI Worker	7.31E+03	lethal	1.00E+00	1.80E-01	1.80E-01	
Workers	7.31E+04	lethal	1.00E+01	1.80E-01	1.80E+00	
MEI noninvolved worker	1.76E+03	lethal	1.00E+00	1.80E-01	1.80E-01	
Noninvolved workers	2.47E+04	4.00E-04	9.88E+00	1.80E-01	1.78E+00	
MEI general public	4.26E+00	5.00E-04	2.13E-03	1.80E-01	3.83E-04	
General public	3.72E+03	5.00E-04	1.86E+00	1.80E-01	3.35E-01	3.91E+00

Table E.10.3.6 Latent Cancer Fatality Risk from Loss of Filtration

Receptor	Dose pers - rem	LCF/rem	LCF	Probability	LCF Risk point-est	
Nominal Scenario						
MEI Worker	4.89E+01	8.00E-04	3.91E-02	2.20E-04	8.61E-06	
Workers	4.89E+02	8.00E-04	3.91E-01	2.20E-04	8.61E-05	
MEI noninvolved worker	3.22E-01	4.00E-04	1.29E-04	2.20E-04	2.83E-08	
Noninvolved workers	1.37E+01	4.00E-04	5.48E-03	2.20E-04	1.21E-06	
MEI general public	1.38E-03	5.00E-04	6.90E-07	2.20E-04	1.52E-10	
General public	2.07E+00	5.00E-04	1.04E-03	2.20E-04	2.28E-07	8.75E-05
Bounding Scenario						
MEI Worker	3.26E+03	lethal	1.00E+00	2.20E-04	2.20E-04	
Workers	3.26E+04	lethal	1.00E+01	2.20E-04	2.20E-03	
MEI noninvolved worker	2.14E+01	8.00E-04	1.71E-02	2.20E-04	3.77E-06	
Noninvolved workers	9.16E+02	4.00E-04	3.66E-01	2.20E-04	8.06E-05	
MEI general public	9.22E-02	5.00E-04	4.61E-05	2.20E-04	1.01E-08	
General public	1.38E+02	5.00E-04	6.90E-02	2.20E-04	1.52E-05	2.30E-03

Table E.10.3.8 Latent Cancer Fatality Risk from Seismic Induced Line Break in Vault

Receptor	Dose pers - rem	LCF/rem	LCF	Probability	LCF Risk point-est	
Nominal Scenario						
MEI Worker	1.84E+00	4.00E-04	7.36E-04	1.63E-02	1.20E-05	
Workers	1.84E+01	4.00E-04	7.36E-03	1.63E-02	1.20E-04	
MEI noninvolved worker	2.74E-02	4.00E-04	1.10E-05	1.63E-02	1.79E-07	
Noninvolved workers	1.03E+00	4.00E-04	4.12E-04	1.63E-02	6.72E-06	
MEI general public	1.20E-04	5.00E-04	6.00E-08	1.63E-02	9.78E-10	
General public	2.53E-01	5.00E-04	1.27E-04	1.63E-02	2.06E-06	1.29E-04
Bounding Scenario						
MEI Worker	6.97E+00	4.00E-04	2.79E-03	1.63E-02	4.54E-05	
Workers	6.97E+01	4.00E-04	2.79E-02	1.63E-02	4.54E-04	
MEI noninvolved worker	1.04E-01	4.00E-04	4.16E-05	1.63E-02	6.78E-07	
Noninvolved workers	3.92E+00	4.00E-04	1.57E-03	1.63E-02	2.56E-05	
MEI general public	4.57E-04	5.00E-04	2.29E-07	1.63E-02	3.72E-09	
General public	9.60E-01	5.00E-04	4.80E-04	1.63E-02	7.82E-06	4.88E-04

Table E.10.3.10 Latent Cancer Fatality Risk from Breached Canister

Receptor	Dose pers - rem	LCF/rem	LCF	Probability	LCF Risk point-est	
Nominal Scenario						
MEI Worker	4.53E-08	4.00E-04	1.81E-11	1.00E+00	1.81E-11	
Workers	4.53E-07	4.00E-04	1.81E-10	1.00E+00	1.81E-10	
MEI noninvolved worker	6.77E-10	4.00E-04	2.71E-13	1.00E+00	2.71E-13	
Noninvolved workers	2.55E-08	4.00E-04	1.02E-11	1.00E+00	1.02E-11	
MEI general public	1.00E-12	5.00E-04	5.00E-16	1.00E+00	5.00E-16	
General public	2.23E-09	5.00E-04	1.12E-12	1.00E+00	1.12E-12	1.93E-10
Bounding Scenario						
MEI Worker	2.72E-05	4.00E-04	1.09E-08	1.00E+00	1.09E-08	
Workers	2.72E-04	4.00E-04	1.09E-07	1.00E+00	1.09E-07	
MEI noninvolved worker	4.06E-07	4.00E-04	1.62E-10	1.00E+00	1.62E-10	
Noninvolved workers	1.53E-05	4.00E-04	6.12E-09	1.00E+00	6.12E-09	
MEI general public	6.01E-10	5.00E-04	3.01E-13	1.00E+00	3.01E-13	
General public	1.34E-06	5.00E-04	6.70E-10	1.00E+00	6.70E-10	1.16E-07

Table E.10.3.12 Latent Cancer Fatality Risk from Tank Dome Collapse

Receptor	Dose pers - rem	LCF/rem	LCF	Probability	LCF Risk point-est	
Nominal Scenario						
MEI Worker	1.22E+02	8.00E-04	9.76E-02	1.00E-04	9.76E-06	
Workers	1.22E+03	8.00E-04	9.76E-01	1.00E-04	9.76E-05	
MEI noninvolved worker	2.93E+01	8.00E-04	2.34E-02	1.00E-04	2.34E-06	
Noninvolved workers	4.11E+02	4.00E-04	1.64E-01	1.00E-04	1.64E-05	
MEI general public	7.09E-02	5.00E-04	3.55E-05	1.00E-04	3.55E-09	
General public	6.20E+01	5.00E-04	3.10E-02	1.00E-04	3.10E-06	1.17E-04
Bounding Scenario						
MEI Worker	8.11E+03	lethal	1.00E+00	1.00E-04	1.00E-04	
Workers	8.11E+04	lethal	1.00E+01	1.00E-04	1.00E-03	
MEI noninvolved worker	1.95E+03	lethal	1.00E+00	1.00E-04	1.00E-04	
Noninvolved workers	2.74E+04	4.00E-04	1.10E+01	1.00E-04	1.10E-03	
MEI general public	4.73E+00	5.00E-04	2.37E-03	1.00E-04	2.37E-07	
General public	4.13E+03	5.00E-04	2.07E+00	1.00E-04	2.07E-04	2.30E-03

Table E.10.3.14 Latent Cancer Fatality Risk from Seismic Event

Receptor	Dose pers - rem	LCF/rem	LCF	Probability	LCF Risk point-est	
Nominal Scenario						
MEI Worker	1.21E+02	8.00E-04	9.68E-02	3.50E-03	3.39E-04	
Workers	1.21E+03	8.00E-04	9.68E-01	3.50E-03	3.39E-03	
MEI noninvolved worker	2.90E+01	8.00E-04	2.32E-02	3.50E-03	8.12E-05	
Noninvolved workers	4.07E+02	4.00E-04	1.63E-01	3.50E-03	5.70E-04	
MEI general public	7.03E-02	5.00E-04	3.52E-05	3.50E-03	1.23E-07	
General public	6.14E+01	5.00E-04	3.07E-02	3.50E-03	1.07E-04	4.07E-03
Bounding Scenario						
MEI Worker	8.04E+03	lethal	1.00E+00	3.50E-03	3.50E-03	
Workers	8.04E+04	lethal	1.00E+01	3.50E-03	3.50E-02	
MEI noninvolved worker	1.93E+03	lethal	1.00E+00	3.50E-03	3.50E-03	
Noninvolved workers	2.71E+04	4.00E-04	1.08E+01	3.50E-03	3.79E-02	
MEI general public	4.68E+00	5.00E-04	2.34E-03	3.50E-03	8.19E-06	
General public	4.09E+03	5.00E-04	2.05E+00	3.50E-03	7.16E-03	8.01E-02

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Table E.11.2.8 Latent Cancer Fatality Risk from Mispositioned Jumper

Receptor	Dose pers - rem	LCF/rem	LCF	Probability	LCF Risk point-est	
Nominal Scenario						
MEI Worker	5.88E+01	8.00E-04	4.70E-02	3.03E-01	1.43E-02	
Workers	5.88E+02	8.00E-04	4.70E-01	3.03E-01	1.43E-01	
MEI noninvolved worker	1.92E+01	4.00E-04	7.68E-03	3.03E-01	2.33E-03	
Noninvolved workers	7.23E+02	4.00E-04	2.89E-01	3.03E-01	8.76E-02	
MEI general public	8.44E-02	5.00E-04	4.22E-05	3.03E-01	1.28E-05	
General public	1.77E+02	5.00E-04	8.85E-02	3.03E-01	2.68E-02	2.57E-01
Bounding Scenario						
MEI Worker	1.33E+03	lethal	1.00E+00	3.03E-01	3.03E-01	
Workers	1.33E+04	lethal	1.00E+01	3.03E-01	3.03E+00	
MEI noninvolved worker	4.35E+02	lethal	1.00E+00	3.03E-01	3.03E-01	
Noninvolved workers	1.64E+04	4.00E-04	6.56E+00	3.03E-01	1.99E+00	
MEI general public	1.91E+00	5.00E-04	9.55E-04	3.03E-01	2.89E-04	
General public	4.01E+03	5.00E-04	2.01E+00	3.03E-01	6.08E-01	5.63E+00

Table E.11.2.10 Latent Cancer Fatality Risk from Hydrogen Deflagration in Waste Storage Tank

Receptor	Dose pers - rem	LCF/rem	LCF	Probability	LCF Risk point-est	
Nominal Scenario						
MEI Worker	3.91E+01	8.00E-04	3.13E-02	2.23E-01	6.98E-03	
Workers	3.91E+02	8.00E-04	3.13E-01	2.23E-01	6.98E-02	
MEI noninvolved worker	9.40E+00	4.00E-04	3.76E-03	2.23E-01	8.38E-04	
Noninvolved workers	1.32E+02	4.00E-04	5.28E-02	2.23E-01	1.18E-02	
MEI general public	2.28E-02	5.00E-04	1.14E-05	2.23E-01	2.54E-06	
General public	1.99E+01	5.00E-04	9.95E-03	2.23E-01	2.22E-03	8.37E-02
Bounding Scenario						
MEI Worker	7.31E+03	lethal	1.00E+00	2.23E-01	2.23E-01	
Workers	7.31E+04	lethal	1.00E+01	2.23E-01	2.23E+00	
MEI noninvolved worker	1.76E+03	lethal	1.00E+00	2.23E-01	2.23E-01	
Noninvolved workers	2.47E+04	4.00E-04	9.88E+00	2.23E-01	2.20E+00	
MEI general public	4.26E+00	5.00E-04	2.13E-03	2.23E-01	4.75E-04	
General public	3.72E+03	5.00E-04	1.86E+00	2.23E-01	4.15E-01	4.85E+00

Table E.11.2.12 Latent Cancer Fatality Risk from Loss of Filtration

Receptor	Dose pers - rem	LCF/rem	LCF	Probability	LCF Risk point-est	
Nominal Scenario						
MEI Worker	4.89E+01	8.00E-04	3.91E-02	2.73E-04	1.07E-05	
Workers	4.89E+02	8.00E-04	3.91E-01	2.73E-04	1.07E-04	
MEI noninvolved worker	3.22E-01	4.00E-04	1.29E-04	2.73E-04	3.52E-08	
Noninvolved workers	1.37E+01	4.00E-04	5.48E-03	2.73E-04	1.50E-06	
MEI general public	1.38E-03	5.00E-04	6.90E-07	2.73E-04	1.88E-10	
General public	2.07E+00	5.00E-04	1.04E-03	2.73E-04	2.83E-07	1.09E-04
Bounding Scenario						
MEI Worker	3.26E+03	lethal	1.00E+00	2.73E-04	2.73E-04	
Workers	3.26E+04	lethal	1.00E+01	2.73E-04	2.73E-03	
MEI noninvolved worker	2.14E+01	8.00E-04	1.71E-02	2.73E-04	4.67E-06	
Noninvolved workers	9.16E+02	4.00E-04	3.66E-01	2.73E-04	1.00E-04	
MEI general public	9.22E-02	5.00E-04	4.61E-05	2.73E-04	1.26E-08	
General public	1.38E+02	5.00E-04	6.90E-02	2.73E-04	1.88E-05	2.85E-03

Table E.11.2.14 Latent Cancer Fatality Risk from Seismic Induced Line Break in Vault

Receptor	Dose pers - rem	LCF/rem	LCF	Probability	LCF Risk point-est	
Nominal Scenario						
MEI Worker	1.84E+00	4.00E-04	7.36E-04	2.02E-02	1.49E-05	
Workers	1.84E+01	4.00E-04	7.36E-03	2.02E-02	1.49E-04	
MEI noninvolved worker	2.74E-02	4.00E-04	1.10E-05	2.02E-02	2.21E-07	
Noninvolved workers	1.03E+00	4.00E-04	4.12E-04	2.02E-02	8.32E-06	
MEI general public	1.20E-04	5.00E-04	6.00E-08	2.02E-02	1.21E-09	
General public	2.53E-01	5.00E-04	1.27E-04	2.02E-02	2.56E-06	1.60E-04
Bounding Scenario						
MEI Worker	6.97E+00	4.00E-04	2.79E-03	2.02E-02	5.63E-05	
Workers	6.97E+01	4.00E-04	2.79E-02	2.02E-02	5.63E-04	
MEI noninvolved worker	1.04E-01	4.00E-04	4.16E-05	2.02E-02	8.40E-07	
Noninvolved workers	3.92E+00	4.00E-04	1.57E-03	2.02E-02	3.17E-05	
MEI general public	4.57E-04	5.00E-04	2.29E-07	2.02E-02	4.62E-09	
General public	9.60E-01	5.00E-04	4.80E-04	2.02E-02	9.70E-06	6.05E-04

Table E.11.2.16 Latent Cancer Fatality Risk from Breached Canister

Receptor	Dose pers - rem	LCF/rem	LCF	Probability	LCF Risk point-est	
Nominal Scenario						
MEI Worker	4.53E-08	4.00E-04	1.81E-11	1.00E+00	1.81E-11	
Workers	4.53E-07	4.00E-04	1.81E-10	1.00E+00	1.81E-10	
MEI noninvolved worker	6.77E-10	4.00E-04	2.71E-13	1.00E+00	2.71E-13	
Noninvolved workers	2.55E-08	4.00E-04	1.02E-11	1.00E+00	1.02E-11	
MEI general public	1.00E-12	5.00E-04	5.00E-16	1.00E+00	5.00E-16	
General public	2.23E-09	5.00E-04	1.12E-12	1.00E+00	1.12E-12	1.93E-10
Bounding Scenario						
MEI Worker	2.72E-05	4.00E-04	1.09E-08	1.00E+00	1.09E-08	
Workers	2.72E-04	4.00E-04	1.09E-07	1.00E+00	1.09E-07	
MEI noninvolved worker	4.06E-07	4.00E-04	1.62E-10	1.00E+00	1.62E-10	
Noninvolved workers	1.53E-05	4.00E-04	6.12E-09	1.00E+00	6.12E-09	
MEI general public	6.01E-10	5.00E-04	3.01E-13	1.00E+00	3.01E-13	
General public	1.34E-06	5.00E-04	6.70E-10	1.00E+00	6.70E-10	1.16E-07

Table E.11.2.18 Latent Cancer Fatality Risk from Seismic Event

Receptor	Dose pers - rem	LCF/rem	LCF	Probability	LCF Risk point-est	
Nominal Scenario						
MEI Worker	1.21E+02	8.00E-04	9.68E-02	4.34E-03	4.20E-04	
Workers	1.21E+03	8.00E-04	9.68E-01	4.34E-03	4.20E-03	
MEI noninvolved worker	2.90E+01	8.00E-04	2.32E-02	4.34E-03	1.01E-04	
Noninvolved workers	4.07E+02	4.00E-04	1.63E-01	4.34E-03	7.07E-04	
MEI general public	7.03E-02	5.00E-04	3.52E-05	4.34E-03	1.53E-07	
General public	6.14E+01	5.00E-04	3.07E-02	4.34E-03	1.33E-04	5.04E-03
Bounding Scenario						
MEI Worker	8.04E+03	lethal	1.00E+00	4.34E-03	4.34E-03	
Workers	8.04E+04	lethal	1.00E+01	4.34E-03	4.34E-02	
MEI noninvolved worker	1.93E+03	lethal	1.00E+00	4.34E-03	4.34E-03	
Noninvolved workers	2.71E+04	4.00E-04	1.08E+01	4.34E-03	4.70E-02	
MEI general public	4.68E+00	5.00E-04	2.34E-03	4.34E-03	1.02E-05	
General public	4.09E+03	5.00E-04	2.05E+00	4.34E-03	8.88E-03	9.93E-02

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Table E.11.1.8 Latent Cancer Fatality Risk from Mispositioned Jumper

Receptor	Dose pers - rem	LCF/rem	LCF	Probability	LCF Risk point-est	
Nominal Scenario						
MEI Worker	5.88E+01	8.00E-04	4.70E-02	1.10E-01	5.17E-03	
Workers	5.88E+02	8.00E-04	4.70E-01	1.10E-01	5.17E-02	
MEI noninvolved worker	1.92E+01	4.00E-04	7.68E-03	1.10E-01	8.45E-04	
Noninvolved workers	7.23E+02	4.00E-04	2.89E-01	1.10E-01	3.18E-02	
MEI general public	8.44E-02	5.00E-04	4.22E-05	1.10E-01	4.64E-06	
General public	1.77E+02	5.00E-04	8.85E-02	1.10E-01	9.74E-03	9.33E-02
Bounding Scenario						
MEI Worker	1.33E+03	lethal	1.00E+00	1.10E-01	1.10E-01	
Workers	1.33E+04	lethal	1.00E+01	1.10E-01	1.10E+00	
MEI noninvolved worker	4.35E+02	lethal	1.00E+00	1.10E-01	1.10E-01	
Noninvolved workers	1.64E+04	4.00E-04	6.56E+00	1.10E-01	7.22E-01	
MEI general public	1.91E+00	5.00E-04	9.55E-04	1.10E-01	1.05E-04	
General public	4.01E+03	5.00E-04	2.01E+00	1.10E-01	2.21E-01	2.04E+00

Table E.11.1.10 Latent Cancer Fatality Risk from Seismic Induced Line Break in Vault

Receptor	Dose pers - rem	LCF/rem	LCF	Probability	LCF Risk point-est	
Nominal Scenario						
MEI Worker	1.84E+00	4.00E-04	7.36E-04	6.50E-03	4.78E-06	
Workers	1.84E+01	4.00E-04	7.36E-03	6.50E-03	4.78E-05	
MEI noninvolved worker	2.74E-02	4.00E-04	1.10E-05	6.50E-03	7.12E-08	
Noninvolved workers	1.03E+00	4.00E-04	4.12E-04	6.50E-03	2.68E-06	
MEI general public	1.20E-04	5.00E-04	6.00E-08	6.50E-03	3.90E-10	
General public	2.53E-01	5.00E-04	1.27E-04	6.50E-03	8.22E-07	5.13E-05
Bounding Scenario						
MEI Worker	6.97E+00	4.00E-04	2.79E-03	6.50E-03	1.81E-05	
Workers	6.97E+01	4.00E-04	2.79E-02	6.50E-03	1.81E-04	
MEI noninvolved worker	1.04E-01	4.00E-04	4.16E-05	6.50E-03	2.70E-07	
Noninvolved workers	3.92E+00	4.00E-04	1.57E-03	6.50E-03	1.02E-05	
MEI general public	4.57E-04	5.00E-04	2.29E-07	6.50E-03	1.49E-09	
General public	9.60E-01	5.00E-04	4.80E-04	6.50E-03	3.12E-06	1.95E-04

TWRS EIS
CALCULATION COVER SHEET

DISCIPLINE & TITLE Safety: Latent cancer fatalities (LCFs) resulting from radiological accidents. Includes bounding and nominal scenarios

ORIGINATOR Michael Harker DATE 7-28-96

REVISION NO. 3

OBJECTIVE Show LCFs resulting from radiological accidents evaluated in the TWRS EIS

METHODOLOGY See attachments

ASSUMPTIONS Source terms, Chi/Q, breathing rates, and unit liter doses are taken from the WHC data package WHC-SD-WM-ANAL-041 Rev 0

(Continue on another sheet if necessary)

SIGNATURE/DATE

Loretta Crow 8/28/96
CHECKED/DATE

CALCULATION & RESULTS
ATTACHED

JACOBS\FORMS\CALCVR.SHT

DOSE CONSEQUENCES FOR SPRAY RELEASE								
Noninvolved Worker and General Public Radiological Dose Calculation								
D(rem) = Q (L) x Chi/Q (s/m3) x BR (m3/s) x ULD (rem/L)								
where:								
Q = liters respirable tank waste released - respirable release rate = 0.054 L/min								
Chi/Q = time integrated atmoshperic dispersion coefficient; NW = 8hr, GP = 16hr								
BR = Breathing rate 3.3E-04 for onsite and offsite.								
ULD = CEDE per unit liter inhaled - Bounding (SST 30% solids) - Nominal (reactor products)								
latent cancer fatalities (LCF) = CF (LCF/rem) * D (rem)								
where:								
CF = dose-to-risk conversion factor								
D = dose								
			Bounding Scenario					
exposure	receptor	Q	Chi/Q	BR	ULD	D	CF	LCF
(h)		(L)	(s/m3)	(m3/s)	(rem/L)	(rem)	LCF/rem	
8.00E+00	MEI NW	2.59E+01	6.51E-03	3.30E-04	7.81E+06	4.35E+02	Lethal dose	
8.00E+00	pop NW	2.59E+01	2.45E-01	3.30E-04	7.81E+06	1.64E+04	4.00E-04	6.55E+00
1.60E+01	MEI GP	5.18E+01	1.43E-05	3.30E-04	7.81E+06	1.91E+00	5.00E-04	9.55E-04
1.60E+01	pop GP	5.18E+01	3.00E-02	3.30E-04	7.81E+06	4.01E+03	5.00E-04	2.00E+00
			Nominal Scenario					
exposure	receptor	Q	Chi/Q	BR	ULD	D	CF	LCF
(h)		(L)	(s/m3)	(m3/s)	(rem/L)	(rem)	LCF/rem	
8.00E+00	MEI NW	2.59E+01	6.51E-03	3.30E-04	3.45E+05	1.92E+01	4.00E-04	7.68E-03
8.00E+00	pop NW	2.59E+01	2.45E-01	3.30E-04	3.45E+05	7.23E+02	4.00E-04	2.89E-01
1.60E+01	MEI GP	5.18E+01	1.43E-05	3.30E-04	3.45E+05	8.44E-02	5.00E-04	4.22E-05
1.60E+01	pop GP	5.18E+01	3.00E-02	3.30E-04	3.45E+05	1.77E+02	5.00E-04	8.85E-02
Worker Radiological Dose Calculation								
D(rem) =[Q(L) * ULD(rem/L) * T(s) * R(m3/s) * 3/2pir3(m-3)] + [MEI NW dose]								
where:								
T (s) W Max 15min x 60s/min =			9.00E+02					
R (m) =	radius of work area =		1.00E+01					
Volume (m-3) = 3/2pir3 =			4.77E-04/m3					
			Bounding Scenario					
receptor	Q	ULD	T	BR	Volume	Dose	CF	LCF
	(L)	(rem/L)	(s)	(m3/s)	(m-3)	(rem)	LCF/rem	
MEI W	8.10E-01	7.81E+06	9.00E+02	3.30E-04	4.77E-04	1.33E+03	lethal dose	
Pop W	worker population of 10 * MEI W dose =					1.33E+04	lethal dose	
			Nominal Scenario					
receptor	Q	ULD	T	BR	Volume	Dose	CF	LCF
	(L)	(rem/L)	(s)	(m3/s)	(m-3)	(rem)	LCF/rem	
MEI W	8.10E-01	3.45E+05	9.00E+02	3.30E-04	4.77E-04	5.88E+01	8.00E-04	4.70E-02
Pop W	worker population of 10 * MEI W dose =					5.88E+02	8.00E-04	4.70E-01

DOSE CONSEQUENCES FOR FLAMMABLE GAS DEFLAGRATION

Noninvolved Worker and General Public Radiological Dose Calculation

D(rem) = Q (L) x Chi/Q (s/m3) x R (m3/s) x ULD (rem/L)

where:

Q = liters respirable tank waste released

Chi/Q = time integrated atmoshperic dispersion coefficient; NW = < 1hr, GP = < 1hr

R = Breathing rate 3.3E-04 for onsite and offsite.

ULD = CEDE per unit liter inhaled - DST solids

latent cancer fatalities (LCF) = CF (LCF/rem) * D (rem)

where:

CF = dose-to-risk conversion factor

D = dose

Bounding Scenario

exposure (h)	receptor	Q (L)	Chi/Q (s/m3)	BR (m3/s)	ULD (rem/L)	D (rem)	CF LCF/rem	LCF
< 1	MEI NW	2.40E+00	3.44E-02	3.30E-04	6.45E+07	1.76E+03	Lethal dose	
< 1	pop NW	2.40E+00	4.83E-01	3.30E-04	6.45E+07	2.47E+04	4.00E-04	9.87E+00
< 1	MEI GP	2.40E+00	8.34E-05	3.30E-04	6.45E+07	4.26E+00	5.00E-04	2.13E-03
< 1	pop GP	2.40E+00	7.29E-02	3.30E-04	6.45E+07	3.72E+03	5.00E-04	1.86E+00

Nominal Scenario

exposure (h)	receptor	Q (L)	Chi/Q (s/m3)	BR (m3/s)	ULD (rem/L)	D (rem)	CF LCF/rem	LCF
< 1	MEI NW	2.40E+00	3.44E-02	3.30E-04	3.45E+05	9.40E+00	4.00E-04	3.76E-03
< 1	pop NW	2.40E+00	4.83E-01	3.30E-04	3.45E+05	1.32E+02	4.00E-04	5.28E-02
< 1	MEI GP	2.40E+00	8.34E-05	3.30E-04	3.45E+05	2.28E-02	5.00E-04	1.14E-05
< 1	pop GP	2.40E+00	7.29E-02	3.30E-04	3.45E+05	1.99E+01	5.00E-04	9.96E-03

Worker Radiological Dose Calculation

D(rem) = Q(L) * ULD(rem/L) * T(s) * R(m3/s) * 3/2pir3(m-3)

where:

T (s) W Max 5min x 60s/min = 3.00E+02

R (m) = radius of work area = 1.00E+01

Volume (m-3) = 3/2pir3 = 4.77E-04/m3

Bounding Scenario

receptor	Q (L)	ULD (rem/L)	T (s)	BR (m3/s)	Volume (m-3)	Dose (rem)	CF LCF/rem	LCF
MEI W	2.40E+00	6.45E+07	3.00E+02	3.30E-04	4.77E-04	7.31E+03	lethal dose	
Pop W	worker population of 10 * MEI W dose =					7.31E+04	lethal dose	

Nominal Scenario

receptor	Q (L)	ULD (rem/L)	T (s)	BR (m3/s)	Volume (m-3)	Dose (rem)	CF LCF/rem	LCF
MEI W	2.40E+00	3.45E+05	3.00E+02	3.30E-04	4.77E-04	3.91E+01	8.00E-04	3.13E-02
Pop W	worker population of 10 * MEI W dose =					3.91E+02	8.00E-04	3.13E-01

DOSE CONSEQUENCES FOR SEISMIC EVENT - REMEDIATION

D(rem) = Q (L) x Chi/Q (s/m3) x R (m3/s) x ULD (rem/L)

where:

Q = liters respirable tank waste released

Chi/Q = time integrated atmoshperic dispersion coefficient; NW = < 1hr, GP = < 1hr

R = Breathing rate 3.3E-04 for onsite and offsite.

ULD = CEDE per unit liter inhaled - bounding (SST solids) - nominal (reactor products)

latent cancer fatalities (LCF) = CF (LCF/rem) * D (rem)

where:

CF = dose-to-risk conversion factor

D = dose

Bounding Scenario

exposure (h)	receptor	Q (L)	Chi/Q (s/m3)	R (m3/s)	ULD (rem/L)	D (rem)	CF LCF/rem	LCF
< 1	MEI NW	7.40E+00	3.44E-02	3.30E-04	2.30E+07	1.93E+03	lethal dose	
< 1	pop NW	7.40E+00	4.83E-01	3.30E-04	2.30E+07	2.71E+04	4.00E-04	1.09E+01
< 1	MEI GP	7.40E+00	8.34E-05	3.30E-04	2.30E+07	4.68E+00	5.00E-04	2.34E-03
< 1	pop GP	7.40E+00	7.29E-02	3.30E-04	2.30E+07	4.09E+03	5.00E-04	2.05E+00

Nominal Scenario

exposure (h)	receptor	Q (L)	Chi/Q (s/m3)	R (m3/s)	ULD (rem/L)	D (rem)	CF LCF/rem	LCF
< 1	MEI NW	7.40E+00	3.44E-02	3.30E-04	3.45E+05	2.90E+01	8.00E-04	2.32E-02
< 1	pop NW	7.40E+00	4.83E-01	3.30E-04	3.45E+05	4.07E+02	4.00E-04	1.63E-01
< 1	MEI GP	7.40E+00	8.34E-05	3.30E-04	3.45E+05	7.03E-02	5.00E-04	3.51E-05
< 1	pop GP	7.40E+00	7.29E-02	3.30E-04	3.45E+05	6.14E+01	5.00E-04	3.07E-02

Worker Radiological Dose Calculation

D(rem) = Q(L) * ULD(rem/L) * T(s) * R(m3/s) * 3/2pir3(m-3)

where:

T (s) W Max 5min x 60s/min = 3.00E+02

R (m) = radius of work area = 1.00E+01

Volume (m-3) = 3/2pir3 = 4.77E-04/m3

Bounding

receptor	Q (L)	ULD (rem/L)	T (s)	BR (m3/s)	Volume (m-3)	D (rem)	CF LCF/rem	LCF
MEI W	7.40E+00	2.30E+07	3.00E+02	3.30E-04	4.77E-04	8.04E+03	lethal dose	
Pop W	worker population of 10 * MEI W dose =					8.04E+04	lethal dose	

Nominal

receptor	Q (L)	ULD (rem/L)	T (s)	BR (m3/s)	Volume (m-3)	D (rem)	CF LCF/rem	LCF
MEI W	7.40E+00	3.45E+05	3.00E+02	3.30E-04	4.77E-04	1.21E+02	8.00E-04	9.64E-02
Pop W	worker population of 10 * MEI W dose =					1.21E+03	8.00E-04	9.64E-01

DOSE CONSEQUENCES FOR EXPLOSION FROM ROCK SLINGER								
D(rem) = Q (L) x Chi/Q (s/m3) x R (m3/s) x ULD (rem/L)								
where:								
Q = liters respirable tank waste released								
Chi/Q = time integrated atmoshperic dispersion coefficient; NW = < 1hr, GP = < 1 hr								
R = Breathing rate 3.3E-04 for onsite and offsite.								
ULD = CEDE per unit liter inhaled - Bounding (SST solids) - Nominal (reactor products)								
latent cancer fatalities (LCF) = CF (LCF/rem) * D (rem)								
where:								
CF = dose-to-risk conversion factor								
D = dose								
			Bounding Scenario					
exposure	receptor	Q	Chi/Q	R	ULD	D	CF	LCF
(h)		(L)	(s/m3)	(m3/s)	(rem/L)	(rem)	LCF/rem	
< 1	MEI NW	7.47E+00	3.44E-02	3.30E-04	2.30E+07	1.95E+03	lethal dose	
< 1	pop NW	7.47E+00	4.83E-01	3.30E-04	2.30E+07	2.74E+04	4.00E-04	1.10E+01
< 1	MEI GP	7.47E+00	8.34E-05	3.30E-04	2.30E+07	4.73E+00	5.00E-04	2.36E-03
< 1	pop GP	7.47E+00	7.29E-02	3.30E-04	2.30E+07	4.13E+03	5.00E-04	2.07E+00
			Nominal Scenario					
exposure	receptor	Q	Chi/Q	R	ULD	D	CF	LCF
(h)		(L)	(s/m3)	(m3/s)	(rem/L)	(rem)	LCF/rem	
< 1	MEI NW	7.47E+00	3.44E-02	3.30E-04	3.45E+05	2.93E+01	8.00E-04	2.34E-02
< 1	pop NW	7.47E+00	4.83E-01	3.30E-04	3.45E+05	4.11E+02	4.00E-04	1.64E-01
< 1	MEI GP	7.47E+00	8.34E-05	3.30E-04	3.45E+05	7.09E-02	5.00E-04	3.55E-05
< 1	pop GP	7.47E+00	7.29E-02	3.30E-04	3.45E+05	6.20E+01	5.00E-04	3.10E-02
Worker Radiological Dose Calculation								
D(rem) = Q(L) * ULD(rem/L) * T(s) * R(m3/s) * 3/2pir3								
where:								
T (s) W Max 5min x 60s/min =			3.00E+02					
R (m) =	radius of work area =		1.00E+01					
Volume (m-3) = 3/2pir3 =			4.77E-04/m3					
			Bounding					
receptor	Q	ULD	T	BR	Volume	D	CF	LCF
	(L)	(rem/L)	(s)	(m3/s)	(m-3)	(rem)	LCF/rem	
MEI W	7.47E+00	2.30E+07	3.00E+02	3.30E-04	4.77E-04	8.11E+03	lethal dose	
Pop W	worker population of 10 * MEI W dose =					8.11E+04	lethal dose	
			Nominal					
receptor	Q	ULD	T	BR	Volume	D	CF	LCF
	(L)	(rem/L)	(s)	(m3/s)	(m-3)	(rem)	LCF/rem	
MEI W	7.47E+00	3.45E+05	3.00E+02	3.30E-04	4.77E-04	1.22E+02	8.00E-04	9.74E-02
Pop W	worker population of 10 * MEI W dose =					1.22E+03	8.00E-04	9.74E-01

DOSE CONSEQUENCES FOR OFF GAS DUCT RUPTURE - (4.4.4.3)

D(rem) = Q (L) x Chi/Q (s/m3) x R (m3/s) x ULD (rem/L)

where:

Q = liters respirable tank waste released

Chi/Q = time integrated atmoshperic dispersion coefficient; NW = 8hr, GP = 16hr

R = Breathing rate 3.3E-04 for onsite and offsite.

ULD = CEDE per unit liter inhaled - Bounding (DST solids) - Nominal (reactor products)

latent cancer fatalities (LCF) = CF (LCF/rem) * D (rem)

where:

CF = dose-to-risk conversion factor

D = dose

Bounding Scenario

exposure (h)	receptor	Q (L)	Chi/Q (s/m3)	R (m3/s)	ULD (rem/L)	D (rem)	CF LCF/rem	LCF
8	MEI NW	8.70E+00	6.51E-03	3.30E-04	6.45E+07	1.21E+03	lethal dose	
8	pop NW	8.70E+00	2.45E-01	3.30E-04	6.45E+07	4.54E+04	8.00E-04	3.63E+01
16	MEI GP	1.73E+01	1.43E-05	3.30E-04	6.45E+07	5.27E+00	5.00E-04	2.63E-03
16	pop GP	1.73E+01	3.00E-02	3.30E-04	6.45E+07	1.10E+04	5.00E-04	5.52E+00

Nominal Scenario

exposure (h)	receptor	Q (L)	Chi/Q (s/m3)	R (m3/s)	ULD (rem/L)	D (rem)	CF LCF/rem	LCF
8	MEI NW	8.70E+00	6.51E-03	3.30E-04	3.45E+05	6.45E+00	4.00E-04	2.58E-03
8	pop NW	8.70E+00	2.45E-01	3.30E-04	3.45E+05	2.43E+02	4.00E-04	9.71E-02
16	MEI GP	1.73E+01	1.43E-05	3.30E-04	3.45E+05	2.82E-02	5.00E-04	1.41E-05
16	pop GP	1.73E+01	3.00E-02	3.30E-04	3.45E+05	5.91E+01	5.00E-04	2.95E-02

Worker Radiological Dose Calculation

D(rem) =[Q(L) * ULD(rem/L) * T(s) * R(m3/s) * 3/2pir3(m-3)] + [MEI NW dose]

where:

T (s) W Max 15min x 60s/min = 9.00E+02

R (m) = radius of work area = 1.00E+01

Volume (m-3) = 3/2pir3 = 4.77E-04/m3

Bounding

receptor	Q (L)	ULD (rem/L)	T (s)	BR (m3/s)	Volume (m-3)	D (rem)	CF LCF/rem	LCF
MEI W	2.72E-01	6.45E+07	9.00E+02	3.30E-04	4.77E-04	3.69E+03	lethal dose	
Pop W	worker population of 10 * MEI W dose =					3.69E+04	lethal dose	

Nominal

receptor	Q (L)	ULD (rem/L)	T (s)	BR (m3/s)	Volume (m-3)	D (rem)	CF LCF/rem	LCF
MEI W	2.72E-01	3.45E+05	9.00E+02	3.30E-04	4.77E-04	1.97E+01	4.00E-04	7.90E-03
Pop W	worker population of 10 * MEI W dose =					1.97E+02	4.00E-04	7.90E-02

DOSE CONSEQUENCES FOR LOSS OF FILTRATION - (4.3.1.10)

D(rem) = Q (L) x Chi/Q (s/m3) x R (m3/s) x ULD (rem/L)

where:

Q = liters respirable tank waste released

Chi/Q = time integrated atmoshperic dispersion coefficient; NW = 1hr, GP = 1hr

R = Breathing rate 3.3E-04 for onsite and offsite.

ULD = CEDE per unit liter inhaled - Bounding (SST solids) - Nominal (reactor products)

latent cancer fatalities (LCF) = CF (LCF/rem) * D (rem)

where:

CF = dose-to-risk conversion factor

D = dose

Bounding Scenario

exposure (h)	receptor	Q (L)	Chi/Q (s/m3)	R (m3/s)	ULD (rem/L)	D (rem)	CF LCF/rem	LCF
1	MEI NW	2.50E-01	1.13E-02	3.30E-04	2.30E+07	2.14E+01	8.00E-04	1.72E-02
1	pop NW	2.50E-01	4.83E-01	3.30E-04	2.30E+07	9.16E+02	4.00E-04	3.67E-01
1	MEI GP	2.50E-01	4.86E-05	3.30E-04	2.30E+07	9.22E-02	5.00E-04	4.61E-05
1	pop GP	2.50E-01	7.29E-02	3.30E-04	2.30E+07	1.38E+02	5.00E-04	6.92E-02

Nominal Scenario

exposure (h)	receptor	Q (L)	Chi/Q (s/m3)	R (m3/s)	ULD (rem/L)	D (rem)	CF LCF/rem	LCF
1	MEI NW	2.50E-01	1.13E-02	3.30E-04	3.45E+05	3.22E-01	4.00E-04	1.29E-04
1	pop NW	2.50E-01	4.83E-01	3.30E-04	3.45E+05	1.37E+01	4.00E-04	5.50E-03
1	MEI GP	2.50E-01	4.86E-05	3.30E-04	3.45E+05	1.38E-03	5.00E-04	6.92E-07
1	pop GP	2.50E-01	7.29E-02	3.30E-04	3.45E+05	2.07E+00	5.00E-04	1.04E-03

Worker Radiological Dose Calculation

D(rem) = Q(L) * ULD(rem/L) * T(s) * R(m3/s) * 3/2pir3(m-3)

where:

T (s) W Max 60min x 60s/min = 3.60E+03

R (m) = radius of work area = 1.00E+01

Volume (m-3) = 3/2pir3 = 4.77E-04/m3

Bounding

receptor	Q (L)	ULD (rem/L)	T (s)	BR (m3/s)	Volume (m-3)	D (rem)	CF LCF/rem	LCF
MEI W	2.50E-01	2.30E+07	3.60E+03	3.30E-04	4.77E-04	3.26E+03	lethal dose	
Pop W	worker population of 10 * MEI W dose =					3.26E+04	lethal dose	

Nominal

receptor	Q (L)	ULD (rem/L)	T (s)	BR (m3/s)	Volume (m-3)	D (rem)	CF LCF/rem	LCF
MEI W	2.50E-01	3.45E+05	3.60E+03	3.30E-04	4.77E-04	4.89E+01	8.00E-04	3.91E-02
Pop W	worker population of 10 * MEI W dose =					4.89E+02	8.00E-04	3.91E-01

DOSE CONSEQUENCES FOR SEISMIC INDUCED LINE BREAK IN VAULT - (4.5.1.1.2)

D(rem) = Q (L) x Chi/Q (s/m3) x R (m3/s) x ULD (rem/L)

where:

Q = liters respirable tank waste released

Chi/Q = time integrated atmoshperic dispersion coefficient; NW = 8hr, GP = 16hr

R = Breathing rate 3.3E-04 for onsite and offsite.

ULD = CEDE per unit liter inhaled - Bounding (SST liquids) - Nominal (reactor products)

latent cancer fatalities (LCF) = CF (LCF/rem) * D (rem)

where:

CF = dose-to-risk conversion factor

D = dose

Bounding Scenario

exposure (h)	receptor	Q (L)	Chi/Q (s/m3)	R (m3/s)	ULD (rem/L)	D (rem)	CF LCF/rem	LCF
8	MEI NW	3.70E-02	6.51E-03	3.30E-04	1.31E+06	1.04E-01	4.00E-04	4.17E-05
8	pop NW	3.70E-02	2.45E-01	3.30E-04	1.31E+06	3.92E+00	4.00E-04	1.57E-03
16	MEI GP	7.40E-02	1.43E-05	3.30E-04	1.31E+06	4.57E-04	5.00E-04	2.29E-07
16	pop GP	7.40E-02	3.00E-02	3.30E-04	1.31E+06	9.60E-01	5.00E-04	4.80E-04

Nominal Scenario

exposure (h)	receptor	Q (L)	Chi/Q (s/m3)	R (m3/s)	ULD (rem/L)	D (rem)	CF LCF/rem	LCF
8	MEI NW	3.70E-02	6.51E-03	3.30E-04	3.45E+05	2.74E-02	4.00E-04	1.10E-05
8	pop NW	3.70E-02	2.45E-01	3.30E-04	3.45E+05	1.03E+00	4.00E-04	4.13E-04
16	MEI GP	7.40E-02	1.43E-05	3.30E-04	3.45E+05	1.20E-04	5.00E-04	6.02E-08
16	pop GP	7.40E-02	3.00E-02	3.30E-04	3.45E+05	2.53E-01	5.00E-04	1.26E-04

Worker Radiological Dose Calculation

D(rem) =[Q(L) * ULD(rem/L) * T(s) * R(m3/s) * 3/2pir3(m-3)] + [MEI NW dose]

where:

T (s) W Max 15min x 60s/min = 9.00E+02

R (m) = radius of work area = 1.00E+01

Volume (m-3) = 3/2pir3 = 4.77E-04/m3

Bounding

receptor	Q (L)	ULD (rem/L)	T (s)	BR (m3/s)	Volume (m-3)	D (rem)	CF LCF/rem	LCF
MEI W	3.70E-02	1.31E+06	9.00E+02	3.30E-04	4.77E-04	6.97E+00	4.00E-04	2.79E-03
Pop W	worker population of 10 * MEI W dose =					6.97E+01	4.00E-04	2.79E-02

Nominal

receptor	Q (L)	ULD (rem/L)	T (s)	BR (m3/s)	Volume (m-3)	D (rem)	CF LCF/rem	LCF
MEI W	3.70E-02	3.45E+05	9.00E+02	3.30E-04	4.77E-04	1.84E+00	4.00E-04	7.34E-04
Pop W	worker population of 10 * MEI W dose =					1.84E+01	4.00E-04	7.34E-03

DOSE CONSEQUENCES FOR BREACHED CANISTER

D(rem) = Q (L) x Chi/Q (s/m3) x R (m3/s) x ULD (rem/L)

where:

Q = liters respirable tank waste released

Chi/Q = time integrated atmoshperic dispersion coefficient; NW = 8hr, GP = 24hr

R = Breathing rate 3.3E-04 for onsite and offsite. 2.7E-04 long term offsite > 16hr

ULD = CEDE per unit liter inhaled - Bounding (AWF solids) - Nominal (reactor products)

latent cancer fatalities (LCF) = CF (LCF/rem) * D (rem)

where:

CF = dose-to-risk conversion factor

D = dose

Bounding Scenario

exposure (h)	receptor	Q (L)	Chi/Q (s/m3)	R (m3/s)	ULD (rem/L)	D (rem)	CF LCF/rem	LCF
8	MEI NW	9.13E-10	6.51E-03	3.30E-04	2.07E+08	4.06E-07	4.00E-04	1.62E-10
8	pop NW	9.13E-10	2.45E-01	3.30E-04	2.07E+08	1.53E-05	4.00E-04	6.11E-09
24	MEI GP	9.51E-10	1.13E-05	2.70E-04	2.07E+08	6.01E-10	5.00E-04	3.00E-13
24	pop GP	9.51E-10	2.52E-02	2.70E-04	2.07E+08	1.34E-06	5.00E-04	6.70E-10

Nominal Scenario

exposure (h)	receptor	Q (L)	Chi/Q (s/m3)	R (m3/s)	ULD (rem/L)	D (rem)	CF LCF/rem	LCF
8	MEI NW	9.13E-10	6.51E-03	3.30E-04	3.45E+05	6.77E-10	4.00E-04	2.71E-13
8	pop NW	9.13E-10	2.45E-01	3.30E-04	3.45E+05	2.55E-08	4.00E-04	1.02E-11
24	MEI GP	9.51E-10	1.13E-05	2.70E-04	3.45E+05	1.00E-12	5.00E-04	5.01E-16
24	pop GP	9.51E-10	2.52E-02	2.70E-04	3.45E+05	2.23E-09	5.00E-04	1.12E-12

Worker Radiological Dose Calculation

D(rem) =[Q(L) * ULD(rem/L) * T(s) * R(m3/s) * 3/2pir3(m-3)] + [MEI NW dose]

where:

T (s) W Max 15min x 60s/min = 9.00E+02

R (m) = radius of work area = 1.00E+01

Volume (m-3) = 3/2pir3 = 4.77E-04/m3

Bounding

receptor	Q (L)	ULD (rem/L)	T (s)	BR (m3/s)	Volume (m-3)	D (rem)	CF LCF/rem	LCF
MEI W	9.13E-10	2.07E+08	9.00E+02	3.30E-04	4.77E-04	2.72E-05	4.00E-04	1.09E-08
Pop W	worker population of 10 * MEI W dose =					2.72E-04	4.00E-04	1.09E-07

Nominal

receptor	Q (L)	ULD (rem/L)	T (s)	BR (m3/s)	Volume (m-3)	D (rem)	CF LCF/rem	LCF
MEI W	9.13E-10	3.45E+05	9.00E+02	3.30E-04	4.77E-04	4.53E-08	4.00E-04	1.81E-11
Pop W	worker population of 10 * MEI W dose =					4.53E-07	4.00E-04	1.81E-10

					population deaths from latent cancer fatalities or lethal exposure									
					worker		noninvolved worker		general public		total population		point estimate	
Alternative	accident	frequency per year	years	probability	nominal	bounding	nominal	bounding	nominal	bounding	nominal	bounding	nominal	bounding
No action	spray	1.10E-02	1.00E+01	1.10E-01	4.70E-01	1.00E+01	2.89E-01	6.55E+00	8.85E-02	2.00E+00	8.48E-01	1.86E+01	9.32E-02	2.04E+00
	flam gas	7.20E-03	1.00E+02	7.20E-01	3.13E-01	1.00E+01	5.28E-02	9.87E+00	9.96E-03	1.86E+00	3.76E-01	2.17E+01	2.71E-01	1.56E+01
	seismic-4	1.40E-04	1.00E+02	1.40E-02	9.64E-01	1.00E+01	1.63E-01	1.09E+01	3.07E-02	2.05E+00	1.16E+00	2.30E+01	1.62E-02	3.21E-01
Long term	spray	1.10E-02	2.00E+01	2.20E-01	4.70E-01	1.00E+01	2.89E-01	6.55E+00	8.85E-02	2.00E+00	8.48E-01	1.86E+01	1.86E-01	4.08E+00
	flam gas	7.20E-03	1.00E+02	7.20E-01	3.13E-01	1.00E+01	5.28E-02	9.87E+00	9.96E-03	1.86E+00	3.76E-01	2.17E+01	2.71E-01	1.56E+01
	seismic-4	1.40E-04	1.00E+02	1.40E-02	9.64E-01	1.00E+01	1.63E-01	1.09E+01	3.07E-02	2.05E+00	1.16E+00	2.30E+01	1.62E-02	3.21E-01
Fill & cap	spray	1.10E-02	1.20E+01	1.32E-01	4.70E-01	1.00E+01	2.89E-01	6.55E+00	8.85E-02	2.00E+00	8.48E-01	1.86E+01	1.12E-01	2.45E+00
	flam gas	7.20E-03	1.20E+01	8.64E-02	3.13E-01	1.00E+01	5.28E-02	9.87E+00	9.96E-03	1.86E+00	3.76E-01	2.17E+01	3.25E-02	1.88E+00
	seismic-4	1.40E-04	1.20E+01	1.68E-03	9.64E-01	1.00E+01	1.63E-01	1.09E+01	3.07E-02	2.05E+00	1.16E+00	2.30E+01	1.94E-03	3.86E-02
	sling exp			1.00E-04	9.74E-01	1.00E+01	1.64E-01	1.10E+01	3.10E-02	2.07E+00	1.17E+00	2.31E+01	1.17E-04	2.31E-03
in situ vit	spray	1.10E-02	1.60E+01	1.76E-01	4.70E-01	1.00E+01	2.89E-01	6.55E+00	8.85E-02	2.00E+00	8.48E-01	1.86E+01	1.49E-01	3.26E+00
	flam gas	7.20E-03	1.60E+01	1.15E-01	3.13E-01	1.00E+01	5.28E-02	9.87E+00	9.96E-03	1.86E+00	3.76E-01	2.17E+01	4.33E-02	2.50E+00
	seismic-4	1.40E-04	1.60E+01	2.24E-03	9.64E-01	1.00E+01	1.63E-01	1.09E+01	3.07E-02	2.05E+00	1.16E+00	2.30E+01	2.59E-03	5.14E-02
	ogd ruptur	1.00E-03	1.60E+01	1.60E-02	7.90E-02	1.00E+01	9.71E-02	3.63E+01	2.95E-02	5.52E+00	2.06E-01	5.18E+01	3.29E-03	8.29E-01
intermed	spray	1.10E-02	2.50E+01	2.75E-01	4.70E-01	1.00E+01	2.89E-01	6.55E+00	8.85E-02	2.00E+00	8.48E-01	1.86E+01	2.33E-01	5.10E+00
	flam gas	7.20E-03	2.50E+01	1.80E-01	3.13E-01	1.00E+01	5.28E-02	9.87E+00	9.96E-03	1.86E+00	3.76E-01	2.17E+01	6.76E-02	3.91E+00
	seismic-4	1.40E-04	2.50E+01	3.50E-03	9.64E-01	1.00E+01	1.63E-01	1.09E+01	3.07E-02	2.05E+00	1.16E+00	2.30E+01	4.05E-03	8.03E-02
	filtration	8.80E-06	2.50E+01	2.20E-04	3.91E-01	1.00E+01	5.50E-03	3.67E-01	1.04E-03	6.92E-02	3.98E-01	1.04E+01	8.75E-05	2.30E-03
	pretreat	6.50E-04	2.50E+01	1.63E-02	7.34E-03	2.79E-02	4.13E-04	1.57E-03	1.26E-04	4.80E-04	7.88E-03	3.00E-02	1.28E-04	4.87E-04
	canister	6.00E-01	2.50E+01	1.50E+01	1.81E-10	1.09E-07	1.02E-11	6.11E-09	1.12E-12	6.70E-10	1.92E-10	1.16E-07	2.88E-09	1.74E-06
no treat	spray	1.10E-02	2.25E+01	2.48E-01	4.70E-01	1.00E+01	2.89E-01	6.55E+00	8.85E-02	2.00E+00	8.48E-01	1.86E+01	2.10E-01	4.59E+00
	flam gas	7.20E-03	2.30E+01	1.66E-01	3.13E-01	1.00E+01	5.28E-02	9.87E+00	9.96E-03	1.86E+00	3.76E-01	2.17E+01	6.22E-02	3.60E+00
	seismic-4	1.40E-04	2.30E+01	3.22E-03	9.64E-01	1.00E+01	1.63E-01	1.09E+01	3.07E-02	2.05E+00	1.16E+00	2.30E+01	3.73E-03	7.39E-02
	filtration	8.80E-06	2.30E+01	2.02E-04	3.91E-01	1.00E+01	5.50E-03	3.67E-01	1.04E-03	6.92E-02	3.98E-01	1.04E+01	8.05E-05	2.11E-03
	pretreat	6.50E-04	2.30E+01	1.50E-02	7.34E-03	2.79E-02	4.13E-04	1.57E-03	1.26E-04	4.80E-04	7.88E-03	3.00E-02	1.18E-04	4.48E-04
	canister	6.00E-01	2.30E+01	1.38E+01	1.81E-10	1.09E-07	1.02E-11	6.11E-09	1.12E-12	6.70E-10	1.92E-10	1.16E-07	2.65E-09	1.60E-06
ext. treat	spray	1.10E-02	2.60E+01	2.86E-01	4.70E-01	1.00E+01	2.89E-01	6.55E+00	8.85E-02	2.00E+00	8.48E-01	1.86E+01	2.42E-01	5.31E+00
	flam gas	7.20E-03	2.60E+01	1.87E-01	3.13E-01	1.00E+01	5.28E-02	9.87E+00	9.96E-03	1.86E+00	3.76E-01	2.17E+01	7.03E-02	4.07E+00
	seismic-4	1.40E-04	2.60E+01	3.64E-03	9.64E-01	1.00E+01	1.63E-01	1.09E+01	3.07E-02	2.05E+00	1.16E+00	2.30E+01	4.21E-03	8.35E-02
	filtration	8.80E-06	2.60E+01	2.29E-04	3.91E-01	1.00E+01	5.50E-03	3.67E-01	1.04E-03	6.92E-02	3.98E-01	1.04E+01	9.10E-05	2.39E-03
	pretreat	6.50E-04	2.60E+01	1.69E-02	7.34E-03	2.79E-02	4.13E-04	1.57E-03	1.26E-04	4.80E-04	7.88E-03	3.00E-02	1.33E-04	5.06E-04
	canister	6.00E-01	2.60E+01	1.56E+01	1.81E-10	1.09E-07	1.02E-11	6.11E-09	1.12E-12	6.70E-10	1.92E-10	1.16E-07	3.00E-09	1.81E-06
combo 1	spray	1.10E-02	1.85E+01	2.04E-01	4.70E-01	1.00E+01	2.89E-01	6.55E+00	8.85E-02	2.00E+00	8.48E-01	1.86E+01	1.72E-01	3.77E+00
	flam gas	7.20E-03	2.60E+01	1.87E-01	3.13E-01	1.00E+01	5.28E-02	9.87E+00	9.96E-03	1.86E+00	3.76E-01	2.17E+01	7.03E-02	4.07E+00
	seismic-4	1.40E-04	2.60E+01	3.64E-03	9.64E-01	1.00E+01	1.63E-01	1.09E+01	3.07E-02	2.05E+00	1.16E+00	2.30E+01	4.21E-03	8.35E-02
	filtration	8.80E-06	2.60E+01	2.29E-04	3.91E-01	1.00E+01	5.50E-03	3.67E-01	1.04E-03	6.92E-02	3.98E-01	1.04E+01	9.10E-05	2.39E-03
	pretreat	6.50E-04	2.60E+01	1.69E-02	7.34E-03	2.79E-02	4.13E-04	1.57E-03	1.26E-04	4.80E-04	7.88E-03	3.00E-02	1.33E-04	5.06E-04
	canister	6.00E-01	2.60E+01	1.56E+01	1.81E-10	1.09E-07	1.02E-11	6.11E-09	1.12E-12	6.70E-10	1.92E-10	1.16E-07	3.00E-09	1.81E-06
	sling exp			1.00E-04	9.74E-01	1.00E+01	1.64E-01	1.10E+01	3.10E-02	2.07E+00	1.17E+00	2.31E+01	1.17E-04	2.31E-03
combo 2	spray	1.10E-02	1.59E+01	1.75E-01	4.70E-01	1.00E+01	2.89E-01	6.55E+00	8.85E-02	2.00E+00	8.48E-01	1.86E+01	1.48E-01	3.24E+00
	flam gas	7.20E-03	2.50E+01	1.80E-01	3.13E-01	1.00E+01	5.28E-02	9.87E+00	9.96E-03	1.86E+00	3.76E-01	2.17E+01	6.76E-02	3.91E+00
	seismic-4	1.40E-04	2.50E+01	3.50E-03	9.64E-01	1.00E+01	1.63E-01	1.09E+01	3.07E-02	2.05E+00	1.16E+00	2.30E+01	4.05E-03	8.03E-02
	filtration	8.80E-06	2.50E+01	2.20E-04	3.91E-01	1.00E+01	5.50E-03	3.67E-01	1.04E-03	6.92E-02	3.98E-01	1.04E+01	8.75E-05	2.30E-03
	pretreat	6.50E-04	2.50E+01	1.63E-02	7.34E-03	2.79E-02	4.13E-04	1.57E-03	1.26E-04	4.80E-04	7.88E-03	3.00E-02	1.28E-04	4.87E-04
	canister	6.00E-01	2.50E+01	1.50E+01	1.81E-10	1.09E-07	1.02E-11	6.11E-09	1.12E-12	6.70E-10	1.92E-10	1.16E-07	2.88E-09	1.74E-06
	sling exp			1.00E-04	9.74E-01	1.00E+01	1.64E-01	1.10E+01	3.10E-02	2.07E+00	1.17E+00	2.31E+01	1.17E-04	2.31E-03
phased	spray	1.10E-02	2.75E+01	3.03E-01	4.70E-01	1.00E+01	2.89E-01	6.55E+00	8.85E-02	2.00E+00	8.48E-01	1.86E+01	2.56E-01	5.61E+00
	flam gas	7.20E-03	3.10E+01	2.23E-01	3.13E-01	1.00E+01	5.28E-02	9.87E+00	9.96E-03	1.86E+00	3.76E-01	2.17E+01	8.39E-02	4.85E+00
	seismic-4	1.40E-04	3.10E+01	4.34E-03	9.64E-01	1.00E+01	1.63E-01	1.09E+01	3.07E-02	2.05E+00	1.16E+00	2.30E+01	5.02E-03	9.96E-02
	filtration	8.80E-06	3.10E+01	2.73E-04	3.91E-01	1.00E+01	5.50E-03	3.67E-01	1.04E-03	6.92E-02	3.98E-01	1.04E+01	1.08E-04	2.85E-03
	pretreat	6.50E-04	3.10E+01	2.02E-02	7.34E-03	2.79E-02	4.13E-04	1.57E-03	1.26E-04	4.80E-04	7.88E-03	3.00E-02	1.59E-04	6.03E-04
	canister	6.00E-01	3.10E+01	1.86E+01	1.81E-10	1.09E-07	1.02E-11	6.11E-09	1.12E-12	6.70E-10	1.92E-10	1.16E-07	3.58E-09	2.15E-06

POST-REMEDIATION ACCIDENT - SEISMIC - 177 TANKS COLLAPSE

D(rem) = Q (L) x Chi/Q (s/m3) x R (m3/s) x ULD (rem/L)

where:

Q = liters respirable tank waste released

Chi/Q = time integrated atmoshperic dispersion coefficient; < 1hr acute, 1yr chronic

R = Breathing rate 3.3E-04 for onsite and offsite.

ULD = CEDE per unit liter inhaled - bounding (SST solids) - nominal (reactor products)

latent cancer fatalities (LCF) = CF (LCF/rem) * D (rem)

where:

CF = dose-to-risk conversion factor

D = dose

Summary Table

receptor	LCF
MEI NW	2.82E+00
pop NW	4.23E+01
MEI GP	3.05E-03
pop GP	3.68E+00

Nominal inventory - ingestion acute

exposure (h)	receptor	Q (L)	Chi/Q (s/m3)	R (m3/s)	ULD (rem/L)	D (rem)	CF LCF/rem	LCF
< 1	MEI NW	8.97E+02	3.44E-02	3.30E-04	4.10E+00	4.17E-02	5.00E-04	2.09E-05
< 1	pop NW	8.97E+02	4.83E-01	3.30E-04	4.10E+00	5.86E-01	5.00E-04	2.93E-04
< 1	MEI GP	8.97E+02	8.34E-05	3.30E-04	4.10E+00	1.01E-04	5.00E-04	5.06E-08
< 1	pop GP	8.97E+02	7.29E-02	3.30E-04	4.10E+00	8.85E-02	5.00E-04	4.42E-05

Nominal inventory - inhalation acute

exposure (h)	receptor	Q (L)	Chi/Q (s/m3)	R (m3/s)	ULD (rem/L)	D (rem)	CF LCF/rem	LCF
< 1	MEI NW	8.97E+02	3.44E-02	3.30E-04	2.30E+05	2.34E+03	1.00E-03	2.34E+00
< 1	pop NW	8.97E+02	4.83E-01	3.30E-04	2.30E+05	3.29E+04	1.00E-03	3.29E+01
< 1	MEI GP	8.97E+02	8.34E-05	3.30E-04	2.30E+05	5.68E+00	5.00E-04	2.84E-03
< 1	pop GP	8.97E+02	7.29E-02	3.30E-04	2.30E+05	4.96E+03	5.00E-04	2.48E+00

Nominal inventory - ingestion chronic

exposure (yr)	receptor	Q (L)	Chi/Q (s/m3)	R (m3/s)	ULD (rem/L)	D (rem)	CF LCF/rem	LCF
1	MEI NW	1.55E+04	4.03E-04	3.30E-04	4.10E+00	8.45E-03	5.00E-04	4.23E-06
1	pop NW	1.55E+04	8.01E-03	3.30E-04	4.10E+00	1.68E-01	5.00E-04	8.40E-05
1	MEI GP	1.55E+04	3.52E-07	3.30E-04	4.10E+00	7.38E-06	5.00E-04	3.69E-09
1	pop GP	1.55E+04	2.03E-03	3.30E-04	4.10E+00	4.26E-02	5.00E-04	2.13E-05

Nominal inventory - inhalation chronic

exposure (yr)	receptor	Q (L)	Chi/Q (s/m3)	R (m3/s)	ULD (rem/L)	D (rem)	CF LCF/rem	LCF
1	MEI NW	1.55E+04	4.03E-04	3.30E-04	2.30E+05	4.74E+02	1.00E-03	4.74E-01
1	pop NW	1.55E+04	8.01E-03	3.30E-04	2.30E+05	9.42E+03	1.00E-03	9.42E+00
1	MEI GP	1.55E+04	3.52E-07	3.30E-04	2.30E+05	4.14E-01	5.00E-04	2.07E-04
1	pop GP	1.55E+04	2.03E-03	3.30E-04	2.30E+05	2.39E+03	5.00E-04	1.19E+00

DOSE CONSEQUENCES FOR SPRAY RELEASE - 100% liquid

Noninvolved Worker and General Public Radiological Dose Calculation

D(rem) = Q (L) x Chi/Q (s/m3) x BR (m3/s) x ULD (rem/L)

where:

Q = liters respirable tank waste released - respirable release rate = 0.054 L/min

Chi/Q = time integrated atmoshperic dispersion coefficient; NW = 8hr, GP = 16hr

BR = Breathing rate 3.3E-04 for onsite and offsite.

ULD = CEDE per unit liter inhaled - Bounding (SST liquids) - Nominal (reactor products)

latent cancer fatalities (LCF) = CF (LCF/rem) * D (rem)

where:

CF = dose-to-risk conversion factor

D = dose

Bounding Scenario

exposure (h)	receptor	Q (L)	Chi/Q (s/m3)	BR (m3/s)	ULD (rem/L)	D (rem)	CF LCF/rem	LCF
8.00E+00	MEI NW	2.59E+01	6.51E-03	3.30E-04	1.31E+06	7.29E+01	8.00E-04	5.84E-02
8.00E+00	pop NW	2.59E+01	2.45E-01	3.30E-04	1.31E+06	2.75E+03	4.00E-04	1.10E+00
1.60E+01	MEI GP	5.18E+01	1.43E-05	3.30E-04	1.31E+06	3.20E-01	5.00E-04	1.60E-04
1.60E+01	pop GP	5.18E+01	3.00E-02	3.30E-04	1.31E+06	6.72E+02	5.00E-04	3.36E-01

Nominal Scenario

exposure (h)	receptor	Q (L)	Chi/Q (s/m3)	BR (m3/s)	ULD (rem/L)	D (rem)	CF LCF/rem	LCF
8.00E+00	MEI NW	2.59E+01	6.51E-03	3.30E-04	3.45E+05	1.92E+01	4.00E-04	7.68E-03
8.00E+00	pop NW	2.59E+01	2.45E-01	3.30E-04	3.45E+05	7.23E+02	4.00E-04	2.89E-01
1.60E+01	MEI GP	5.18E+01	1.43E-05	3.30E-04	3.45E+05	8.44E-02	5.00E-04	4.22E-05
1.60E+01	pop GP	5.18E+01	3.00E-02	3.30E-04	3.45E+05	1.77E+02	5.00E-04	8.85E-02

Worker Radiological Dose Calculation

D(rem) =[Q(L) * ULD(rem/L) * T(s) * R(m3/s) * 3/2pir3(m-3)] + [MEI NW dose]

where:

T (s) W Max 15min x 60s/min = 9.00E+02

R (m) = radius of work area = 1.00E+01

Volume (m-3) = 3/2pir3 = 4.77E-04/m3

Bounding Scenario

receptor	Q (L)	ULD (rem/L)	T (s)	BR (m3/s)	Volume (m-3)	Dose (rem)	CF LCF/rem	LCF
MEI W	8.10E-01	1.31E+06	9.00E+02	3.30E-04	4.77E-04	2.23E+02	8.00E-04	1.79E-01
Pop W	worker population of 10 * MEI W dose =					2.23E+03	8.00E-04	1.79E+00

Nominal Scenario

receptor	Q (L)	ULD (rem/L)	T (s)	BR (m3/s)	Volume (m-3)	Dose (rem)	CF LCF/rem	LCF
MEI W	8.10E-01	3.45E+05	9.00E+02	3.30E-04	4.77E-04	5.88E+01	8.00E-04	4.70E-02
Pop W	worker population of 10 * MEI W dose =					5.88E+02	8.00E-04	4.70E-01

					population deaths from latent cancer fatalities or lethal exposure									
					worker		noninvolved worker		general public		total population		point estimate	
Alternative	accident	frequency per year	years	probability	nominal	bounding	nominal	bounding	nominal	bounding	nominal	bounding	nominal	bounding
No action	spray	1.10E-02	1.00E+01	1.10E-01	4.70E-01	1.00E+01	2.89E-01	6.56E+00	8.85E-02	2.01E+00	8.48E-01	1.86E+01	9.32E-02	2.04E+00
	flam gas	7.20E-03	1.00E+02	7.20E-01	3.13E-01	1.00E+01	5.28E-02	9.88E+00	9.95E-03	1.86E+00	3.76E-01	2.17E+01	2.71E-01	1.57E+01
	org nit fire	4.48E-04	1.00E+02	4.48E-02	1.00E+01	1.00E+01	3.17E+00	5.40E+01	5.97E-01	5.09E+00	1.38E+01	6.91E+01	6.17E-01	3.10E+00
	seismic-4	1.40E-04	1.00E+02	1.40E-02	9.68E-01	1.00E+01	1.63E-01	1.08E+01	3.07E-02	2.05E+00	1.16E+00	2.29E+01	1.63E-02	3.20E-01
Long term	spray	1.10E-02	2.00E+01	2.20E-01	4.70E-01	1.00E+01	2.89E-01	6.56E+00	8.85E-02	2.01E+00	8.48E-01	1.86E+01	1.86E-01	4.09E+00
	flam gas	7.20E-03	1.00E+02	7.20E-01	3.13E-01	1.00E+01	5.28E-02	9.88E+00	9.95E-03	1.86E+00	3.76E-01	2.17E+01	2.71E-01	1.57E+01
	org nit fire	4.48E-04	1.00E+02	4.48E-02	1.00E+01	1.00E+01	3.17E+00	5.40E+01	5.97E-01	5.09E+00	1.38E+01	6.91E+01	6.17E-01	3.10E+00
	seismic-4	1.40E-04	1.00E+02	1.40E-02	9.68E-01	1.00E+01	1.63E-01	1.08E+01	3.07E-02	2.05E+00	1.16E+00	2.29E+01	1.63E-02	3.20E-01
Fill & cap	spray	1.10E-02	1.20E+01	1.32E-01	4.70E-01	1.00E+01	2.89E-01	6.56E+00	8.85E-02	2.01E+00	8.48E-01	1.86E+01	1.12E-01	2.45E+00
	flam gas	7.20E-03	1.20E+01	8.64E-02	3.13E-01	1.00E+01	5.28E-02	9.88E+00	9.95E-03	1.86E+00	3.76E-01	2.17E+01	3.25E-02	1.88E+00
	org nit fire	4.48E-04	1.20E+01	5.38E-03	1.00E+01	1.00E+01	3.17E+00	5.40E+01	5.97E-01	5.09E+00	1.38E+01	6.91E+01	7.40E-02	3.71E-01
	seismic-4	1.40E-04	1.20E+01	1.68E-03	9.68E-01	1.00E+01	1.63E-01	1.08E+01	3.07E-02	2.05E+00	1.16E+00	2.29E+01	1.95E-03	3.84E-02
	sling exp	7.20E-03	1.20E+01	1.00E-04	9.76E-01	1.00E+01	1.64E-01	1.10E+01	3.10E-02	2.07E+00	1.17E+00	2.31E+01	1.17E-04	2.31E-03
in situ vit	spray	1.10E-02	1.60E+01	1.76E-01	4.70E-01	1.00E+01	2.89E-01	6.56E+00	8.85E-02	2.01E+00	8.48E-01	1.86E+01	1.49E-01	3.27E+00
	flam gas	7.20E-03	1.60E+01	1.15E-01	3.13E-01	1.00E+01	5.28E-02	9.88E+00	9.95E-03	1.86E+00	3.76E-01	2.17E+01	4.33E-02	2.50E+00
	org nit fire	4.48E-04	1.60E+01	7.17E-03	1.00E+01	1.00E+01	3.17E+00	5.40E+01	5.97E-01	5.09E+00	1.38E+01	6.91E+01	9.87E-02	4.95E-01
	seismic-4	1.40E-04	1.60E+01	2.24E-03	9.68E-01	1.00E+01	1.63E-01	1.08E+01	3.07E-02	2.05E+00	1.16E+00	2.29E+01	2.60E-03	5.12E-02
	ogd ruptur	1.00E-03	1.60E+01	1.60E-02	7.88E-02	1.00E+01	9.72E-02	3.63E+01	2.96E-02	5.50E+00	2.06E-01	5.18E+01	3.29E-03	8.29E-01
intermed	spray	1.10E-02	2.50E+01	2.75E-01	4.70E-01	1.00E+01	2.89E-01	6.56E+00	8.85E-02	2.01E+00	8.48E-01	1.86E+01	2.33E-01	5.11E+00
	flam gas	7.20E-03	2.50E+01	1.80E-01	3.13E-01	1.00E+01	5.28E-02	9.88E+00	9.95E-03	1.86E+00	3.76E-01	2.17E+01	6.76E-02	3.91E+00
	org nit fire	4.48E-04	2.50E+01	1.12E-02	1.00E+01	1.00E+01	3.17E+00	5.40E+01	5.97E-01	5.09E+00	1.38E+01	6.91E+01	1.54E-01	7.74E-01
	seismic-4	1.40E-04	2.50E+01	3.50E-03	9.68E-01	1.00E+01	1.63E-01	1.08E+01	3.07E-02	2.05E+00	1.16E+00	2.29E+01	4.07E-03	8.00E-02
	filtration	8.80E-06	2.50E+01	2.20E-04	3.91E-01	1.00E+01	5.48E-03	3.66E-01	1.04E-03	6.90E-02	3.98E-01	1.04E+01	8.75E-05	2.30E-03
	pretreat	6.50E-04	2.50E+01	1.63E-02	7.36E-03	2.79E-02	4.12E-04	1.57E-03	1.27E-04	4.80E-04	7.90E-03	3.00E-02	1.28E-04	4.87E-04
	canister	6.00E-01	2.50E+01	1.00E+00	1.81E-10	1.09E-07	1.02E-11	6.12E-09	1.12E-12	6.70E-10	1.92E-10	1.16E-07	1.92E-10	1.16E-07
no treat	spray	1.10E-02	2.25E+01	2.48E-01	4.70E-01	1.00E+01	2.89E-01	6.56E+00	8.85E-02	2.01E+00	8.48E-01	1.86E+01	2.10E-01	4.60E+00
	flam gas	7.20E-03	2.30E+01	1.66E-01	3.13E-01	1.00E+01	5.28E-02	9.88E+00	9.95E-03	1.86E+00	3.76E-01	2.17E+01	6.22E-02	3.60E+00
	org nit fire	4.48E-04	2.30E+01	1.03E-02	1.00E+01	1.00E+01	3.17E+00	5.40E+01	5.97E-01	5.09E+00	1.38E+01	6.91E+01	1.42E-01	7.12E-01
	seismic-4	1.40E-04	2.30E+01	3.22E-03	9.68E-01	1.00E+01	1.63E-01	1.08E+01	3.07E-02	2.05E+00	1.16E+00	2.29E+01	3.74E-03	7.36E-02
	filtration	8.80E-06	2.30E+01	2.02E-04	3.91E-01	1.00E+01	5.48E-03	3.66E-01	1.04E-03	6.90E-02	3.98E-01	1.04E+01	8.05E-05	2.11E-03
	pretreat	0.00E+00	0.00E+00	0.00E+00	7.36E-03	2.79E-02	4.12E-04	1.57E-03	1.27E-04	4.80E-04	7.90E-03	3.00E-02	0.00E+00	0.00E+00
	canister	6.00E-01	2.30E+01	1.00E+00	1.81E-10	1.09E-07	1.02E-11	6.12E-09	1.12E-12	6.70E-10	1.92E-10	1.16E-07	1.92E-10	1.16E-07
ext. treat	spray	1.10E-02	2.60E+01	2.86E-01	4.70E-01	1.00E+01	2.89E-01	6.56E+00	8.85E-02	2.01E+00	8.48E-01	1.86E+01	2.42E-01	5.31E+00
	flam gas	7.20E-03	2.60E+01	1.87E-01	3.13E-01	1.00E+01	5.28E-02	9.88E+00	9.95E-03	1.86E+00	3.76E-01	2.17E+01	7.03E-02	4.07E+00
	org nit fire	4.48E-04	2.60E+01	1.16E-02	1.00E+01	1.00E+01	3.17E+00	5.40E+01	5.97E-01	5.09E+00	1.38E+01	6.91E+01	1.60E-01	8.05E-01
	seismic-4	1.40E-04	2.60E+01	3.64E-03	9.68E-01	1.00E+01	1.63E-01	1.08E+01	3.07E-02	2.05E+00	1.16E+00	2.29E+01	4.23E-03	8.32E-02
	filtration	8.80E-06	2.60E+01	2.29E-04	3.91E-01	1.00E+01	5.48E-03	3.66E-01	1.04E-03	6.90E-02	3.98E-01	1.04E+01	9.10E-05	2.39E-03
	pretreat	6.50E-04	2.60E+01	1.69E-02	7.36E-03	2.79E-02	4.12E-04	1.57E-03	1.27E-04	4.80E-04	7.90E-03	3.00E-02	1.33E-04	5.06E-04
	canister	6.00E-01	2.60E+01	1.00E+00	1.81E-10	1.09E-07	1.02E-11	6.12E-09	1.12E-12	6.70E-10	1.92E-10	1.16E-07	1.92E-10	1.16E-07
combo 1	spray	1.10E-02	1.85E+01	2.04E-01	4.70E-01	1.00E+01	2.89E-01	6.56E+00	8.85E-02	2.01E+00	8.48E-01	1.86E+01	1.72E-01	3.78E+00
	flam gas	7.20E-03	2.60E+01	1.87E-01	3.13E-01	1.00E+01	5.28E-02	9.88E+00	9.95E-03	1.86E+00	3.76E-01	2.17E+01	7.03E-02	4.07E+00
	org nit fire	4.48E-04	2.60E+01	1.16E-02	1.00E+01	1.00E+01	3.17E+00	5.40E+01	5.97E-01	5.09E+00	1.38E+01	6.91E+01	1.60E-01	8.05E-01
	seismic-4	1.40E-04	2.60E+01	3.64E-03	9.68E-01	1.00E+01	1.63E-01	1.08E+01	3.07E-02	2.05E+00	1.16E+00	2.29E+01	4.23E-03	8.32E-02
	filtration	8.80E-06	2.60E+01	2.29E-04	3.91E-01	1.00E+01	5.48E-03	3.66E-01	1.04E-03	6.90E-02	3.98E-01	1.04E+01	9.10E-05	2.39E-03
	pretreat	6.50E-04	2.60E+01	1.69E-02	7.36E-03	2.79E-02	4.12E-04	1.57E-03	1.27E-04	4.80E-04	7.90E-03	3.00E-02	1.33E-04	5.06E-04
	canister	6.00E-01	2.60E+01	1.00E+00	1.81E-10	1.09E-07	1.02E-11	6.12E-09	1.12E-12	6.70E-10	1.92E-10	1.16E-07	1.92E-10	1.16E-07
	sling exp	0.00E+00	0.00E+00	1.00E+04	9.76E-01	1.00E+01	1.64E-01	1.10E+01	3.10E-02	2.07E+00	1.17E+00	2.31E+01	1.17E+04	2.31E+05
combo 2	spray	1.10E-02	1.60E+01	1.76E-01	4.70E-01	1.00E+01	2.89E-01	6.56E+00	8.85E-02	2.01E+00	8.48E-01	1.86E+01	1.49E-01	3.27E+00
	flam gas	7.20E-03	2.50E+01	1.80E-01	3.13E-01	1.00E+01	5.28E-02	9.88E+00	9.95E-03	1.86E+00	3.76E-01	2.17E+01	6.76E-02	3.91E+00
	org nit fire	4.48E-04	2.50E+01	1.12E-02	1.00E+01	1.00E+01	3.17E+00	5.40E+01	5.97E-01	5.09E+00	1.38E+01	6.91E+01	1.54E-01	7.74E-01
	seismic-4	1.40E-04	2.50E+01	3.50E-03	9.68E-01	1.00E+01	1.63E-01	1.08E+01	3.07E-02	2.05E+00	1.16E+00	2.29E+01	4.07E-03	8.00E-02
	filtration	8.80E-06	2.50E+01	2.20E-04	3.91E-01	1.00E+01	5.48E-03	3.66E-01	1.04E-03	6.90E-02	3.98E-01	1.04E+01	8.75E-05	2.30E-03
	pretreat	6.50E-04	2.50E+01	1.63E-02	7.36E-03	2.79E-02	4.12E-04	1.57E-03	1.27E-04	4.80E-04	7.90E-03	3.00E-02	1.28E-04	4.87E-04
	canister	6.00E-01	2.50E+01	1.00E+00	1.81E-10	1.09E-07	1.02E-11	6.12E-09	1.12E-12	6.70E-10	1.92E-10	1.16E-07	1.92E-10	1.16E-07
	sling exp	0.00E+00	0.00E+00	1.00E-04	9.76E-01	1.00E+01	1.64E-01	1.10E+01	3.10E-02	2.07E+00	1.17E+00	2.31E+01	1.17E-04	2.31E-03
phased	spray	1.10E-02	2.75E+01	3.03E-01	4.70E-01	1.00E+01	2.89E-01	6.56E+00	8.85E-02	2.01E+00	8.48E-01	1.86E+01	2.56E-01	5.62E+00
	flam gas	7.20E-03	3.10E+01	2.23E-01	3.13E-01	1.00E+01	5.28E-02	9.88E+00	9.95E-03	1.86E+00	3.76E-01	2.17E+01	8.39E-02	4.85E+00
	org nit fire	4.48E-04	3.10E+01	1.39E-02	1.00E+01	1.00E+01	3.17E+00	5.40E+01	5.97E-01	5.09E+00	1.38E+01	6.91E+01	1.91E-01	9.60E-01
	seismic-4	1.40E-04	3.10E+01	4.34E-03	9.68E-01	1.00E+01	1.63E-01	1.08E+01	3.07E-02	2.05E+00	1.16E+00	2.29E+01	5.04E-03	9.92E-02
	filtration	8.80E-06	3.10E+01	2.73E-04	3.91E-01	1.00E+01	5.48E-03	3.66E-01	1.04E-03	6.90E-02	3.98E-01	1.04E+01	1.08E-04	2.85E-03
	pretreat	6.50E-04	3.10E+01	2.02E-02	7.36E-03	2.79E-02	4.12E-04	1.57E-03	1.27E-04	4.80E-04	7.90E-03	3.00E-02	1.59E-04	6.03E-04
	canister	6.00E-01	3.10E+01	1.00E+00	1.81E-10	1.09E-07	1.02E-11	6.12E-09	1.12E-12	6.70E-10	1.92E-10	1.16E-07	1.92E-10	1.16E-07

JACOBS ENGINEERING GROUP INC.

DATE 7/12/92 SUBJECT SHEET NO. 2-2

BY DLS CHKD. JOB NO.

Δ other op. costs

29,100 canisters (10 m³ each) vs 21,400 canisters (10 m³ each) WHC Data Pkg.

		Δ$ (Thou)
Canisters	(29,100 − 21,400) × $20,000/each =	154,000
casks	(29,100 − 21,400) × $65,000/each =	500,500
		$654,500

Δ op. cost summary

Δ glass formers, etc	$85,267,000
Δ other op. costs	$654,500,000
total Δ op. costs	$739,767,000
previous op. costs	$4,427,000,000
new op costs	$5,166,767,000

or

$5,167 million
no sep. vitrification

JACOBS ENGINEERING GROUP INC.

DATE 7/12/96 SUBJECT SHEET NO. 1-1

BY DLS CHKD. JOB NO.

Ex Situ No Separations Calcination

preliminary FEIS (PFEIS)

There is no change from original HLW calcination which was 10,300 canisters (10 m^3)

Glass loading and blend factors do not apply to Calcination Alternative.

original and current op. costs

$3,233,000,000

or

$3,233 million
no. sep. calcination

JACOBS ENGINEERING GROUP INC.

DATE 7/12/96 SUBJECT SHEET NO. 1-3

BY DLL CHKD. JOB NO.

Ex Situ Extensive Separations

preliminary FEIS (PFEIS)

WHC Data Pkg HLW glass - 34% waste oxide loading, 1.0 blend factor

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

PFEIS HLW glass - 20% waste oxide, 1.2 blend factor

from mass balance info
1.31 E +03 MT glass formers
1.76 E +03 MT glass product

570 canisters
(1.17 m^3 each)

ratio glass formers

$$\frac{1.31\,E+03}{8.73\,E+02} = 1.50$$

ratio glass product

$$\frac{1.76\,E+03}{1.32\,E+03} = 1.33$$

WHC Data Pkg LAW glass - 25% Na_2O loading, 1.0 blend factor

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

PFEIS LAW glass - 15% Na_2O loading, 1.0 blend factor

from mass balance info
5.22 E +05 MT glass formers
6.43 E +05 MT glass product

ratio glass formers

$$\frac{5.22}{2.65} = 1.97$$

ratio glass product

$$\frac{6.43}{3.86} = 1.67$$

JACOBS ENGINEERING GROUP INC.

DATE 7/12/96 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 former cost is small compared to LAW glass formers, ratio all glass former cost from LAW ratio only.

Δ cost for glass formers

Category	previous $ (Thou)	ratio	Δ $ (Thou)
B_2O_3	57,500	1.97	79,323
LiO_2	10,500	1.97	
SiO_2	11,480	1.97	
MgO	2,050	1.97	
CaO	246	1.97	
Kerosene	10,525	1.67	50,113
Sulfur	62,927	1.67	
DCPD	672	1.67	
CPD	672	1.67	
Electricity	498,000	1.4 (same electricity ratio $\frac{new}{prev}$ as used for inter sep)	199,200
			$328,636

With addition of 2yrs startup time and with yrs of operation for LAW vitrification + separations about the same as previous, the reduced yrs of operation for HLW vitrification is very small in labor savings. Assume Δ labor = 0.

JACOBS ENGINEERING GROUP INC.

DATE 7/12/96 SUBJECT SHEET NO. 3-3

BY DL CHKD. JOB NO.

Δ other op. costs

	previous $(Thou)	ratio	Δ$ (Thou)
vaults	190,000	66/38 = 1.74	140,600
Canisters	4,480	570/448 = 1.27	1,210
Overpacks	6,720	570/448 = 1.27	1,814
			$ 143,624

add containers for LAW glass — Δ$ (Thou)

@ $1000 each (2.6 m^3 volume each)

$$\frac{3.51E+05\ m^3\ LAW\ glass}{2.6\ m^3/container} \times \$1000\ each = \$135,000$$

Δ Summary op. costs

LAW/HLW combined op. costs	$328,636,000
other op. costs	$143,624,000
LAW containers	$135,000,000
Δ total	$607,260,000
previous op. cost	$4,556,000,000
new op. cost	$5,163,000,000

or

$5,163 million
ext. separation

JACOBS ENGINEERING GROUP INC.

DATE 7/12/92 SUBJECT SHEET NO. 1-9

BY DKS CHKD. JOB NO.

Ex Situ Intermediate Separations
preliminary FEIS (PFEIS)

WHC Data Pkg 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

PFEIS HLW glass - 20% waste oxide loading, 1.2 blend factor

from mass balance info
2.58 E+04 MT glass formers
3.73 E+04 MT glass product

ratio glass formers

$\frac{2.58}{1.36} = 1.90$

ratio glass product

$\frac{3.73}{2.51} = 1.49$

WHC Data Pkg LAW glass -25% Na_2O loading, 1.0 blend factor

from mass balance info
2.81 E+05 MT glass formers
3.87 E+05 MT glass product

PFEIS LAW glass -15% Na_2O loading, 1.0 blend factor

from mass balance info
5.39 E+05 MT glass formers
6.45 E+05 MT glass product

ratio glass formers

$\frac{5.39}{2.81} = 1.92$

ratio glass product

$\frac{6.45}{3.87} = 1.67$

8-18
20

JACOBS ENGINEERING GROUP INC.

DATE 7/12/96 SUBJECT SHEET NO. 2-9

BY DLS CHKD. JOB NO.

Δ cost for glass formers

HLW

category	previous $ (Thou)	ratio	Δ$ (Thou)
SiO_2	452	1.90	4,232
B_2O_3	1,750	1.90	
Li_2O	2,500	1.90	
electricity	110,700	1.49	54,243
		total HLW Δ	$58,475

LAW

SiO_2	9,160	1.92	24,787
Al_2O_3	6,600	1.92	
CaO	2,322	1.92	
other electricity	159,300 × ½ (estimated)	1.67	94,750
Kerosene	8,670	1.67	
sulfur	46,990	1.67	
DCPD	504	1.67	
CPD	504	1.67	
		total LAW Δ	$119,537

Δ other costs

vaults	225,000	$\frac{66}{40}$ = 1.65	146,250
canisters	68,200	$\frac{12200}{6800}$ = 1.79	53,878
containers	42,625	1.79	33,674
casks	102,300	1.79	80,817
pads	26,000	1.79	20,540
		total other	$335,159

FORM 91-005-1 (4/81)

JACOBS ENGINEERING GROUP INC.

DATE 7/12/96 SUBJECT SHEET NO. 3-9

BY DLS CHKD. JOB NO.

Δ labor costs

total labor per TPA → $1,700,000,000

save 3 yrs on HLW op. (11 vs 14 yrs)

spend 3 yr on LAW op. (17 vs 14 yrs)

PFEIS yrs include 2 yrs of startup.

per Table 9-2 in TPA report

HLW vitr. → 1.1E+07 staff-hrs

LAW vitr. → 1.1E+07 staff-hrs

total staff hrs (everything) → 3.1E+07 staff-hrs

2.2E+07

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

$$\Delta \text{ labor costs} = \left[(1.1E+07)\tfrac{11}{14} + (1.1E+07)\tfrac{17}{14} - 2.2E+07\right] \$55/\text{hr}$$

Δ labor costs ≈ 0

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

add containers for LAW glass @$1000 each (2.6 m³ volume each) — Δ $ (thou)

$$\frac{3.51E+05 \text{ m}^3 \text{ LAW glass}}{2.6 \text{ m}^3/\text{container}} \times \$1000 \text{ each} = \$135,000$$

Δ summary op costs

HLW	$ 58,475,000
LAW	119,537,000
other	335,159,000
LAW containers	135,000,000
total Δ	648,171,000
previous op. cost	3,900,000,000
new op cost	$4,548,171,000

or $\boxed{\$4.548 \text{ million in tr. sep.}}$

FORM 91-005-1 (4/81)

JACOBS ENGINEERING GROUP INC.

DATE ~~2/15/96~~ 7/12/96 rev. SUBJECT revisions for PFEIS 7/12/96 SHEET NO. 4-~~8~~ 9 10-18 20

BY DLS CHKD. JOB NO.

Intermediate Separations
Low Bounding Case

(See Attachment for summary of results)

HLW @ 15%, ~~1.5~~ 1.2 bland factor
LAW @ 10%, ~~1.25~~ 1.0 bland factor

Low Bounding Case HLW glass – 15% waste oxide, ~~1.5~~ 1.2 bland

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) (total now, total prev., former prev.)
7.26E+04 MT glass product

ratio glass formers

$\frac{.6 \times 6.11}{1.36} = 2.70$

~~$\frac{6.11 E+04}{1.36 E+04} = 4.49$~~

ratio glass product

~~$\frac{7.26 E+04}{2.51 E+04} = 2.89$~~

$\frac{.69 \times 7.26}{2.51} = 2.0$

Low Bounding Case LAW glass – 10% sodium oxide loading, ~~1.25~~ 1.0 bland

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) (total now, total prev, former prev)
1.21E+06 MT glass product

ratio glass formers

$\frac{.77 \times 11}{2.81} = 3.01$

~~$\frac{11.0}{2.81} = 3.91$~~

ratio glass product

~~$\frac{12.1}{3.87} = 3.13$~~

$\frac{.50 \times 12.1}{3.87} = 2.50$

FORM 91-005-1 (4/81)

JACOBS ENGINEERING GROUP INC.

DATE ~~2/25/91~~ 7/12/96 rev. SUBJECT

BY DLS CHKD.

SHEET NO. 5 - ~~18~~ 9 11-18 20

JOB NO.

Δ cost for glass formers

HLW

category	$ (thousands) previous	ratio used	Δ	$ (thousands) Δ
SiO_2	452	~~4.49~~ 2.70	1,577	7,993
B_2O_3	1,750	~~4.49~~ 2.70	6,107	~~[illegible]~~
Li_2O	2,500	~~4.49~~ 2.70	8,725	
electricity	110,700	~~2.89~~ 2.00	~~209,223~~	110,700

17 yrs operation

total HLW Δ ~~$225,632~~ 118,693

LAW

SiO_2	9,160		~~3.91~~ 3.01	20,658		~~[illegible]~~
Al_2O_3	6,600		~~3.91~~ 3.01	19,206		34,345
CaO	2,322		~~3.91~~ 3.01	6,757		
other electricity	159,300	× ½	~~3.13~~ 2.5	169,655*		204,477
Kerosene	8,670		~~3.13~~ 2.5	18,467		
Sulfur	46,990		~~3.13~~ 2.5	100,089		
DCPD	504		~~3.13~~ 2.5	1,074		
CPD	504		~~3.13~~ 2.5	1,074		

total LAW Δ ~~$342,977~~ 240,822

26 yrs operation

* previously calculated in error @ $90,005

Δ Other Op. Cost

	$ previous (thousands)	HLW ratio	LAW ratio	Δ	$ (thousands) Δ
vaults	225,000		$\frac{124}{40} = 3.10$ $\frac{98}{40} = 2.45$	~~472,500~~	333,000
canisters	66,200	$\frac{44500}{6600} = 6.54$	— $\frac{18900}{6800} = 2.78$	~~[illegible]~~ 230	121,342
containers	42,625	6.54	— 2.78	~~236,140~~	304,241
casks	102,300	6.54	— 2.78	566,740	
pails	26,600	6.54	— 2.78	~~147,040~~	

total Δ other op costs ~~$1,047,250~~ 758,642

FORM 91-005-1 (4/81)

JACOBS ENGINEERING GROUP INC.

DATE ~~2/15/96~~ 7/12/96 rev. SUBJECT

BY DLS CHKD.

SHEET NO. 6-~~20~~ 9 (12-18 20)

JOB NO.

△ labor costs

new HLW hrs = (1.1E+07) × ~~17~~ 16 / 14 = ~~1.34~~ 1.26 E+07

new LAW hrs = (1.1E+07) × ~~24~~ 21 / 14 = ~~2.04~~ 1.79 E+07

~~3.38~~ 3.15 E+07 vs 2.2E+7 before

△ labor cost = (~~3.38~~ 3.15 E+07) − (2.2E+07) × $55/hr

△ labor costs = ~~$649,000,000~~ $522,500,000

△ summary on op. costs

△ HLW	$ ~~225,632,000~~	115,693
△ LAW	~~342,977,000~~	240,822
△ other	~~1,797,250,000~~	758,642
△ labor	~~649,000,000~~	522,500,000
△ total	$ ~~3,014,859,000~~	202,500,000
	LAW containers	3,900,000,000
previous op. cost	3,900,000,000	
new op. cost	$6,914,859,000	$5,743,157,000

repository fee for ~~44,500~~ 18,900 canisters = ~~$7.8 billion~~ $7.190

LAW containers $\frac{99}{66} \times 135{,}000{,}000 = \$202{,}500{,}000$

low loading of cost for treatment

FORM 91-005-1 (4/81)

JACOBS ENGINEERING GROUP INC.

DATE ~~2/13/96~~ 7/12/96 SUBJECT rev

BY DLS CHKD.

SHEET NO. 7-9 (13-18 / 20)

JOB NO.

Intermediate Separations
High Bounding Case

HLW @ 40%, ~~1.5~~ 1.2 blend
LAW @ 25%, ~~1.25~~ 1.0 blend

High Bounding Case HLW glass – 40%, ~~1.5~~ 1.2 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 prod, total prod, formers prod)
2.72 E+04 MT glass product

ratio glass formers: $\frac{.6 \times 1.57}{1.36} = .69$ ~~$\frac{1.57}{1.36} = 1.15$~~

ratio glass product: $\frac{.69 \times 2.72}{2.51} = .75$ ~~$\frac{2.72}{2.51} = 1.08$~~

High Bounding Case LAW glass – 25%, ~~1.25~~ 1.0 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: $\frac{.77 \times 3.78}{2.81} = 1.04$ ~~$\frac{3.78}{2.81} = 1.35$~~

ratio glass product: $\frac{.80 \times 4.84}{3.87} = 1.00$ ~~$\frac{4.84}{3.87} = 1.25$~~

FORM 91-005-1 (4/81)

JACOBS ENGINEERING GROUP INC.

DATE ~~2/13/96~~ 7/12/96 rev. SUBJECT

BY DLS CHKD.

SHEET NO. 8-~~10~~ 9 14-18 20

JOB NO.

Δ cost for glass formers

HLW category	$ (Thousands) previous	ratio used	$ (Thousands) Δ	
SiO_2	452	~~1.15~~ .69	~~68~~	−1458
B_2O_3	1,750	~~1.15~~ .69	~~262~~	
Li_2O	2,500	~~1.15~~ .69	375	−27,675
electricity	110,700	~~1.08~~ .75	~~8856~~	

7 yrs operation — total HLW Δ $ ~~9,561~~ −29,133

LAW

SiO_2	9,160	~~1.35~~		~~3206~~	+723
Al_2O_3	6,600	~~1.35~~	1.04	~~2310~~	
CaO	2,322	~~1.35~~		~~813~~	
other electricity	159,300 × ½	~~1.25~~		~~19913~~	+0
Kerosene	8,670	~~1.25~~	1.00	~~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~~ +723

Δ other Op. Costs	$ previous (thou)	HLW ratio	LAW ratio	$ (Thousands) Δ	
vaults	225,000	—	$\frac{50}{40}=1.25$ $\frac{40}{40}=1$	~~56,250~~	0
Canisters	68,200	$\frac{16,700}{6800}=2.46$	— $\frac{7080}{6800}=1.04$	~~99,572~~	
Containers	42,625	2.46	— 1.04	~~62,232~~	956
Casks	102,300	2.46	— 1.04	~~149,358~~	
pots	26,000	2.46	— 1.04	~~37,960~~	

total Δ other $ ~~405,372~~ +956

FORM 91-005-1 (4/81)

JACOBS ENGINEERING GROUP INC.

DATE ~~2/13/96~~ 7/12/96 rev. SUBJECT

BY DLL CHKD.

SHEET NO. 9 - ~~10~~ 9 15-18 20

JOB NO.

△ labor costs

new HLW hrs = $(1.1E+07) \times \frac{\cancel{7}\,6}{14} = 0.\cancel{55}\,.47\,E+7$

new LAW hrs = $(1.1E+07) \times \frac{\cancel{7}\,9}{14} = \cancel{0.86}\,0.91\,E+7$

$\cancel{1.41}\,1.41\,E+7$ vs $2.2E+7$

△ labor cost = $(\cancel{1.41}\,1.41\,E+7) - (2.2\,E+7) \times \$55/hr$

△ labor costs = $-\cancel{\$434,500,000}$

$-561,000,000$

△ Summary on op. costs

△ HLW	$ ~~9,561,000~~	$-29,133,000$
△ LAW	~~40,410,000~~	$+723,000$
△ other	~~405,372,000~~	$+9,565,000$
△ labor	~~-434,500,000~~	$-561,000,000$
△ total	$ ~~20,843,000~~ LAW contain	$+81,818,000$
previous op. cost	$ 3,900,000,000	$+3,900,000,000$
new op. cost	$ ~~3,920,843,000~~	$3,401,973

repository fee for ~~11,700~~ 7080 canisters = $ ~~$10 billion~~ $2,967

LAW contains

$\frac{40}{66} \times 135,000,000 = \$81,818,182$

with locals op. cost for now

FORM 91-005-1 (4/81)

JACOBS ENGINEERING GROUP INC.

DATE 7/12/96 SUBJECT SHEET NO. 1-1

BY DLS CHKD. JOB NO.

Ex Situ / In Situ Combos

preliminary FEIS (PFEIS)

Category	Inter Sep.	Combo 1	(% of Inter)	Combo 2	(% of Inter)
vaults (LAW)	66	40	(61%)	24	(36%)
canisters (HLW)	12,200	8,540	(70%)	4,940	(40%)
op. costs	$4,548 million				
LAW	200 T/D	120 T/D		70 T/D	
HLW	20 T/D	8 T/D		5 T/D	
yr. op incl. startup	11 HLW / 17 LAW	13 HLW / 17 LAW		18 HLW / 17 LAW	

avg 46%

avg 38

if we assume about same manpower to operate each facility then Δ labor for op. yrs & factor other op. costs based on above percentages

Δ labor for combo 1 $\left[\frac{13}{11}(1.1E+07) - (1.1E+07)\right] \times \$55/hr = \$110{,}000$ million

Δ labor for combo 2 $\left[\frac{18}{11}(1.1E+07) - (1.1E+07)\right] \times \$55/hr = \$385{,}000$ million

Total op. costs

ΔHLW	58,475	.7(58,475)	.4(58,475)
ΔLAW	119,537	.61(119,537)	.36(119,537)
Δ other	335,159	.66(335,159)	.38(335,159)
LAW containers	135,000	.61(135,000)	.36(135,000)
Δ labor	—	110,000	385,000
prev. op cost	3,900,000	.66(3,900,000)	.38(3,900,000)
total op. cost	$4,548 million inter. sep.	$3,101 million combo 1	$2,109 million combo 2

FORM 91-005-1 (4/81)

JACOBS ENGINEERING GROUP INC.

DATE 7/12/96 SUBJECT SHEET NO. 1-2

BY DLS CHKD. JOB NO.

Phased Implementation

preliminary FEIS (PFEIS)

for phase 1 (which has not changed), keep op. costs for treatment the same at $1,500 million. Add $20 million for WR+T operating which was neglected previously.

Assign all extra op. costs due to changes in canister size, # canisters, containers, casks, vaults, extra glass, electricity, kerosene, etc to phase 2. Δ op. cost will therefore be about the same as inter. separations, except extra labor will have to be added to account for 2 plants now operating in phase 2.

Phase 2 - Δ Labor Estimate

per WHC data pkg for Inter. Sep - labor for LAW plant is 1.1E+07 hrs at $55/hr for 14 yrs operation but phase 2 LAW to operate 13 yrs. Therefore labor Δ will be ~ $1.1E+07 \text{ hrs} \times \frac{13}{14} \times \$55/\text{hr} = \$560{,}000{,}000$

Phase 2 op. costs

Δ labor costs	$560,000,000
inter Sep op. costs	$4,548,000,000
	$5,108,000,000

or $5,108 million phase 2

JACOBS ENGINEERING GROUP INC.

DATE 7/12/96 SUBJECT SHEET NO. 2-2

BY DLS CHKD. JOB NO.

Phased Implementation Summary

	Phase 1	Phase 2	Total
Current Op.	4900	3700	8600
R+D	0	190	190
Capital			
WR+T	—	2280	2280
Treatment	1328	3972	5300
Closure	41	170	211
total	1369	6422	7791
Operating			
WR+T	20	3990	4010
Treatment	1500	5108	6608
total	1520	9098	10618
Repository fee	—	5280	5280
Total Cost	7789	24690	32479

JACOBS ENGINEERING GROUP INC.

DATE 9/17/96 SUBJECT SHEET NO. 19/20

BY DSK CHKD. JOB NO.

Phased Impl.

	Phase 1	Phase 2	Total
Current Op.	4900	3700	8600
R + D	0	190	190
Capital			
WR + T	—	2280	2280
Treatment	1328	3972	5300
Closure	41	170	211
total Capital	1369	6422	7791
Operating			
WR + T	164 ~~20~~	3846 ~~3990~~	~~4010~~ 4010
Treatment	1500	5108	6608
Total Operating	~~1520~~ 1664	~~9098~~ ~~2147~~ 8954	~~10618~~ 10,618
Repository Fee	—	5280	5280
total Cost	~~7789~~ 7,933	~~24690~~ ~~24739~~ 24546	32479

FORM 91-005-1 (4/81)

Phased Implementation, Phase 1 Retrieval Cost

From Waste Retrieval and Transfer Data Package, Backup to Table 5-13, DST Retrieval Cost breakdown is as follows:

Mixer pumps	$251
Sluicing	$48
Transfer	$458
DST Total	$752

Now for Phase 1 readily retrievable DST liquid wastes would be transferred to the Phase 1 treatment facilities. This could involve the use of mixer pumps, however it is assumed that the use of mixer pumps would be limited during phase 1. If mixer pumps were to be utilized during phase one the $251 cost would be apportioned between Phase 1 and 2 with no net change for the total alternative. Sluicing of the residual sludges are assumed to take place during Phase 2. Approximately 10 of the 28 tanks would be transferred during Phase 1, so 10/28 x 458=$164 million would be required for Phase 1 DST waste transfers. Phase 2 DST waste transfers would be 18/28 x 458=$294 million. There would be some inefficiency from transferring liquids out during phase 1 and then coming back to retrieve the remaining waste during phase 2, so the phase 2 transfer cost is increased by 10% to 1.1x294= $323 million.

DST waste transfer:

Phase 1 = $164 million
Phase 2 = $323 million
Total = $478 million

Old Total = $458 million
Net Change = $20 million

Table B.8.2.1 Attachment

Inter. Sep. Sensitivity Summary

Cost Summary	Low Loading	Base Case	High Loading
Current Operations	8,600	8,600	8,600
R+D	820	820	820
Capital	6,049	6,049	6,049
Operating	10,563	9,368	8,222
Repository Fee	7,190	5,280	2,967
Total Cost	33,222	30,117	26,658

TWRS EIS
CALCULATION COVER SHEET

DISCIPLINE & TITLE Engineering / Number of Canisters, trips, and Curie Concentrations in the HLW for Radtran input for all Exsitu Alternatives

ORIGINATOR Colin Henderson DATE 7/5/96

REVISION NO. 2*

OBJECTIVE Using Revised Waste blending factors, Calculate the number of Canisters, trips, and isotopic Concentrations in the HLW Product for the TWRS FEIS.

METHODOLOGY Using WHC data Package material balances to determine Curie Concentrations in the original analysis Ratio by the Change in Volume to determine new Concentrations. Combination alternatives based on % recovery on an isotope by isotope basis.

ASSUMPTIONS Noted.

(Continue on another sheet if necessary)

* Supersedes in total previous Calc Rev 1 dated 2/9/96.

7/5/96
SIGNATURE/DATE

8/22/96
CHECKED/DATE

CALCULATION & RESULTS
ATTACHED

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 1.17 m^3 (2X canister), except No Separations Vit and Calcination HLW canister is 10 m^3
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 by using the Extensive Separations material balance for Cs, Sr, Tc, and TRU elements.
8. For purposes of interim onsite storage and transportation to the repository 4 of the 2x and 1 of the 10 m^3 canisters 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					

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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		

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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							

No Separations Alternative FEIS (7/5/96)					
	20 wt% sodium oxide loading, 1.2 blending factor				
			Vitrification		**Calcination**
			Radionuclide		Radionuclide
			Concentration		Concentration
			Curies /m^3		Curies /m^3
Am-241			3.57E-01		1.08E+00
Am-243			1.14E-04		3.46E-04
Cm-244			4.05E-04		1.23E-03
Cs-137			1.20E+02		3.64E+02
Ni-63			9.23E-01		2.80E+00
Np-237			2.39E-04		7.26E-04
Pu-238			3.71E-03		1.13E-02
Pu-239			9.06E-02		2.75E-01
Pu-240			2.30E-02		6.98E-02
Pu-241			2.57E-01		7.80E-01
Ru-106			1.30E-07		3.95E-07
Sm-151			2.16E+00		6.56E+00
Sn-126			2.15E-03		6.53E-03
Sr-90			1.50E+02		4.54E+02
Tc-99			1.10E-01		3.34E-01
U-233			4.15E-08		1.26E-07
U-234			7.28E-07		2.21E-06
U-235			7.07E-05		2.15E-04
U-238			1.65E-03		5.01E-03
Zr-93			1.35E-02		4.10E-02
Total (m3)			2.91E+05		9.60E+04
Number of 10 m^3 canisters			2.91E+04		10300
Number of 10 m^3 canisters per HMPC			1		1
Number of trips to the repository			2910		1030
Based on 10 HMPCs per train and rounded to nearest whole trip					
Note: Curies from decay daughter products not included					

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Intermediate Separations FEIS Case (7/5/96)			
20 wt% waste oxide loading, 1.2 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 6.58E+00	4.26E+00		1.14E+01
Am-243 2.11E-03	1.36E-03		3.63E-03
C-14 0.00E+00	0.00E+00		0.00E+00
Cm-244 3.88E-03	2.51E-03		6.70E-03
Cs-135 9.88E-03	6.39E-03		1.70E-02
Cs-137 2.44E+03	1.58E+03		4.20E+03
I-129 0.00E+00	0.00E+00		0.00E+00
Ni-63 1.84E+01	1.19E+01		3.18E+01
Np-237 4.35E-03	2.81E-03		7.49E-03
Pu-238 7.24E-02	4.68E-02		1.25E-01
Pu-239 1.71E+00	1.11E+00		2.95E+00
Pu-240 4.41E-01	2.85E-01		7.61E-01
Pu-241 5.14E+00	3.32E+00		8.86E+00
Ra-226 0.00E+00	0.00E+00		0.00E+00
Ru-106 2.50E-06	1.62E-06		4.31E-06
Sm-151 4.35E+01	2.81E+01		7.49E+01
Sn-126 3.29E-02	2.13E-02		5.68E-02
Sr-90 3.69E+03	2.38E+03		6.36E+03
Tc-99 4.15E-01	2.68E-01		7.15E-01
Th-230 2.70E-09	1.75E-09		4.65E-09
U-233 7.90E-07	5.11E-07		1.36E-06
U-234 1.38E-05	8.94E-06		2.38E-05
U-235 1.38E-03	8.94E-04		2.38E-03
U-238 3.16E-02	2.04E-02		5.45E-02
Zr-93 2.70E-01	1.75E-01		4.65E-01
Total (m3) 1.43E+04	2.21E+04		8.28E+03
Number of 1.17 m^3 canisters 1.22E+04	1.89E+04		7.08E+03
Number of 1.17 m^3 can/HMPC 4	4		4
Number of HMPCs 3050	4718		1769
Number of trips to the repository 305	473		177
Note: Curies from decay daughter products not included			
Note: Separations efficiency for Cs and Sr is expected to be lower than used for this analysis and would result in lower Cs and Sr concentrations in the HLW. Numbers were not changed in order to bound impacts			

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Extensive Separations alternative FEIS Case (7/5/96)								
	20 wt% waste oxide loading, 1.2 blending factor							
		Extensive Separations Data Package values						
		Radionuclide Inventory			HLW Glass			
					Base Case (A-1)			
					Ci/m3			
		Am-241			1.55E+02			
		Am-243			4.97E-02			
		C-14			0.00E+00			
		Cm-244			1.71E-01			
		Cs-135			2.16E-01			
		Cs-137			5.22E+04			
		I-129			0.00E+00			
		Ni-63			6.30E+00			
		Np-237			1.04E-01			
		Pu-238			1.60E+00			
		Pu-239			3.90E+01			
		Pu-240			9.89E+00			
		Pu-241			1.11E+02			
		Ra-226			4.01E-10			
		Ru-106			5.63E-05			
		Sm-151			0.00E+00			
		Sn-126			9.29E-01			
		Sr-90			7.95E+04			
		Tc-99			4.78E+01			
		Th-230			5.80E-08			
		U-233			2.74E-08			
		U-234			5.02E-07			
		U-235			4.88E-05			
		U-238			1.14E-03			
		Zr-93			7.13E-02			
		total m3			6.67E+02			
Number of 0.62 m^3 canisters					5.70E+02			
Number of 0.62 m^3 can/HMPC					4			
Number of HMPCs					143			
Number of trips to the repository					15			
Based on 10 HMPCs per train and rounded to nearest whole number								
Note: Curies from decay daughter products not included								

Ex Situ /In Situ Combination 1 Alternative FEIS Case (7/5/96)								
	20 wt% waste oxide loading, 1.2 blending factor							
	Radionuclide Inventory			HLW glass		Sel Ret. Recovery		
						fraction		
				Ci/m^3				
	Am-241			7.22E+00		7.67E-01		
	Am-243			2.77E-03		9.20E-01		
	C-14			0.00E+00		9.00E-01		
	Cm-244			5.22E-03		9.40E-01		
	Cs-135			1.20E-02		8.50E-01		
	Cs-137			3.06E+03		8.80E-01		
	I-129			0.00E+00		9.00E-01		
	Ni-63			2.11E+01		8.00E-01		
	Np-237			5.79E-03		9.32E-01		
	Pu-238			4.11E-02		3.97E-01		
	Pu-239			1.53E+00		6.27E-01		
	Pu-240			3.83E-01		6.07E-01		
	Pu-241			4.15E+00		5.65E-01		
	Ra-226			0.00E+00		8.30E-01		
	Ru-106			1.32E-06		3.70E-01		
	Sm-151			4.47E+01		7.20E-01		
	Sn-126			3.44E-02		7.30E-01		
	Sr-90			3.69E+03		7.00E-01		
	Tc-99			5.34E-01		9.00E-01		
	Th-230			3.16E-09		8.20E-01		
	U-233			9.04E-07		8.00E-01		
	U-234			1.60E-05		8.10E-01		
	U-235			1.80E-03		9.10E-01		
	U-238			4.07E-02		9.00E-01		
	Zr-93			2.59E-01		6.70E-01		
	Total (m3)			9.99E+03				
Number of 1.17 m^3 canisters				8.54E+03				
Number of 1.17 m^3 can/HMPC				4				
Number of HMPCs				2134				
Number of trips to the repository				214				
Based on 10 HMPCs per train and rounded to nearest trip								
Note the combination alt. retrieval fraction is calculated from the % of SST and DST inventory								
recovered as follows: recovery fraction = (curies recovered from SSTs + Curies from DSTs)								
divided by (total curies in the SSTs+total curies in DSTs)								
Note: Curies from decay daughter products not included								

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Ex Situ /In Situ Combination 2 Alternative FEIS Case (7/5/96)								
	20 wt% waste oxide loading, 1.2 blending factor							
	Radionuclide Inventory			HLW glass		Sel Ret. Recovery		
						fraction		
				Ci/m^3				
	Am-241			1.19E+01		7.30E-01		
	Am-243			3.18E-03		6.10E-01		
	C-14			0.00E+00		8.00E-01		
	Cm-244			6.63E-03		6.90E-01		
	Cs-135			1.25E-02		5.10E-01		
	Cs-137			5.00E+03		8.30E-01		
	I-129			0.00E+00		8.10E-01		
	Ni-63			1.28E+01		2.80E-01		
	Np-237			8.49E-03		7.90E-01		
	Pu-238			2.33E-02		1.30E-01		
	Pu-239			1.23E+00		2.90E-01		
	Pu-240			3.05E-01		2.80E-01		
	Pu-241			2.67E+00		2.10E-01		
	Ra-226			0.00E+00		3.00E-01		
	Ru-106			5.57E-07		9.00E-02		
	Sm-151			2.26E+01		2.10E-01		
	Sn-126			1.79E-02		2.20E-01		
	Sr-90			3.28E+03		3.60E-01		
	Tc-99			8.72E-01		8.50E-01		
	Th-230			1.80E-09		2.70E-01		
	U-233			9.37E-07		4.80E-01		
	U-234			8.54E-06		2.50E-01		
	U-235			1.71E-03		5.00E-01		
	U-238			3.98E-02		5.10E-01		
	Zr-93			7.34E-02		1.10E-01		
	Total (m3)			5.78E+03				
Number of 1.17 m^3 canisters				4.94E+03				
Number of 1.17 m^3 can/HMPC				4				
Number of HMPCs				1230				
Number of trips to the repository				124				
Based on 10 HMPCs per train and rounded to nearest trip								
Note the combination alt. retrieval fraction is calculated from the % of SST and DST inventory								
recovered as follows: recovery fraction = (curies recovered from SSTs + Curies from DSTs)								
divided by (total curies in the SSTs+total curies in DSTs)								
Note: Curies from decay daughter products not included								

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Phased Implementation alternative FEIS Case (7/5/96)			
	20 wt % waste oxide loading, 1.2 blending factor		
			Base Case
	Radionuclide Inventory		HLW
			glass
			Ci/m^3
	Am-241		7.26E+00
	Am-243		2.32E-03
	C-14		0.00E+00
	Cm-244		7.99E-03
	Cs-135		1.01E-02
	Cs-137		2.44E+03
	I-129		0.00E+00
	Ni-63		1.84E+01
	Np-237		4.34E-03
	Pu-238		7.24E-02
	Pu-239		1.82E+00
	Pu-240		4.62E-01
	Pu-241		5.18E+00
	Ra-226		1.88E-11
	Ru-106		2.50E-06
	Sm-151		4.34E+01
	Sn-126		3.29E-02
	Sr-90		3.72E+03
	Tc-99		2.23E+00
	Th-230		2.70E-09
	U-233		7.90E-07
	U-234		1.38E-05
	U-235		1.38E-03
	U-238		3.16E-02
	Zr-93		2.70E-01
	Total (m3)		1.43E+04
Number of 1.17 m^3 canisters			1.22E+04
Number of 1.17 m^3 can/HMPC			4
Number of HMPCs			3051
Number of trips to the repository			305
Based on 10 HMPCs per train and rounded to nearest trip			
Note: Curies from decay daughter products not included			
Note: Separations efficiency for Cs and Sr is expected to be lower than used for this analysis and would			
result in lower Cs and Sr concentrations in the HLW. Numbers were not changed in order to bound impacts			
In order to bound the HLW transportation impacts the separations efficiency (total curies)			
of Cs, Tc, Sr, and TRU elements was assumed to be the same as Extensive Separations			
other isotopes were assumed to be the same as Intermediate Separations			

TWRS EIS
CALCULATION COVER SHEET

DISCIPLINE & TITLE ENGINEERING / LAND USE NUMBERS FOR FEIS.

ORIGINATOR Cain Henderson DATE 6/25/96

REVISION NO. ~~0~~ 1 7/8/96.

OBJECTIVE Identify the Temporary and permanent land use Commitments for each of the alternatives

METHODOLOGY Land use requirements and locations were summarized on a spreadsheet. The summarized numbers were then added together as appropriate for the Section 5 tables as shown.

ASSUMPTIONS This Land use Calc supersedes all previous land use calcs. Percentage of shrub-steppe at each potential area of disturbance is as noted. Land use requirements derived from resource requirements calculation. Land use requirements for permanently disturbed area do not exactly match the areas used to derive resources. This is because the land use areas are based on generalized foot prints and the barrier area includes a buffer zone.

(Continue on another sheet if necessary)

Rev 1 Revised Combo 1 & Combo 2

SIGNATURE/DATE

RW 8-1-96
CHECKED/DATE

CALCULATION & RESULTS
ATTACHED

JACOBS\FORMS\CALCVR.SHT

JACOBS ENGINEERING GROUP INC.

DATE _____ SUBJECT _____ SHEET NO. 2/14

BY _____ CHKD. _____ JOB NO. _____

LAND USE CALCULATION:

LAND USE IS A Combination of the area disturbed during remediation and during Closure. The remediation disturbance is made up of disturbances at the tank farms, at Pit 30 for borrow site requirements (Sand & Gravel for Concrete), and in the 200 Areas for Retrieval & Transfer and waste treatment facilities.

- Treatment facility disturbances were scaled from Facility Layout drawings.

- Borrow site disturbances were calculated using the Volume of borrow required and a 3m excavation depth.

- Tank farms were assumed to cover 17 ha.

- Tank farms Covered with barriers were assumed to cover 25 ha.

Shrub-Steppe disturbance percentages taken from previous habitat Calculations developed for the DEIS.

The following spreadsheet contains entries for each land use Component by alternative. These components are then summed together as required for the EIS Section 5 tables.

FORM 91-005-1 (4/81)

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Alternative	Location	Remediation Temporary Disturbance hectares	Remediation Temporary Disturbance % Shrub-Steppe	Remediation Shrub-Steppe Impacts hectares	Remediation Permanent Disturbance hectares	Post Remediation (Closure) Temporary Disturbance hectares	Temporary Dist. % Shrub-Steppe	Temporary Shrub-Steppe hectares	Temporary Shrub-Steppe hectares	Permanent Disturbance hectares	Permanent Dist % shrub-steppe	Permanent SS Dist. hectares
No Action												
	Tank Farms	0								17		
Long Term Management												
	Tank Farms									17		
	New Tank Farms	50	20%	10	8							
	Pit 30 (tank construction)	16	90%	14								
	Total	66		24	8					17		0
In Situ Fill and Cap												
	Tank Farms(operations)	1	0%	0	17						0	
	Pit 30 (operations)	25	90%	23								
	Tank Farms (barrier const.)					20	0	0		8		
	Pit 30 (barrier)					14	0.9	13			0.9	
	McGee					16	0.75	12				
	Vernita					21	0.8	17				
	Total	26		23	17	71		42		8		0
In Situ Vitrification												
	Tank Farms (operations)	21	0%	0	17						0	
	Power Lines	70	33%	23								
	Pit 30 (operations)	23	90%	21								
	Tank Farms (barrier const.)					20	0	0		8	0	0
	Pit 30 (barrier)					14	0.9	13			0.9	
	McGee (barrier)					16	0.75	12			0.75	
	Vernita (barrier)					21	0.8	17			0.8	
	Total	114		44	17	71		42	0	8		0
Ex Situ Intermediate Separations												
	Retrieval Annexes	3	0%	0	0.4							
	Pit 30 (retrieval annexes)	1	90%	1								
	Vit Plant	85	67%	57	7							
	LAW Vaults				11					3	0	
	Pit 30 (treatment facilities)	35	90%	32								
	Tank Farms				17	24	0	0		8	0	
	Pit 30 (post rem)					45	0.9	41				
	McGee	0				17	0.75	13				
	Vernita	0				29	0.8	23				
	Total	124		90	35	115		77	0	11		0
Ex Situ No Separations												
	Retrieval Annexes	3	0%	0	0.4							
	Pit30 (ret annexes)	1	90%	1								
	Vit Plant	65	67%	44	3							
	LAW Vaults	0										
	Pit 30 (treatment facilities)	98	90%	88								
	Tank Farms				17	20	0	0		8	0	
	Pit 30 (post rem)					39	0.9	35				
	McGee					16	0.75	12				
	Vernita					21	0.8	17				
	Total	167		133	20	96		64	0	8		0
Ex Situ Extensive Separations												
	Retrieval Annexes	3	0%	0	0.4							
	Pit30 (ret annexes)	1	90%	1								
	Vit Plant	85	67%	57	7							
	LAW Vaults				9					3	0	
	Pit 30 (treatment facilities)	31	90%	28								
	Tank Farms	0			17	24	0	0		8	0	
	Pit 30 (post rem)	0				45	0.9	41				
	McGee					19	0.75	14				

A/14

Alternative	Location	Remediation Temporary Disturbance hectares	Remediation Temporary Disturbance % Shrub-Steppe	Remediation Shrub-Steppe Impacts hectares	Remediation Permanent Disturbance hectares	Post Remediation (Closure) Temporary Disturbance hectares	Temporary Dist. % Shrub-Steppe	Temporary Shrub-Steppe hectares	Temporary Shrub-Steppe hectares	Permanent Disturbance hectares	Permanent Dist % shrub-steppe	Permanent SS Dist. hectares		
	Vernita					32	0.8	26						
	Total	120		86	33	120		81	0	11		0		
Ex Situ/In Situ Combination - 1														
	Retrieval Annexes	2	0%	0	0.2									
	Pit30 (ret annexes)	1	90%	1										
	Vit Plant	83	67%	56	7									
	LAW Vaults				7					2	0			
	Pit 30 (treatment facilities)	34	90%	31										
	Tank Farms	0			17	22	0	0		8	0			
	Pit 30 (post rem)	0				28	0.9	25						
	McGee					16	0.75	12						
	Vernita					26	0.8	21						
	Total	120		88	31	92		58	0	10		0		
Ex Situ/In Situ Combination - 2														
	Retrieval Annexes	2	0%	0	0.2									
	Pit30 (ret annexes)	1	90%	1										
	Vit Plant	60	67%	40	4									
	LAW Vaults				4					1	0			
	Pit 30 (treatment facilities)	32	90%	29										
	Tank Farms				17	22	0	0		8	0			
	Pit 30 (post rem)					20	0.9	18						
	McGee					14	0.75	11						
	Vernita					24	0.8	19						
	Total	95		70	25	80		48	0	9		0		
Phased Implementation (Phase1)														
	Retrieval Annexes	0												
	Vit Plant	32		20										
	Pit 30	1		1										
	Tank Farms	0												
	Total	33		21	0									
Phased Imp's Total Alternative														
	Retrieval Annexes	3			0.4									
	Pit30 (ret annexes)	1	90%	1										
	Vit Plant	118	67%	79	7									
	LAW Vaults				11					3				
	Pit 30 (treatment facilities)	40	90%	36										
	Tank Farms				17	24	0	0		8				
	Pit 30 (post rem)					45	0.9	41						
	McGee					19	0.75	14						
	Vernita					32	0.8	26						
	Phase 1 Vit Plant				3									
	Total	195		116	38	120		81	0	11		0		
Capsules/No Action														
	WESF	0			0.6									
Capsules/On-Site Disposal														
	Dry-Well Facility	4		1.5	1.8									
Capsules/Overpack and Ship														
	Vit Site	2	0%											
Capsules/Vitrify with Tank Waste														
	Vit Site	1	0%											
All Capsule Alternatives														

5/14

	Table 5.7.1				Table 5.7.1					Table 5.14.1			
	Temporary Land Commitments				Permanent Land Commitments					200 Area Temp		200 Area Perm.	
	Remediation		Total		Remediation		Total			Remediation		Total	
	ha	(ac)	ha	(ac)	ha	(ac)	ha	(ac)		ha	(ac)	ha	(ac)
No Action	0	0	0	0	0	0	17	(42)		0	0	17	(42)
Long Term Management	66	(160)	66	(160)	8	(20)	25	(62)		50	(120)	25	(62)
In Situ Fill and Cap	26	(64)	97	(240)	17	(42)	25	(62)		21	(52)	25	(62)
In Situ Vitrification	110	(270)	190	(470)	17	(42)	25	(62)		110	(270)	25	(62)
Ex Situ Intermediate Separations	120	(300)	240	(590)	35	(86)	46	(110)		110	(270)	46	(110)
Ex Situ No Separations	170	(420)	263	(650)	20	(49)	28	(69)		90	(220)	28	(69)
Ex Situ Extensive Separations	120	(300)	240	(590)	33	(82)	44	(110)		110	(270)	44	(110)
Ex Situ/In Situ Combination -1	120	(300)	210	(520)	31	(77)	41	(100)		110	(270)	41	(100)
Ex Situ/In Situ Combination -2	100	(250)	180	(440)	25	(62)	34	(80)		80	(200)	34	(80)
Phased Implementation (Phase1)	33	(82)	33	(82)	0	0	0	0		32	(79)	0	0
Phased Imp. Total Alternative	**200**	**(490)**	**320**	**(790)**	5b **38**	**(94)**	4 **49**	**(120)**		180	(440)	49	(120)
Capsules No Action	0	0	0	0	0.6	(1.5)	0.6	(1.5)		0.6	(1.5)	0.6	(1.5)
Capsules On-Site Disposal	4	(10)	4	(10)	1.8	(4.4)	1.8	(4.4)		1.8	(4.4)	1.8	(4.4)
Capsules Overpack and Ship	2	(5)	2	(5)	0	0	0	0		0	0	0	0
Capsules Vitrify with Tank Waste	1	(2)	1	(2)	0	0	0	0		0	0	0	0
All Capsule Alternatives													

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	Table 5.14.1				Table 5.14.1		Table 5.14.1		Table 5.19.2			
	Borrow Sites		200 Area		Borrow Site		LAW Vault Area		Continued Access Restrictions			
	temporary		Shrub-Steppe		Shrub-Steppe				Remediation		Total	
	ha	(ac)	ha	(ac)	ha	(ac)	ha	(ac)	ha	(ac)	ha	(ac)
No Action	0	0	0	0	0	0	N/A		0	0	17	(42)
Long Term Management	16	(40)	10	(25)	14	(35)	N/A		8	(20)	25	(62)
In Situ Fill and Cap	76	(190)	0	0	65	(160)	N/A		17	(42)	25	(62)
In Situ Vitrification	74	(180)	23	(57)	63	(160)	N/A		17	(42)	25	(62)
Ex Situ Intermediate Separations	130	(320)	57	(140)	110	(270)	14	(35)	35	(86)	46	(110)
Ex Situ No Separations	180	(440)	44	(110)	150	(370)	N/A		20	(49)	28	(69)
Ex Situ Extensive Separations	130	(320)	57	(140)	110	(270)	12	(30)	33	(82)	44	(110)
Ex Situ/In Situ Combination -1	110	(270)	56	(140)	90	(220)	9	(22)	31	(77)	41	(101)
Ex Situ/In Situ Combination -2	91	(220)	20	(49)	78	(190)	5	(12)	25	(62)	34	(84)
Phased Implementation (Phase1)	1	(2)	20	(49)	1	(2)	N/A		0	0	0	0
Phased Imp. Total Alternative	140	(350)	99	(240)	120	(300)	14	(35)	38	(94)	49	(120)
Capsules No Action			0	0	0	0					0.6	[1.5]
Capsules On-Site Disposal			1.5	(3.7)	0	0					1.8	[4.4]
Capsules Overpack and Ship			0	0	0	0					none	
Capsules Vitrify with Tank Waste			0	0	0	0					none	
All Capsule Alternatives												

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	Table 5.4.1 Shrub-Steppe Habitat				Table 5.4.1 Shrub-Steppe Habitat				Table 5.4.1 Shrub-Steppe Habitat			
	200 Areas Remediation				Borrow Sites				Total			
	Temporary		Total		Remediation		Total		Remediation		Total	
	ha	(ac)	ha	(ac)	ha	(ac)	ha	(ac)	ha	(ac)	ha	(ac)
No Action	0	0	0	0	0	0	0	0	0	0	0	0
Long Term Management	10	(25)	10	(25)	14	(35)	14	(35)	24	(59)	24	(59)
In Situ Fill and Cap	0	0	0	0	23	(57)	65	(160)	23	(57)	65	(160)
In Situ Vitrification	23	(57)	23	(57)	21	(52)	63	(160)	44	(110)	86	(210)
Ex Situ Intermediate Separations	57	(140)	57	(140)	33	(82)	110	(270)	90	(220)	170	(420)
Ex Situ No Separations	44	(110)	44	(110)	89	(220)	153	(380)	130	(320)	200	(490)
Ex Situ Extensive Separations	57	(140)	57	(140)	29	(72)	110	(270)	86	(210)	170	(420)
Ex Situ/In Situ Combination -1	56	(140)	56	(140)	32	(79)	90	(220)	88	(220)	150	(370)
Ex Situ/In Situ Combination -2	40	(100)	40	(100)	30	(74)	78	(190)	70	(170)	120	(300)
Phased Implementation (Phase1)	20	(49)	20	(49)	1	(2)	1	(2)	21	(52)	21	(52)
Phased Imp. Total Alternative	99	(240)	99	(240)	37	(91)	120	(300)	**136**	**(340)**	**220**	**(540)**
Capsules No Action												
Capsules On-Site Disposal												
Capsules Overpack and Ship												
Capsules Vitrify with Tank Waste												
All Capsule Alternatives	<2	<5	0	0	0	0	0	0	<2	<5	<2	<5

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	Table 5.1.1				Table 5.1.1			
	Soil Disturbance Remediation				Soil Distsurbance Total Proj.			
	Temporary		Permanent		Temporary		Permanent	
	ha	(ac)	ha	(ac)	ha	(ac)	ha	(ac)
No Action	0	0	0	0	0	0	17	(42)
Long Term Management	66	(160)	8	(20)	66	(160)	25	(62)
In Situ Fill and Cap	26	(64)	17	(42)	97	(240)	25	(62)
In Situ Vitrification	110	(270)	17	(42)	180	(440)	25	(62)
Ex Situ Intermediate Separations	120	(300)	35	(86)	240	(590)	46	(110)
Ex Situ No Separations	170	(420)	20	(49)	260	(640)	28	(69)
Ex Situ Extensive Separations	120	(300)	33	(82)	240	(590)	44	(110)
Ex Situ/In Situ Combination -1	120	(300)	31	(77)	210	(520)	41	(100)
Ex Situ/In Situ Combination -2	100	(250)	25	(62)	180	(440)	34	(80)
Phased Implementation (Phase1)	33	(82)	0	0	33	(82)	0	0
Phased Imp. Total Alternative	200	(490)	38	(94)	320	(790)	49	(120)
Capsules No Action	0	0	0.6	(1.5)	0	0	0.6	(1.5)
Capsules On-Site Disposal	4	(10)	1.8	(4.4)	4	(10)	1.8	(4.4)
Capsules Overpack and Ship	2	(5)	0	0	2	(5)	0	0
Capsules Vitrify with Tank Waste	1	(3)	0	0	1	(2)	0	0
All Capsule Alternatives								

JACOBS ENGINEERING GROUP INC.

DATE _____ SUBJECT _____ SHEET NO. 9/14

BY _____ CHKD. _____ JOB NO. _____

Appended Material –

Supporting data used for developing Land Use numbers.

FORM 91-005-1 (4/81)

JACOBS ENGINEERING GROUP INC.

DATE _____ SUBJECT PERMANT DISTURBED AREA SHEET NO. 10/A

BY _____ CHKD. _____ FEIS - LAND USE PLANNING NOS. JOB NO. _____

REVISED LAND USE PLANNING NUMBERS

INTERMEDIATE SEPARATIONS: FACILITY SIZES

SCALED FROM SITE PLANS

200 Mt/day LAW = 160 x 160m = 25600 m²

20 mt/day HLW PLANT = 125m x 312m = 39000 m²

TOTAL = 25600 + 39000 = 65,000 ~ 70,000 = 7 ha.

Phased Implementation Phase 2.

Assume the Footprint for 100 mt/day LAW PLANT is 75% of the Footprint for 200 mt/day

Assume Footprint for 10 mt/day HLW plant is 75% of the 20 mt/day HLW plant

Permanent Commitment = 2 x .75 x 25600 m² + .75 x 39,000 m²

= 38400 + 29250

= 68,000 ~ 70,000 = 7 ha.

PERMANENT DISTURBANCE - EX SITU/IN SITU COMBINATION - 1

VIT PLANT SIZE HLW = 5 mt/day ; LAW = 120 mt/day

Assume 5 mt/day = 50% of 20 mt/day footprint
= .5 x 39,000 = 20,000 = 2 ha

Assume 120 mt/day Plant = 80% of 200 mt/day Plant (LLW)
= .8 x 25600 m² = 20480 = 2 ha

240 TOTAL VIT PLANT = 4 ha.

FORM 91-005-1 (4/81)

JACOBS ENGINEERING GROUP INC.

DATE _____ SUBJECT _____ SHEET NO. 11/14

BY _____ CHKD. _____ JOB NO. _____

PERMANENT DISTURBANCE EX SITU / IN SITU COMBINATION -2 (COMBOLOW)
3 mt/day HLW PLANT + 70 mt/day LAW PLANT
ASSUME PERMANENT DISTURBANCE
OF 3 mt/day HLW PLANT = PERM. DIST. 5 mt/day HLW

AND 70 mt/day LAW PLANT = 120 mt/day LAW PLANT

COMBO LOW PERM. DIST = 4 ha.

FORM 91-005-1 (4/81)

JACOBS ENGINEERING GROUP INC.

DATE _____ SUBJECT _____ SHEET NO. 12/14

BY _____ CHKD. _____ JOB NO. _____

LAND USE DATA FROM RESOURCE CALCS.

EX SITU INTERMEDIATE SEPARATIONS.

PIT 30

A. RETRIEVAL ANNEXES = No Change 1

B. WASTE TREATMENT = 18 + 17

C. CLOSURE (TANK STAB + BARRIER) = 45

McGEE RANCH

A BARRIER = 17 ha

Vernita

A BARRIER = 29 ha

EX SITU No SEPARATIONS.

PIT 30

	Retrieval annex (Included with Construction) 1 ha	Vitrifi		Calcination
		Construction	10 ha	10 ha
A. WASTE TREATMENT FACILITIES =		operation	88 ha	35
B. CLOSURE (TANK STAB + BARRIER) =		No Change	39 ha	39
	Retrieval 1 ha (Included with construction)		total = 138 ha	

EX SITU EXTENSIVE SEPARATIONS

PIT 30

A. Retrieval Annexes = No Change 1

B. WASTE Treatment FACILITIES = 17 + 14

C. CLOSURE (TANK STABILIZATION + BARRIER) = 45

McGee Ranch

BARRIER = 19 hectares

VERNITA

BARRIER = 32 ha

FORM 91-005-1 (4/81)

MONAO

JACOBS ENGINEERING GROUP INC.

DATE _____ SUBJECT _____ SHEET NO. 13/14

BY _____ CHKD. _____ JOB NO. _____

Ex Situ/In Situ Combination (1) - Original Combo

Pit 30

A. Retrieval Annexes = No Change 1

B. Waste Treatment Facilities = 14+9 + 8 = ~~23~~ 31 — Tank Stab + Vault Box

C. Closure (Tank Stab + Barrier) = ~~23~~ 28 — 39 Barrier over TF

Fill 107 Tanks = $\frac{107}{161} \times 7.58 ES \times \frac{1}{3} \times \frac{1}{10 pw} = 17h$

$\Sigma = 60$

McGee

Barrier = 16 ha

Vernita

Barrier = 26

Ex Situ/In Situ Combination-2 (Combo Low)

Vit Plant

Temporary Disturbance = Const ops 60

Permanent Disturbance = Const/ops 22

Pit 30

A. Retrieval Annexes = Same As Combination 1

B. Treatment Facilities = 6 + 6 > ~~30~~ 33 total

C. In Situ Tank Fill = ~~24~~ 21 ~~28~~ ha (161 tanks)

D. Closure (Stabilization 25 Tanks + Barrier) = ~~20~~ 20

4/ha =

$\Sigma = \underline{54}$ or 33

McGee

Barrier = 14 ha

Vernita

Barrier = 24 ha

Phased Implementation (Phase 2)

Vit Plants

Temp = Const ops = 118

Permanent = Const/ops = 47

FORM 91-005-1 (4/81)

JACOBS ENGINEERING GROUP INC.

DATE _____ SUBJECT _____ SHEET NO. 14/14

BY _____ CHKD. _____ JOB NO. _____

Phased Implementation (Phase 2 Cont.)

PIT 30

A. TREATMENT FACILITIES = 25 + 15

B. RETRIEVAL ANNEXES = SAME AS INTERMEDIATE 1

C. CLOSURE (TANK STAB + BARRIER) = 45

Σ = 86

McGEE

BARRIER 19 ha

Vernita

BARRIER = 32 ha

REVISED LONGTERM Management to include

16 ha @ Pit 30 for Construction SAND/GRAVEL

Revised ISV to include

3 ha @ Pit 30 for Concrete SAND/gravel

for construction

FORM 91-005-1 (4/81)

TWRS EIS
CALCULATION COVER SHEET

DISCIPLINE & TITLE ENGINEERING / ADDITIONAL COST OF CHARACTERIZATION ASSOCIATED WITH INSITU ALTERNATIVES

ORIGINATOR COLIN HENDERSON DATE 3/20/96

REVISION NO. 0

OBJECTIVE ESTIMATE (ROM) THE ADDITIONAL COSTS REQUIRED FOR CHARACTERIZATION UNDER THE INSITU ALTERNATIVES.

METHODOLOGY NOTED.

ASSUMPTIONS NOTED.

(Continue on another sheet if necessary)

J.C. Henderson
SIGNATURE/DATE

3-25-96
CHECKED/DATE

CALCULATION & RESULTS
ATTACHED

JACOBS\FORMS\CALCVR.SHT

Additional Cost of Characterization Associated with the In Situ Alternatives

Per conversation with John Guberski (WHC) and David Forehand (WHC) the current cost of characterization is approximately 4-4.5 million dollars per tank. Of this cost approximately 50% is cost associated with laboratory analysis and 50% is cost associated with taking the samples, maintaining the equipment, personnel...

Additional WHC contacts regarding available information for additional sampling requirements included John Garfield and Vern Hall. No specific information regarding additional costs was obtained. There was a consensus that additional characterization would be required for wastes that would be disposed of in place. The additional characterization would include both an increased number of samples and additional laboratory analyses.

Reviewed the Systems Engineering Study for the Closure of Single Shell Tanks WHC-EP-0405, the Tank Waste Technical Options Report WHC-EP-0616, and the Waste Characterization Plan for the Hanford Site Single Shell Tanks WHC-EP-0210 Revision 1,2, and 3. None of these documents provided specific information regarding the additional characterization requirements for in situ alternatives.

Relevant to the SSTs there is an average of 2 risers per tank that can be used for sampling.

Assumptions:
1. The characterization program would involve approximately two times the number of core samples and would require additional rises to be installed to facilitate sampling.
2. Assume that the additional number of core samples and additional risers would be approximately two times the current cost per tank of taking samples.
3. Assume that the laboratory cost would increase by a factor of 2.24 to account for RCRA analysis requirements.

The current cost of 4.5 million per tank is broken down at 50% for lab analysis and 50% for other activities associated with sampling.

The new characterization cost per tank would then be:

$4.5 \times 0.5 \times 2 + 4.5 \times 0.5 \times 2.25 = 9.6$ million per tank
this is an increase of 5.1 million per tank

5.1million/tank x 177 tanks = 903 million dollars (1995)

Thus adding 903 million to the current operations cost for the In Situ Fill and Cap and In Situ Vitrification alternatives would provide for additional characterization. The Ex Situ/In Situ Combination alternative would be 60% or 542 million dollars.

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JUL - 1 1996
Antoine

TWRS EIS
CALCULATION COVER SHEET

DISCIPLINE & TITLE ENGR / COST
Preliminary FEIS Capital Treatment Costs

ORIGINATOR D. Stem DATE 7/12/96

REVISION NO. ~~3~~ 4

OBJECTIVE Re-estimate capital treatment costs for combo 1, combo 2, and phased impl. based on inter. sep. costs

METHODOLOGY Compare plant sizes to inter. sep. and factor costs using engr. judgement

ASSUMPTIONS "six tenths" factor rule for estimating plant costs is applicable with re-evaluation of most appropriate exponent for plants of this type

(Continue on another sheet if necessary)

JC Hale 8/26/96 D.T. Stem
CHECKED SIGNATURE

CALCULATION & RESULTS ATTACHED

6 ~~5~~ pages total excluding cover sheet

JACOBS\FORMS\CALCVR.SHT

6.18.2

1/6

TWRS Alternative Capital Costs

Alternative Capital costs were re-estimated for the Final EIS for Ex Situ/In Situ Combination 1 and Combination 2 alternatives, and the Phased Implementation treatment facilities based on Ex Situ Intermediate Separations costs. This re-estimation was done by re-evaluating the cost methodology used for scaling capital cost for different sized facilities from a base facility size and cost. The following tables summarize three approaches for estimating costs. Each approach uses different size exponents in the scaling equation:

COST OF PLANT A = COST OF PLANT B * (CAPACITY A/CAPACITY B)^x

Approach 1 uses an exponent of 0.64 for all facilities. The 0.64 exponent was selected based on the data compilation presented in Chemical Engineering Economics by Donald E. Garret, Van Nostrand Reinhold, New York, 1989. This reference recommends using a 0.64 factor for all plants where more accurate plant-specific factors are unavailable. Approach 2 uses different exponent values deem appropriate for each type of plant being scaled (HLW, LAW, central facilities, and separations). Approach 3 is a combination of approaches 1 and 2 and uses a lower scaling exponent (results in a higher capital cost estimate when scaling downward) for the HLW treatment facility. Approach 3 results in the same total capital cost as approach 1 and slightly higher capital cost than approach 2. To be conservative the approach 3 (or approach 1) costs were used in the alternative capital cost estimates since they were higher.

It is recognized that there is considerable uncertainty in scaling capital costs based on plant capacities when the plant capacities vary considerably. This is especially true for shielded nuclear facilities where the cost associated with concrete shielding is a significant portion of the capital cost. However, capital cost scaling is commonly used in the preconceptual engineering stages to develop rough-order-of-magnitude cost estimates. It is also recognized that using the base case cost per train in scaling results in slightly lower capital cost estimates than using the total cost for the 2 train base case (about 28% lower for the Combo 2 LAW plant). However, it was felt that scaling off of the cost per train was appropriate in some cases.

The cost uncertainty analysis used lower probabilities and (or) higher uncertainty ranges for the alternatives that were scaled to account for the higher level of uncertainty associated with scaling capital costs. This results in a larger cost range for the scaled alternatives as compared to the cost range that would result if the scaled alternatives used probabilities and ranges similar to the non-scaled alternatives. In summary the results are:

Summary of Results

Alternative	Capital COST (millions)
Ex Situ/In Situ Combination 1	$1,926
Ex Situ/In Situ Combination 2	$1,383
Phased Implementation - Phase 1	$1,328
Phaed Implementation - Phase 2	$3,972
Phased Implementation - Total	$5,300

SUMMARY OF RESULTS

CASE	Approach 1, $MM	Approach 2, $MM	Approach 3, MM
Intermediate Separations	3,600	3,600	3,600
Combo 1	1,926	1,906	1,926
Combo 2	1,383	1,256	1,383
Phase 1, Phased Implementation	1,328	1,080	1,328
Phase 2, Phased Implementation	3,972	3,922	3,972
Total Phased Implementation	5,300	5,002	5,300

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PLANT COST ESTIMATE - APPROACH 1
Size exponent fixed at 0.64

CASE	PARAMETER	SEP-A	SEP-B	HLW	LAW-A	LAW-B	CNTR-A	CNTR-B	TOTAL
Intermediate Separation (Base Case)	Cost, $MM	380	None	1,400	1,300	None	520	None	3,600
	Capacity, tpd	200	None	20	200	None	200	None	n/a
	No. Trains	2	None	2	2	None	1	None	n/a
	Cost per Train	190	None	700	650	None	520	None	n/a
Combo 1 (Previous case)	Cost	244	None	898	834	None	334	None	2,310
	Capacity	100	None	10	100	None	100	None	n/a
	No. Trains	1	None	1	1	None	1	None	n/a
	Size Exponent	0.64	None	0.64	0.64	None	0.64	None	n/a
Combo 1 (Current Case)	Cost	214	None	607	730	None	375	None	1,926
	Capacity	120	None	8	120	None	120	None	n/a
	No. Trains	1	None	1	1	None	1	None	n/a
	Size Exponent	0.64	None	0.64	0.64	None	0.64	None	n/a
Combo 2 (Current Case)	Cost	151	None	449	517	None	266	None	1383
	Capacity	70	None	5	70	None	70	None	n/a
	No Trains	1	None	1	1	None	1	None	n/a
	Size Exponent	0.64	None	0.64	0.64	None	0.64	None	0.91
Phased Impl. -Phase I	Cost	None	(2 X 233)	160	232	232	119	119	~~1,005~~ 1,328
	Capacity	None	20	1	20	20	20	20	n/a
	No Trains	None	2 X	1	1	1	1	1	n/a
	Size Exponent	None	0.64	0.64	0.64	0.64	0.64	0.64	n/a
Phased Impl. -Phase II	Cost	None	(2 X 652)	700	650	650	334	334	~~3,919~~ 3,972
	Capacity	None	100	10	100	100	100	100	n/a
	No Trains	None	2 X	1	1	1	1	1	n/a
	Size Exponent	None	0.64	0.64	0.64	0.64	0.64	0.64	n/a

7/12/96

PLANT COST ESTIMATE - APPROACH 2

Plant	Analog	Size Exponent	Source
Separations	UF6	0.64	Garrett
HLW	Furnace	0.85	Guthrie
LAW	Furnace	0.85	Guthrie
Central	Cogeneration	0.75	Garrett

CASE	PARAMETER	SEP-A	SEP-B	HLW	LAW-A	LAW-B	CNTR-A	CNTR-B	TOTAL
Intermediate Separation (Base Case)	Cost, $MM	380	None	1,400	1,300	None	520	None	3,600
	Capacity, tpd	200	None	20	200	None	200	None	n/a
	No. Trains	2	None	2	2	None	1	None	n/a
	Cost per Train	190	None	700	650	None	520	None	n/a
Combo 1 (Previous case)	Cost	244	None	777	721	None	309	None	2,051
	Capacity	100	None	10	100	None	100	None	n/a
	No. Trains	1	None	1	1	None	1	None	n/a
	Size Exponent	0.64	None	0.85	0.85	None	0.75	None	n/a
Combo 1 (Current Case)	Cost	214	None	579	759	None	355	None	1,906
	Capacity	120	None	8	120	None	120	None	n/a
	No. Trains	1	None	1	1	None	1	None	n/a
	Size Exponent	0.64	None	0.85	0.85	None	0.75	None	n/a
Combo 2 (Current Case)	Cost	151	None	388	480	None	237	None	1256
	Capacity	70	None	5	70	None	70	None	n/a
	No Trains	1	None	1	1	None	1	None	n/a
	Size Exponent	0.64	None	0.85	0.85	None	0.75	None	1.00
Phased Impl. -Phase I	Cost	None	(2 × 233)	99	165	165	92	92	~~347~~ 1,080
	Capacity	None	20	1	20	20	20	20	n/a
	No Trains	None	2 ×	1	1	1	1	1	n/a
	Size Exponent	None	0.64	0.85	0.85	0.85	0.75	0.75	n/a
Phased Impl. -Phase II	Cost	None	(2 × 652)	700	650	650	309	309	~~3,270~~ 3,922
	Capacity	None	100	10	100	100	100	100	n/a
	No Trains	None	2 ×	1	1	1	1	1	n/a
	Size Exponent	None	0.64	0.85	0.85	0.85	0.75	0.75	n/a

7/12/96

Approach 3

5/6

CASE	PARAMETER	SEP-A	SEP-B	HLW	LAW-A	LAW-B	CNTR-A	CNTR-B	TOTAL
Intermediate Separation (Base Case)	Cost, $MM	380	None	1400	1300	None	520	None	$3,600
	Capacity, tpd	200	None	20	200	None	200	None	
	No. Trains	2	None	2	2	None	1	None	
	Cost Per Train	190	None	700	650	None	520	None	
Combo 1 (Current Case)	Cost, $MM	214	None	619	730	None	363	None	$1,926
	Capacity, tpd	120	None	8	120	None	120	None	
	No. Trains	1	None	1	1	None	1	None	
	Size Exponent	0.64	None	0.55	0.64	None	0.7	None	
Combo 2 (Current Case)	Cost, $MM	151	None	478	517	None	237	None	$1,383
	Capacity, tpd	70	None	5	70	None	70	None	
	No. Trains	1	None	1	1	None	1	None	
	Size Exponent	0.64	None	0.55	0.64	None	0.7	None	
Phased Impl Phase I	Cost, $MM	None	384	270	232	232	105	105	$1,328
	Capacity, tpd		20	1	20	20	20	20	
	No. Trains		2	2	1	1	1	1	
	Size Exponent		0.64	0.55	0.64	0.64	0.7	0.7	
Phased Impl Phase II	Cost, $MM	None	1076	956	650	650	320	320	$3,972
	Capacity, tpd		100	10	100	100	100	100	
	No. Trains		2	2	1	1	1	1	
	Size Exponent		0.64	0.55	0.64	0.64	0.7	0.7	

Notes: The 0.64 factor for Separations and LAW taken from Chemical Engineering Economics by Donald E. Garret, Von Nostrand Reinhold. The 0.55 factor for HLW was selected to yield a more conservative (higher) cost estimate than obtained using a 0.6 or a 0.64 factor. The 0.7 factor used for centralized facilities was selected to maintain consistency with the estimate results obtained from Approach 1 and is more conservative than the 0.75 factor used in Approach 2 (Garret).

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DATE _____ SUBJECT _____ SHEET NO. 6-6

BY _____ CHKD. _____ JOB NO. _____

Phased Implementation Separations

Assume separations to be 1/4 of the way between Intermediate Separations and Extensive Separations and will Cost 1/4 between the two.

From previous Calc (Dated 12/7)

Ext Sep = 2770 million more than the 380 in Int. Sep for pretreatment.

then $C_{200\,t/d} = (2770 \times 1/4) + 380 = 1075$ million

OR $C_{100} = 1/2\, C_{200} = 538$ million

$C_{20} = C_{100}\left(\frac{20}{100}\right)^{0.64} = 192$ million

2 plants $= 2 \times 192 = 384$ million total.

2 100 mt/d during Phase 2 $= 2 \times 538 = 1076$ million

Separations Capital

Phase 1 = 384 million

Phase 2 = 1076 million

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TWRS EIS
CALCULATION COVER SHEET

DISCIPLINE & TITLE ENGR / COST
Preliminary FEIS Capital Treatment Costs

ORIGINATOR D. Stem DATE 7/12/96

REVISION NO. 3

OBJECTIVE Re-estimate capital treatment costs for combo 1, combo 2, and phased impl. based on inter. sep. costs

METHODOLOGY Compare plant sizes to inter. sep. and factor costs using engr. judgement

ASSUMPTIONS "six tenths" factor rule for estimating plant costs is applicable with re-evaluation of most appropriate exponent for plants of this type

(Continue on another sheet if necessary)

D. Stem
SIGNATURE

CALCULATION & RESULTS ATTACHED

5 pages total excluding cover sheet

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1.9.3

6.18.2

JACOBS ENGINEERING GROUP INC.

DATE 7/12/96 SUBJECT TWRS Alternative Capital Costs SHEET NO. 1-5

BY D Stein CHKD. JOB NO.

Alternative Capital Costs were re-estimated for the preliminary FEIS for Combo 1, Combo 2, and Phased Implementation Treatment Facilities based on Intermediate Separations (TPA) costs. This re-estimation was done by re-evaluating the cost methodology used for scaling capital cost for different sized facilities from a base facility size and cost. The following tables summarize two approaches for estimating costs. Each approach uses different size exponents in the scaling equation:

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

Approach 1 uses an exponent

FORM 91-005-1 (4/81)

JACOBS ENGINEERING GROUP INC.

DATE 7/12/96 SUBJECT SHEET NO. 2-5

BY D Stern CHKD. JOB NO.

Value of 0.64 (vs. 0.60 used in the draft EIS). This 0.64 exponent was determined to be more appropriate as an average for the types of plants envisioned in the alternatives. Approach 2 uses different exponent values deemed appropriate for each type of plant being scaled (HLW, LAW, central, and separations). Approach 1 yields similar but slightly higher capital costs than Approach 2. To be conversative Approach 1 costs (higher) were used in the Alternative capital cost estimates. In Summary, results are:

Combo 1	$1926 million
Combo 2	$1383 million
Phased Impl. -I	$1328 million
Phased Impl. -II	$3972 million
Phased Impl. -Total	$5300 million

FORM 91-005-1 (4/81)

SUMMARY OF RESULTS

CASE	Approach 1 $MM	Approach 2 $MM
Intermediate Separation (Base Case)	3,600	3,600
Combo 1 (Previous case)	2,310	2,051
Combo 1 (Current Case)	1,926	1,906
Combo 2 (Current Case)	1,383	1,256
Phased Impl. -Phase I	1328 ~~1,095~~	1080 ~~847~~
Phased Impl. -Phase II	3972 ~~3,919~~	3922 ~~3,870~~

5300 5002

7/12/96

PS. 1/105

TWRS EIS
CALCULATION COVER SHEET

DISCIPLINE & TITLE Engineering / Alternative Cost Uncertainty Analysis - Final EIS.

ORIGINATOR Dave Stein DATE 7/19/96

REVISION NO. 0

OBJECTIVE Using the Range Estimating Program develop Cost Ranges for all tank waste alternatives both with and without repository fee. This Calc. supersedes all previous Cost Uncertainty analysis.

METHODOLOGY Noted

ASSUMPTIONS Noted

(Continue on another sheet if necessary)

CH for Dave Stein 8/26/96
SIGNATURE/DATE

J.C. Henderson 8/26/96
CHECKED/DATE

CALCULATION & RESULTS
ATTACHED

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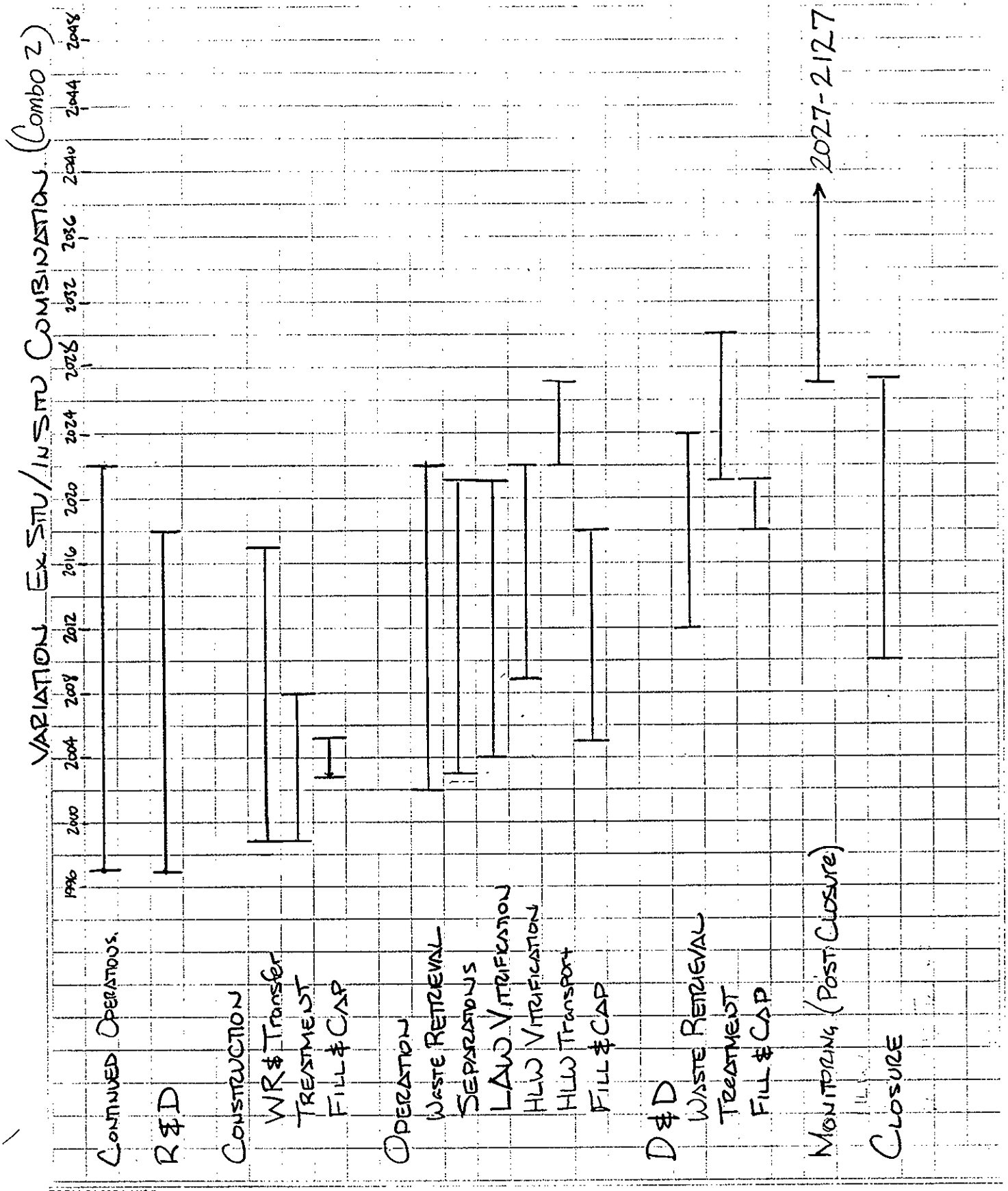
DATE _____ SUBJECT _____ SHEET NO. 86

BY _____ CHKD. _____ JOB NO. _____



FORM 91-005-1 (4/81)

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TWRS EIS
CALCULATION COVER SHEET

DISCIPLINE & TITLE ENGR / COST Tank Waste Alternatives ~~Preliminary~~ FEIS Operating Treatment Costs

ORIGINATOR D. Stein DATE 7/12/96

REVISION NO. 1

OBJECTIVE Re-estimate operating treatment costs for alternatives based on Preliminary FEIS basis changes (canister size + glass loading)

METHODOLOGY factor from previous cost estimates

ASSUMPTIONS similar to revision No. 0 of 2/20/96 for draft EIS.

(Continue on another sheet if necessary)

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D. Stein
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CALCULATION & RESULTS ATTACHED

20 ~~18~~ pages total excluding cover sheet

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DATE 7/12/96 SUBJECT SHEET NO. 1-2

BY DLS CHKD. JOB NO.

Ex Situ No Separations Vitrification preliminary FEIS (PFEIS)

WHC Data Pkg HLW glass - 30% Na_2O loading, 1.0 blend factor

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

PFEIS HLW glass - 20% Na_2O loading, 1.2 blend factor

from mass balance info
4.29E+05 MT glass formers
5.36E+05 MT glass product

ratio glass formers: $\frac{4.29}{2.50} = 1.72$

ratio glass product: $\frac{5.36}{3.57} = 1.50$

Δ cost for glass formers

category	previous $(thou)	ratio	Δ$ (thou)
SiO_2	8,160	1.72	5,875
Al_2O_3	5,000	1.72	3,600
CaO	2,130	1.72	1,534
Kerosene	7,815	1.50	3,908
electricity	140,700	1.50	70,350
			$85,267

with addition of 2yrs startup time, yrs operation is about same as previous. Assume Δlabor ≈ 0.

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DATE _____ SUBJECT _____ SHEET NO. Pg 2/105

BY _____ CHKD. _____ JOB NO. _____

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Table B.8.3.1 Comparison of Tank Waste Alternatives Cost Uncertainty

Alternative	Treatment Cost [1]		Total Alternative Cost [1] (Treatment + Repository Fee)	
	Estimated Cost	Estimated Cost Range [2]	Estimated Cost	Estimated Cost Range [2]
No Action	$14,300	$12,555 - $16,083	$14,300	$12,555 - $16,083
Long-Term Management	$20,770	$18,962 - $23,208	$20,770	$18,962 - $23,208
In Situ Fill and Cap	$7,885	$6,973 - $8,816	$7,885	$6,973 - $8,816
In Situ Vitrification	$16,478	$15,933 - $27,434	$16,478	$15,933 - $27,434
Ex Situ Intermediate Separations	$24,837	$23,887 - $29,950	$30,117	$29,037 - $35,145
Ex Situ No Separations Vitrification	$23,634	$22,646 - $27,717	$62,534	$59,184 - $74,538
Ex Situ No Separations Calcination	$21,700	$20,776 - $25,642	$36,330	$35,185 - $42,524
Ex Situ Extensive Separations	$27,725	$26,935 - $37,464	$27,995	$27,205 - $37,734
Ex Situ/In Situ Combination 1	$19,676	$18,322 - $23,266	$23,386	$22,132 - $26,983
Ex Situ/In Situ Combination 2	$15,432	$14,442 - $17,733	$17,582	$16,617 - $19,870
Phased Implementation	$27,199	$25,091 - $33,010	$32,479	$30,388 - $38,148

Notes:
[1] Cost is in millions of 1995 dollars.
[2] Cost as determined by Decision Science Corporation Range Estimating Program for personal computers (in millions of 1995 dollars).

Technologies that were not included in the alternatives that were developed for impact analysis, but are still viable as potential components of a remediation alternative are discussed in this section. For example, the technology selected for inclusion in the alternatives for immobilizing the LAW was vitrification. However, the ceramic waste form may also be viable and could be substituted as a LAW immobilization process.

B.9.1 IN SITU WASTE TREATMENT TECHNOLOGIES

In Situ Grout

Grout is a common solidification and stabilization technology used in managing hazardous waste. Stabilization is a process in which additives are mixed with the waste to minimize the rate of contaminant migrating from the waste form. Solidification is a process in which additives are mixed with the waste to yield a physical waste form, as measured by properties such as permeability and compressive strength, that is acceptable for waste storage or disposal. Performance measures used to evaluate solidification and stabilization technologies are obtained through leaching tests that provide data on the rate at which contaminants are released from the waste form under the action of water.

In situ grout is a technology that could be used to immobilize the waste and stabilize the tanks as an option to the waste drying and gravel filling operations described in the In Situ Fill and Cap alternative. Applying this technology would involve adding a grout mixture to each of the tanks, mechanically mixing the waste with the grout mixture, and stabilizing the tanks by filling the dome space with grout. Using this technology would leave the waste its current locations for disposal as in the In Situ Fill and

TWRS ALTERNATIVE COST SUMMARY

Cost Component		No Action	Long-Term Management	In Situ Fill and Cap	In Situ Vitrification	Ex Situ Intemediate Separations	Ex Situ No Separations Vitrification
Current Operations		$14,300	$14,300	$6,566	$7,749	$8,600	$8,325
Additional Characterization Reqmts.				$903	$903		
Transfer System Upgrades(in current ops)							
Research and Development							
	Wast Retrieval and Transfer		$100	$0	$0	$190	$190
	Treatment		$0	$0	$70	$630	$280
	Total R&D		$100	$0	$70	$820	$470
Capital							
	Waste Retrieval and Transfer		$1,930	$0	$0	$2,280	$2,280
	Treatment		$4,000	$25	$4,900	$3,600	$2,610
	Closure		$0	$116	$116	$169	$152
	Total Capital Costs		$5,930	$141	$5,016	$6,049	$5,042
Operating (tank alt. include D&D and M&M)							
	Waste Retrieval and Transfer		$440	$0	$0	$4,820	$4,630
	Treatment		$0	$275	$2,740	$4,548	$5,167
	Total Operating Costs		$440	$275	$2,740	$9,368	$9,797
Monitoring and Maintenance							
D&D							
Total Treatment Cost			$20,770	$7,885	$16,478	$24,837	$23,634
Repository Fee			$0	$0	$0	$5,280	$38,900
Total Cost (1995)		$14,300	$20,770	$7,885	$16,478	$30,117	$62,534
Total Cost summary in billions of dollars		$14.30	$20.77	$7.89	$16.48	$30.12	$62.53
Cost Range							
	Lower Limit	$12,555	$18,962	$6,973	$15,933	$29,037	$59,184
	Upper Limit	$16,083	$23,208	$8,816	$27,434	$35,145	$74,538

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TWRS ALTERNATIVE COST SUMMARY

Cost Component			Ex Situ No Separations Calcination	Ex Situ Extensive Separations	Ex Situ/In Situ Combination 1	Ex Situ/In Situ Combination 2	Phased Implementation
Current Operations			$8,325	$8,600	$8,600	$8,300	$8,600
Additional Characterization Reqmts.					$542	$780	
Transfer System Upgrades(in current ops)							
Research and Development							
	Wast Retrieval and Transfer		$190	$190	$186	$183	$190
	Treatment		$280	$1,300	$630	$630	
	Total R&D		$470	$1,490	$816	$813	$190
Capital							
	Waste Retrieval and Transfer		$2,280	$2,280	$1,388	$970	$2,280
	Treatment		$2,610	$5,202	$1,926	$1,383	$5,300
	Closure		$152	$170	$137	$125	$211
	Total Capital Costs		$5,042	$7,652	$3,451	$2,478	$7,791
Operating (tank alt. include D&D and M&M)							
	Waste Retrieval and Transfer		$4,630	$4,820	$3,166	$952	$4,010
	Treatment		$3,233	$5,163	$3,101	$2,109	$6,608
	Total Operating Costs		$7,863	$9,983	$6,267	$3,061	$10,618
Monitoring and Maintenance							
D&D							
Total Treatment Cost			$21,700	$27,725	$19,676	$15,432	$27,199
Repository Fee			$14,630	$270	$3,710	$2,150	$5,280
Total Cost (1995)			$36,330	$27,995	$23,386	$17,582	$32,479
Total Cost summary in billions of dollars			$36.33	$28.00	$23.39	$17.58	$32.48
Cost Range							
	Lower Limit		$35,185	$27,205	$22,132	$16,617	$30,388
	Upper Limit		$42,524	$37,734	$26,983	$19,870	$38,148

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TWRS ALTERNATIVE COST SUMMARY

Cost Component		Capsules No Action	Capsules Onsite Disposal	Capsules Overpack and Ship	Vitrify with Tank Waste
Current Operations		$112	$377	$377	$315
Additional Characterization Reqmts.					
Transfer System Upgrades(in current ops)					
Research and Development					
	Wast Retrieval and Transfer				
	Treatment			$14	$5
	Total R&D	$0	$0	$14	$5
Capital					
	Waste Retrieval and Transfer				
	Treatment		$83	$32	$36
	Closure		$5		
	Total Capital Costs	$0	$88	$32	$36
Operating (tank alt. include D&D and M&M)					
	Waste Retrieval and Transfer				
	Treatment		$226	$34	$37
	Total Operating Costs	$0	$226	$34	$37
Monitoring and Maintenance					$1
D&D			$6	$6	$6
Total Treatment Cost					
Repository Fee			$0	$124	$111
Total Cost (1995)		$112	$697	$587	$511
Total Cost summary in billions of dollars		$0.11	$0.70	$0.59	$0.51
Cost Range				The Overpack and Ship disposal fee is based on sending other wastes	
	Lower Limit			to the repository under the Intermediate Separations alternative.	
	Upper Limit			If no wastes other than capsules are sent to the repository the	
				disposal fee would be approx. $250 million 1995 dollars.	

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7/105

DATE 7/16/96 SUBJECT HANFORD TWRS SHEET NO. 1-4

BY D. Stein CHKD. DRAFT FEIS JOB NO.

BASIS FOR PROB/RANGE ELEMENTS

NUMBER	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 (TREATED AS A CONSTANT)

NOTE: THE BASES ESTIMATED HEREIN WERE DISCUSSED AND AGREED UPON IN 7/16/96 MEETING OF D. STEIN, C. HENDERSON, D. MURRAY (ALL FROM JEG) AND L. SELBY (JEG COST ENGR/ESTIMATOR) THESE ARE RE-ESTIMATES OF 2/4/96 used in DEIS BASED ON CHANGES IN ALTERNATIVE COSTS/SIZES/ETC.

FORM 91-005-1 (4/81)

JACOBS ENGINEERING GROUP INC.

DATE 7/16/96 SUBJECT

BY D Stein CHKD.

8/105

SHEET NO. 2-4

JOB NO.

NUMBER	ELEMENT
4	CAPITAL (WASTE RET. + TRANSFER) (ALL ALTERNATIVES)
	PROB 30%
	RANGE -20%, +70%
7	OPERATING (WASTE RET. + TRANSFER) (ALL ALTERNATIVES)
	PROB 30%
	RANGE -20%, +70%

COMMENT: MODERATE PESSIMISM 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.

FORM 91-005-1 (4/91)

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SHEET NO. 3-4

JOB NO.

NUM	ELEMENT	ALTERNATIVE: LONG TERM MANAGE	IN SITU FILL & CAP	NO SEP. (VITR)	NO SEP. (CALC)	INTER SEP	COMBOS 1 + 2	PHASED IMPL.	EXT. SEP.	IN SITU VITR.
5	CAPITAL (TREATMENT) PROB	50%	NON-CRITICAL	50%	50%	40%	30%	30%	20%	20% ~~15%~~
	RANGE	-20%, +20%		-20%, +70%	-20%, +90%	-20%, +100%	-30%, +125%	-40%, +100%	-20%, +175%	~~-10%, +300%~~ -20, +200

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, AND -30% AND -40% ON COMBOS AND PHASED IMPL. DUE TO OPTIMISM ON COST REDUCTIONS. RANGE ON HIGH SIDE INCREASES DUE TO COMPLEXITY OF PROCESSES AND UNKNOWNS.

8	OPERATING (TREATMENT) PROB	NON-CRITICAL	NON-CRITICAL	50%	50%	50%	55%	60%	50%	15%
	RANGE			-20%, +35%	-20%, +35%	-20%, +35%	-30%, +25%	-40%, +15%	-20%, +35%	-10%, +200%

Comments: PROB. VIEWED AS AMBIVALENCE EXCEPT FOR LIKELY COST REDUCTIONS FOR COMBOS + PHASED IMPL. IN SITU COSTS VIEWED PESSIMISTICALLY. RANGES USE -20%, +35% AS A BASE FOR BASELINE ALTERNATIVES. VARIATION IN RANGE FOR COMBOS + PHASED IMPL. DUE TO LIKELY COST REDUCTIONS. IN SITU VITR. VIEWED PESSIMISTICALLY DUE TO LONGER OPERATION AND ADDITIONAL GLASS RAW MATERIALS

JACOBS ENGINEERING GROUP INC.

SUBJECT

DATE 7/16/96

BY D. Strinchk.

FORM 91-0051 (4/81)

10/105

SHEET NO. 4-4

JOB NO.

NUM	ELEMENT	ALTERNATIVE: NO SEP VITR.	NO SEP CALC	INTER. SEP.	COMBOS + PHASED IMPL	EXT. SEP
10	REPOSITORY FEE					
	PROB	10%	10%	50%	50%	10%
	RANGE	-30%, +30%	-30%, +30%	-20%, +20%	-20%, +20%	-10%, +100%

COMMENTS: AMBIVALENCE ON PROB FOR INTER SEP, COMBOS, AND PHASED IMPL. AS NOMINAL SIZE CANISTER USED AND GLASS LOADING. PESSIMISTIC VIEW FOR NO SEP DUE TO USE OF LARGEST CANISTER AND LARGE TOTAL VOLUME AND FOR EXT. SEP DUE TO SMALL NUMBER CANISTERS AND COST WHICH MOST LIKELY WILL INCREASE. RANGES ESTIMATED BASED ON LIKELY ACCURACY OF REPOSITORY COST ESTIMATES AND UNKNOWNS ABOUT WASTE QUANTITY AND CANISTER SIZE.

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DATE _____ SUBJECT _____

BY _____ CHKD. _____

FORM 91-005-1 (4/81)

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!

11/95

12/105

Revised # 7/19/96 D. Stein
per conversations
today

Modeling reports sent in overnight mail

	Target	95% Range
Combo 1	23,386	22,132 - 26,983
combo 1 (no fee)	19,676	18,322 - 23,266
combo 2	17,582	16,617 - 19,870
combo 2 (no fee)	15,432	14,442 - 17,733
In Situ Vitrification	16,478	15,933 - 27,434

For In Situ Vitr uncertainty model changes as follows for treatment capital:

from 15% prob to 20% prob
-10%, +300% range -20%, +200% rang

TWRS ALTERNATIVE COST SUMMARY

Cost Component		No Action	Long-Term Management	In Situ Fill and Cap	In Situ Vitrification	Ex Situ Intemediate Separations	Ex Situ No Separations Vitrification
Current Operations		$14,300	$14,300	$6,566	$7,749	$8,600	$8,325
Additional Characterization Reqmts.				$903	$903		
Transfer System Upgrades(in current ops)							
Research and Development							
	Wast Retrieval and Transfer		$100	$0	$0	$190	$190
	Treatment		$0	$0	$70	$630	$280
	Total R&D		$100	$0	$70	$820	$470
Capital							
	Waste Retrieval and Transfer		$1,930	$0	$0	$2,280	$2,280
	Treatment		$4,000	$25	$4,900	$3,600	$2,610
	Closure		$0	$116	$116	$169	$152
	Total Capital Costs		$5,930	$141	$5,016	$6,049	$5,042
Operating (tank alt. include D&D and M&M)							
	Waste Retrieval and Transfer		$440	$0	$0	$4,820	$4,630
	Treatment		$0	$275	$2,740	$4,548	$5,167
	Total Operating Costs		$440	$275	$2,740	$9,368	$9,797
Monitoring and Maintenance							
D&D							
Total Treatment Cost			$20,770	$7,885	$16,478	$24,837	$23,634
Repository Fee			$0	$0	$0	$5,280	$38,900
Total Cost (1995)		$14,300	$20,770	$7,885	$16,478	$30,117	$62,534
Total Cost summary in billions of dollars		$14.30	$20.77	$7.89	$16.48	$30.12	$62.53
Cost Range					15933		
	Lower Limit	$12,555	$18,962	$6,973	~~$16,254~~	$29,037	$59,184
	Upper Limit	$16,083	$23,208	$8,816	~~$31,576~~	$35,145	$74,538
					27434		

13/105

changes 7/19/96

TWRS ALTERNATIVE COST SUMMARY

Cost Component		Ex Situ No Separations Calcination	Ex Situ Extensive Separations	Ex Situ/In Situ Combination 1	Ex Situ/In Situ Combination 2	Phased Implementation
Current Operations		$8,325	$8,600	$8,600	$8,300	$8,600
Additional Characterization Reqmts.				$542	780	
Transfer System Upgrades(in current ops)						
Research and Development						
	Wast Retrieval and Transfer	$190	$190	$186	$183	$190
	Treatment	$280	$1,300	630 ~~$670~~	630	—
	Total R&D	$470	$1,490	816 ~~$856~~	813 ~~$486~~	$190
Capital						
	Waste Retrieval and Transfer	$2,280	$2,280	$1,388	$970	$2,280
	Treatment	$2,610	$5,202	$1,926	$1,383	$5,300
	Closure	$152	$170	$137	$125	$211
	Total Capital Costs	$5,042	$7,652	$3,451	$2,478	$7,791
Operating (tank alt. include D&D and M&M)						
	Waste Retrieval and Transfer	$4,630	$4,820	$3,166	$952	$4,010
	Treatment	$3,233	$5,163	$3,101	$2,109	$6,608
	Total Operating Costs	$7,863	$9,983	$6,267	$3,061	$10,618
Monitoring and Maintenance						
D&D						
Total Treatment Cost		$21,700	$27,725	19676 ~~$19,716~~	15432 ~~$14,022~~	$27,199
Repository Fee		$14,630	$270	$3,710	$2,150	$5,280
Total Cost (1995)		$36,330	$27,995	23386 ~~$23,486~~	17582 ~~$16,172~~	$32,479
Total Cost summary in billions of dollars		$36.33	$28.00	$23.43	$16.17	$32.48
Cost Range				22132	16617	
	Lower Limit	$35,185	$27,443	~~$22,472~~	~~$15,900~~	$30,388
	Upper Limit	$42,524	$37,410	~~$27,023~~	~~$18,397~~	$38,148
				26983	19870	

changes changes 7/19/96

14/105

No Repository Fee ± % 93 % conf. 15/105

Alternative	Old Range	New Range
1 No Action	−12.2 +12.5	−12.2 +12.5
2 Long term Manage	−9.1 +11.2	−8.7 +11.7
3 Fill + Cap	−11.6 +11.8	−11.6 +11.8
4 In Situ Vit	−1.8 +44.7	−3.3 +66.5
5 Inter Sep	−7.8 +15.3	−3.8 +20.6
6 No Sep Vit	−38.0 +5.7	−4.2 +17.3
7 No Sep Calc	−14.8 +10.4	−4.3 +18.2
8 EXT Sep	−5.0 +26.8	−2.8 +35.1
9 COMBO 1	−8.0 +14.8	−6.9 +18.3
10 PHASED	−6.4 +16.5	−7.7 +21.4
JUN COMBO 2	—	−6.4 +14.9

① In Situ vitr. — mistake in entry of high range capital for in situ vitr. treatment. 9,600 entered instead of 19,600. However prob + ranges have been changed in this new version from 15% prob −10%, +300% range to 20% prob −20%, + 200% range

② Capital treatment for ex-situ alternatives
- modified to reflect pessimism in cost estimates for alternatives using factoring (combo 1+2 + phased imp)

③ operating treatment for ex-situ alternatives
- modified to reflect changes in canister sizes and glass loadings

④ repository fees for ex-situ alternatives
- modified to reflect changes in canister sizes + rerun of repository model

D. Stern 7/19/96

16/105

FILENAME=C:\CASE01.OUT

07/17/96

11:56:00

No Action

REP/PC (Ver 4.0) - MGMT REPORT 1 RANGE ESTIMATE : 07-17-96

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 Treatment		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

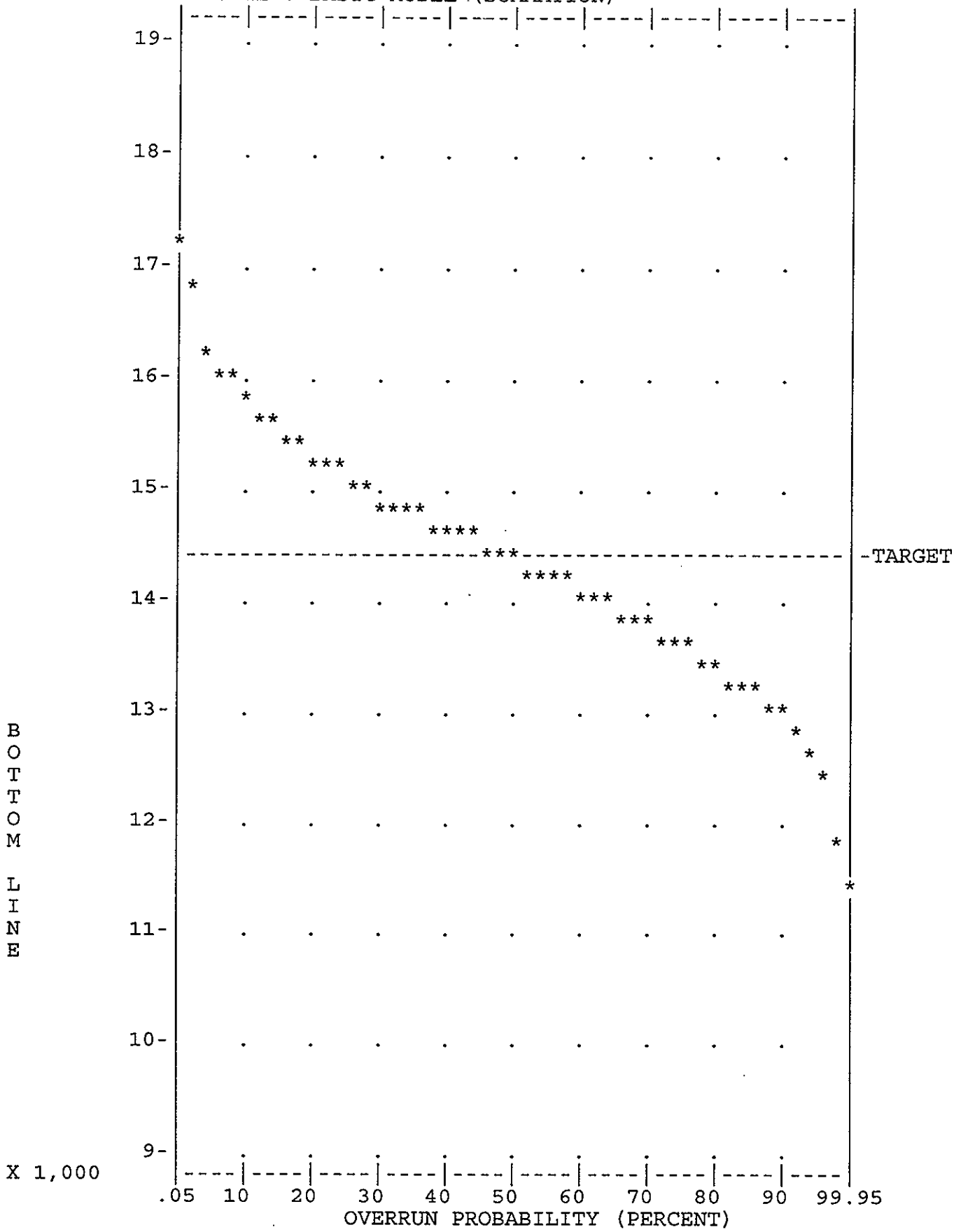
+ PROBABILITY THAT ACTUAL VALUE WILL BE EQUAL TO OR LESS THAN TARGET

No Action 18/105

REP/PC (Ver 4.0) - MGMT REPORT 2 GRAPHICAL OVERRUN PROFILE : 07-17-96

DATA : ExSitu Exten. Case 01

MODEL : BASIC MODEL (SUMMATION)



REP/PC (Ver 4.0) - MGMT REPORT 3 GRAPHICAL PRIORITY PROFILE : 07-17-96

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

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

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

REP/PC (Ver 4.0) - MGMT REPORT 4 CONTINGENCY PROFILE : 07-17-96

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)

FILENAME=C:\CASE02.OUT

07/17/96

11:55:20

Long-Term Management

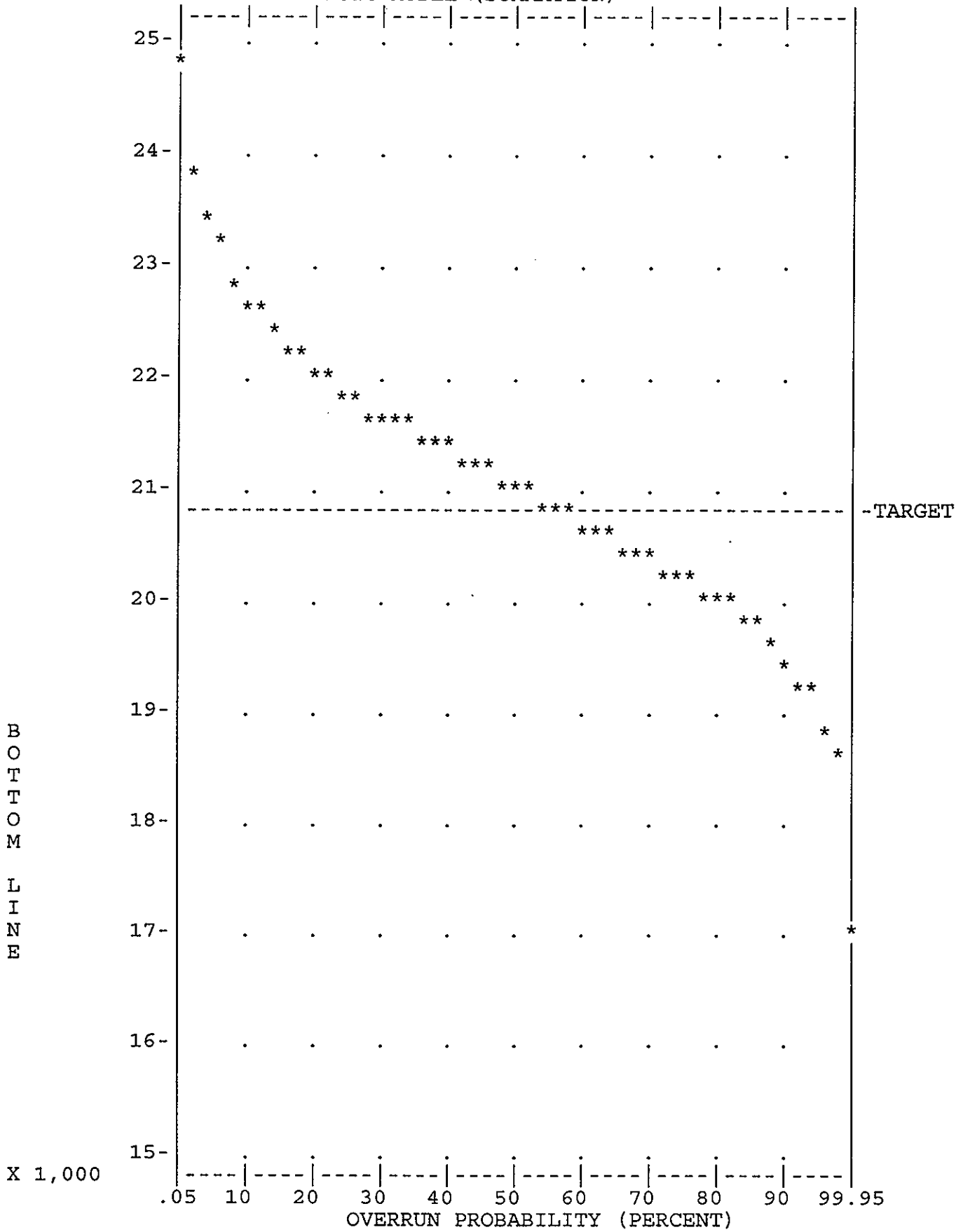
REP/PC (Ver 4.0) - MGMT REPORT 1 RANGE ESTIMATE : 07-17-96

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	30	1544	3281
5	Capital Treatment		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 : 07-17-96
DATA : ExSitu Exten. Case 02
MODEL : BASIC MODEL (SUMMATION)



REP/PC (Ver 4.0) - MGMT REPORT 3 GRAPHICAL PRIORITY PROFILE : 07-17-96

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

TOTAL EXPENSE	PROB OF OVERRUN	NET EFFECT OF FROZEN ELEMENTS
20770	58 PCT	0 = .0 PCT

```
NUM ELEMENT                                UNIT     CORRECT        PROTECT

  1 Current Operations                           -------------|+++++++++++++
  4 Capital Waste Ret. & Transfer                    ---------|+
  5 Capital Treatment                                     ----|++++
    NET EFFECT OF FROZEN ELEMENTS                             |
```

REP/PC (Ver 4.0) - MGMT REPORT 4 CONTINGENCY PROFILE : 07-17-96

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	"	3934	18.9	"
95	"	2438	11.7	"
90	"	1882	9.1	"
85	"	1546	7.4	"
80	"	1294	6.2	"
75	"	1086	5.2	"
70	"	853	4.1	"
65	"	735	3.5	"
60	"	568	2.7	"
55	"	431	2.1	"
50	"	257	1.2	"
45	"	85	.4	"
40	"	-75	-.4	"
35	"	-256	-1.2	"
30	"	-419	-2.0	"
25	"	-579	-2.8	"
20	"	-773	-3.7	"
15	"	-999	-4.8	"
10	"	-1381	-6.6	"
5	"	-1808	-8.7	"
0.05	"	-3853	-18.5	"
0	"	-4046	-19.5	"

(ABOVE RESULTS DERIVED FROM 1000 SIMULATIONS)

26/105

FILENAME=C:\CASE03.OUT

07/17/96

11:54:40

In Situ fill & Cap

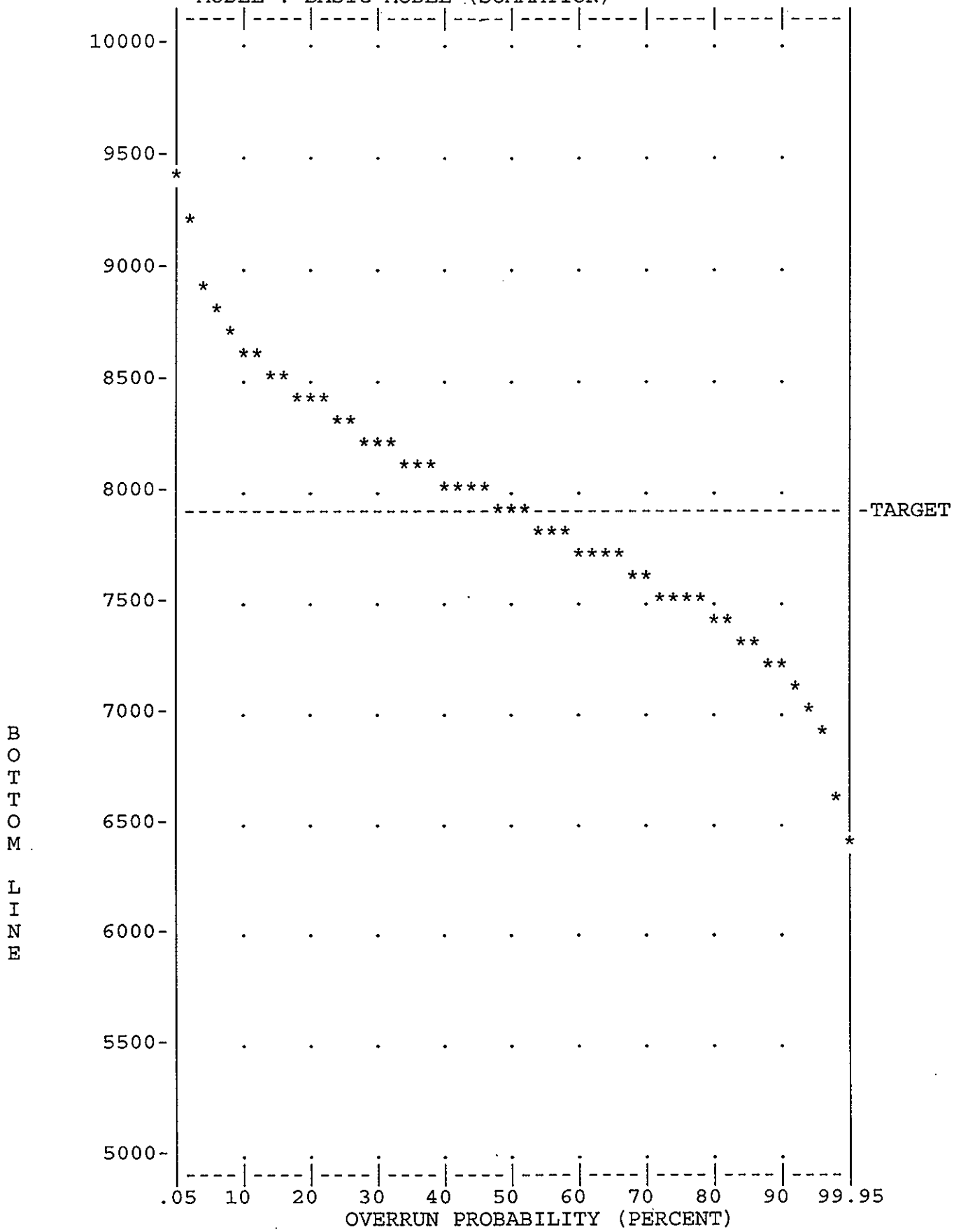
REP/PC (Ver 4.0) - MGMT REPORT 1 RANGE ESTIMATE : 07-17-96

DATA : InSitu Fill & Cap Case 03
MODEL : BASIC MODEL (SUMMATION)

NUM	ELEMENT	UNIT	TARGET	PROB+	LOW	HIGH
1	Current Operations		7469	50	5975	8963
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 Treatment		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		1.00		1.00	1.00
10	Repository Fee		0		0	0
	TOTAL EXPENSE (INPUT TO REP/PC)		7885		6391 (THEORETICALS)	9379

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

REP/PC (Ver 4.0) - MGMT REPORT 2 GRAPHICAL OVERRUN PROFILE : 07-17-96
DATA : InSitu Fill & Cap Case 03
MODEL : BASIC MODEL (SUMMATION)



REP/PC (Ver 4.0) - MGMT REPORT 3 GRAPHICAL PRIORITY PROFILE : 07-17-96

DATA : InSitu Fill & Cap Case 03
MODEL : BASIC MODEL (SUMMATION)

TOTAL EXPENSE	PROB OF OVERRUN	NET EFFECT OF FROZEN ELEMENTS
7885	51 PCT	0 = .0 PCT

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

30/105

REP/PC (Ver 4.0) - MGMT REPORT 4 CONTINGENCY PROFILE : 07-17-96

DATA : InSitu Fill & Cap Case 03
MODEL : BASIC MODEL (SUMMATION)

TO BE THIS CONFIDENT OF NOT HAVING COST OVERRUN		ADD THIS CONTINGENCY ABSOLUTE	RELATIVE	
100	PCT	1494	19.0	PCT
99.95	"	1488	18.9	"
95	"	931	11.8	"
90	"	747	9.5	"
85	"	614	7.8	"
80	"	498	6.3	"
75	"	416	5.3	"
70	"	302	3.8	"
65	"	235	3.0	"
60	"	163	2.1	"
55	"	92	1.2	"
50	"	8	.1	"
45	"	-64	-.8	"
40	"	-138	-1.7	"
35	"	-200	-2.5	"
30	"	-301	-3.8	"
25	"	-374	-4.7	"
20	"	-468	-5.9	"
15	"	-610	-7.7	"
10	"	-719	-9.1	"
5	"	-912	-11.6	"
0.05	"	-1483	-18.8	"
0	"	-1494	-18.9	"

(ABOVE RESULTS DERIVED FROM 1000 SIMULATIONS)

31/105

FILENAME=C:\CASE04.OUT

07/19/96

09:19:01

In Situ Vitrification

Colin
Modeling
Results from
Fri 7/19/96
D. Stein

RECEIVED
JUL 22 1996
Airborne

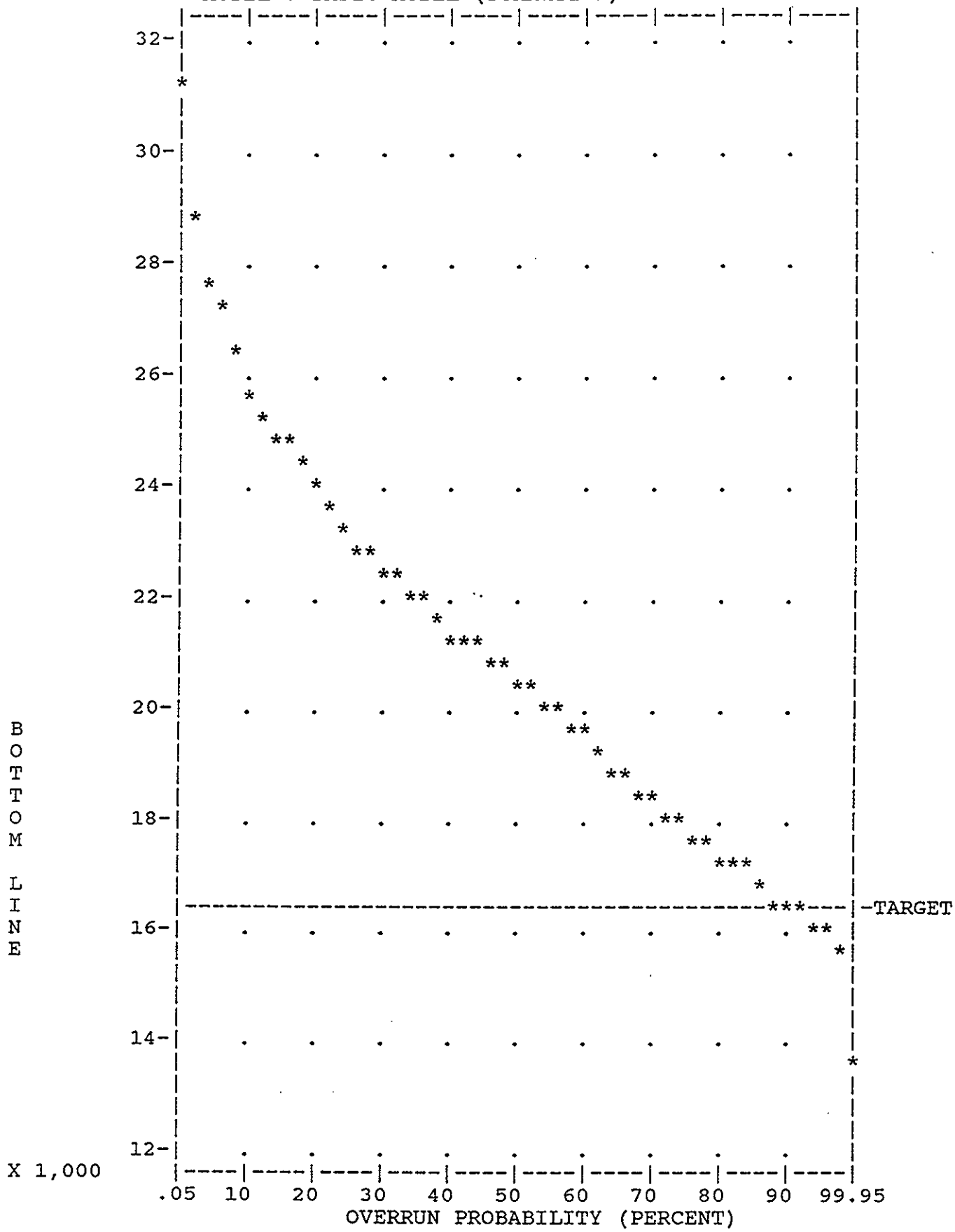
REP/PC (Ver 4.0) - MGMT REPORT 1 RANGE ESTIMATE : 07-19-96

DATA : InSitu Vitrification Case 04
MODEL : BASIC MODEL (SUMMATION)

NUM	ELEMENT	UNIT	TARGET	PROB+	LOW	HIGH
1	Current Operations		8652	50	6922	10382
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 Treatment		4900	20	3920	14700
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)		16478		13494	33488
					(THEORETICALS)	

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

REP/PC (Ver 4.0) - MGMT REPORT 2 GRAPHICAL OVERRUN PROFILE : 07-19-96
DATA : InSitu Vitrification Case 04
MODEL : BASIC MODEL (SUMMATION)



REP/PC (Ver 4.0) - MGMT REPORT 3 GRAPHICAL PRIORITY PROFILE : 07-19-96

DATA : InSitu Vitrification Case 04
MODEL : BASIC MODEL (SUMMATION)

TOTAL EXPENSE	PROB OF OVERRUN	NET EFFECT OF FROZEN ELEMENTS
16478	89 PCT	0 = .0 PCT

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

REP/PC (Ver 4.0) - MGMT REPORT 4 CONTINGENCY PROFILE : 07-19-96

DATA : InSitu Vitrification Case 04
MODEL : BASIC MODEL (SUMMATION)

TO BE THIS CONFIDENT OF NOT HAVING COST OVERRUN		ADD THIS CONTINGENCY ABSOLUTE	RELATIVE	
100	PCT	17010	103.2	PCT
99.95	"	14617	88.7	"
95	"	10956	66.5	"
90	"	9292	56.4	"
85	"	8372	50.8	"
80	"	7518	45.6	"
75	"	6567	39.9	"
70	"	5922	35.9	"
65	"	5443	33.0	"
60	"	4909	29.8	"
55	"	4520	27.4	"
50	"	4035	24.5	"
45	"	3563	21.6	"
40	"	2938	17.8	"
35	"	2355	14.3	"
30	"	1825	11.1	"
25	"	1340	8.1	"
20	"	899	5.5	"
15	"	426	2.6	"
10	"	-47	-.3	"
5	"	-545	-3.3	"
0.05	"	-2853	-17.3	"
0	"	-2984	-18.1	"

(ABOVE RESULTS DERIVED FROM 1000 SIMULATIONS)

FILENAME=C:\CASE05.OUT

07/17/96

11:45:30

Ex Situ Intermediate Separations
(with Repository fee)

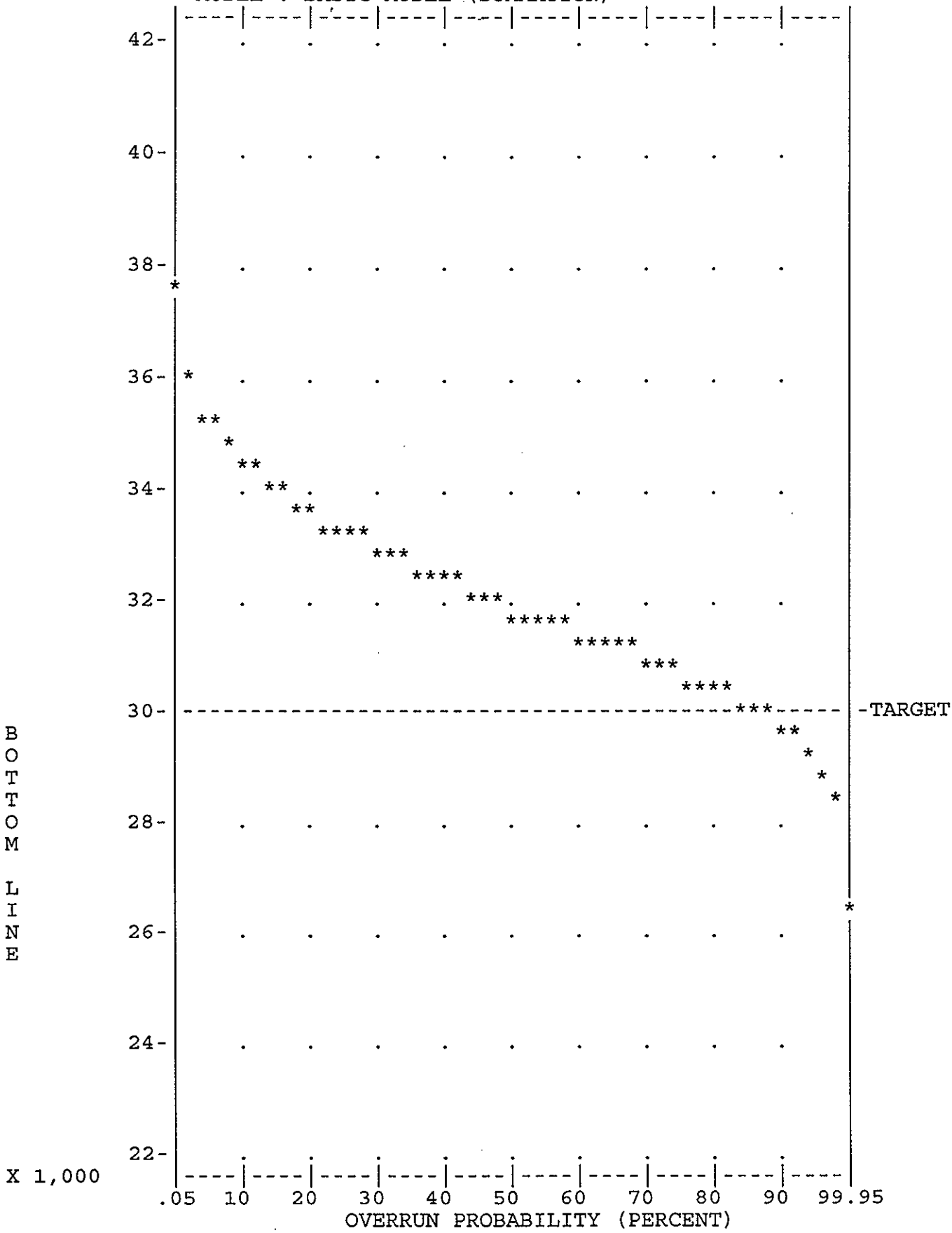
REP/PC (Ver 4.0) - MGMT REPORT 1 RANGE ESTIMATE : 07-17-96

DATA : Inter Sep 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	30	1824	3876
5	Capital Treatment		3600	40	2880	7200
6	Capital Closure		169.00		169.00	169.00
7	Operations Waste Ret. & Transfer		4820	30	3856	8194
8	Operations Treatment		4548	50	3638	6140
9	M & M		0		0	0
10	Repository Fee		5280	50	4224	6336
	TOTAL EXPENSE (INPUT TO REP/PC)		30117		24291 (THEORETICALS)	43055

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

REP/PC (Ver 4.0) - MGMT REPORT 2 GRAPHICAL OVERRUN PROFILE : 07-17-96
DATA : Inter Sep Case 05
MODEL : BASIC MODEL (SUMMATION)



REP/PC (Ver 4.0) - MGMT REPORT 3 GRAPHICAL PRIORITY PROFILE : 07-17-96

DATA : Inter Sep Case 05
MODEL : BASIC MODEL (SUMMATION)

TOTAL EXPENSE	PROB OF OVERRUN	NET EFFECT OF FROZEN ELEMENTS
30117	84 PCT	0 = .0 PCT

```
NUM ELEMENT                                UNIT     CORRECT        PROTECT

  7 Operations Waste Ret. & Transfer              -------------|++
  5 Capital Treatment                               ----------|++
  1 Current Operations                                     ----|++++
  8 Operations Treatment                                  -----|++
  4 Capital Waste Ret. & Transfer                        ------|+
 10 Repository Fee                                          --|++
    NET EFFECT OF FROZEN ELEMENTS                             |
```

REP/PC (Ver 4.0) - MGMT REPORT 4 CONTINGENCY PROFILE : 07-17-96

DATA : Inter Sep Case 05
MODEL : BASIC MODEL (SUMMATION)

TO BE THIS CONFIDENT OF NOT HAVING COST OVERRUN		ADD THIS CONTINGENCY ABSOLUTE	RELATIVE	
100	PCT	12938	43.0	PCT
99.95	"	7579	25.2	"
95	"	5028	16.7	"
90	"	4358	14.5	"
85	"	3776	12.5	"
80	"	3379	11.2	"
75	"	3075	10.2	"
70	"	2778	9.2	"
65	"	2512	8.3	"
60	"	2288	7.6	"
55	"	1972	6.6	"
50	"	1681	5.6	"
45	"	1481	4.9	"
40	"	1216	4.0	"
35	"	1014	3.4	"
30	"	814	2.7	"
25	"	502	1.7	"
20	"	197	.7	"
15	"	-78	-.3	"
10	"	-485	-1.6	"
5	"	-1080	-3.6	"
0.05	"	-3762	-12.5	"
0	"	-5826	-19.3	"

(ABOVE RESULTS DERIVED FROM 1000 SIMULATIONS)

4/105

FILENAME=C:\CASE06.OUT

07/17/96

11:49:32

Ex Sm No Separations Vit.
(with Repository fee)

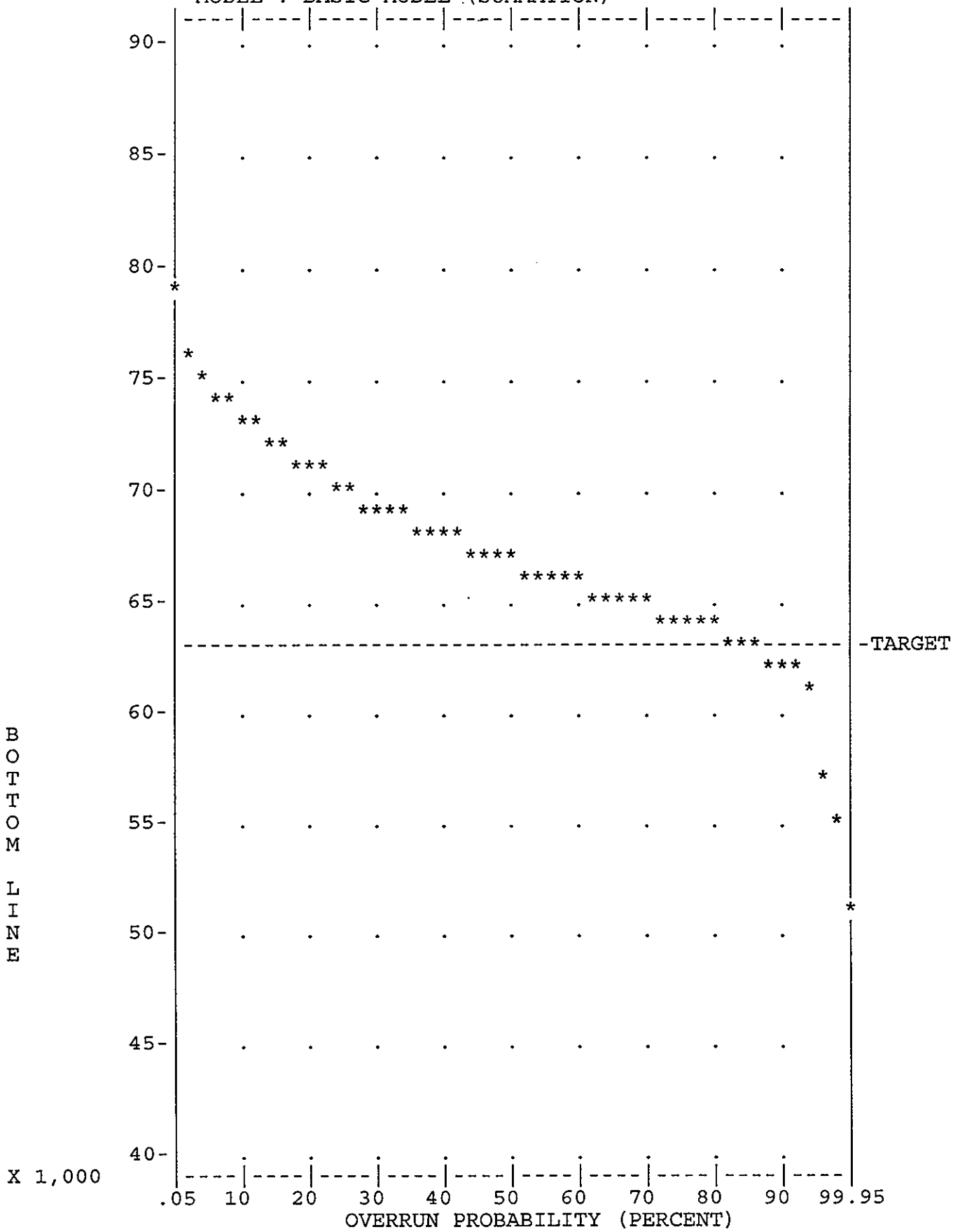
REP/PC (Ver 4.0) - MGMT REPORT 1 RANGE ESTIMATE : 07-17-96

DATA : No Sep Vitr 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	30	1824	3876
5	Capital Treatment		2610	50	2088	4437
6	Capital Closure		152.00		152.00	152.00
7	Operations Waste Ret. & Transfer		4630	30	3704	7871
8	Operations Treatment		5167	50	4134	6975
9	M & M		0		0	0
10	Repository Fee		38900	10	27230	50570
	TOTAL EXPENSE (INPUT TO REP/PC)		62534		46262 (THEORETICALS)	84341

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

REP/PC (Ver 4.0) - MGMT REPORT 2 GRAPHICAL OVERRUN PROFILE : 07-17-96
DATA : No Sep Vitr Case 06
MODEL : BASIC MODEL (SUMMATION)



REP/PC (Ver 4.0) - MGMT REPORT 3 GRAPHICAL PRIORITY PROFILE : 07-17-96

DATA : No Sep Vitr Case 06
MODEL : BASIC MODEL (SUMMATION)

TOTAL EXPENSE	PROB OF OVERRUN	NET EFFECT OF FROZEN ELEMENTS
62534	88 PCT	0 = .0 PCT

```
NUM ELEMENT                                UNIT     CORRECT        PROTECT

 10 Repository Fee                                -------------|++
  7 Operations Waste Ret. & Transfer                        ---|
  1 Current Operations                                        -|+
  8 Operations Treatment                                      -|+
  5 Capital Treatment                                         -|
  4 Capital Waste Ret. & Transfer                             -|
    NET EFFECT OF FROZEN ELEMENTS                              |
```

REP/PC (Ver 4.0) - MGMT REPORT 4 CONTINGENCY PROFILE : 07-17-96

DATA : No Sep Vitr Case 06
MODEL : BASIC MODEL (SUMMATION)

TO BE THIS CONFIDENT OF NOT HAVING COST OVERRUN		ADD THIS CONTINGENCY ABSOLUTE	RELATIVE	
100	PCT	21807	34.9	PCT
99.95	"	16073	25.7	"
95	"	12004	19.2	"
90	"	10494	16.8	"
85	"	9667	15.5	"
80	"	8496	13.6	"
75	"	7446	11.9	"
70	"	6566	10.5	"
65	"	5982	9.6	"
60	"	5263	8.4	"
55	"	4546	7.3	"
50	"	3975	6.4	"
45	"	3538	5.7	"
40	"	3156	5.1	"
35	"	2610	4.2	"
30	"	2117	3.4	"
25	"	1671	2.7	"
20	"	1134	1.8	"
15	"	503	.8	"
10	"	-410	-.7	"
5	"	-3350	-5.4	"
0.05	"	-11224	-17.9	"
0	"	-16272	-26.0	"

(ABOVE RESULTS DERIVED FROM 1000 SIMULATIONS)

FILENAME=C:\CASE07.OUT

07/17/96

11:49:59

Ex Situ No Separations Calcination
(with Repository fee)

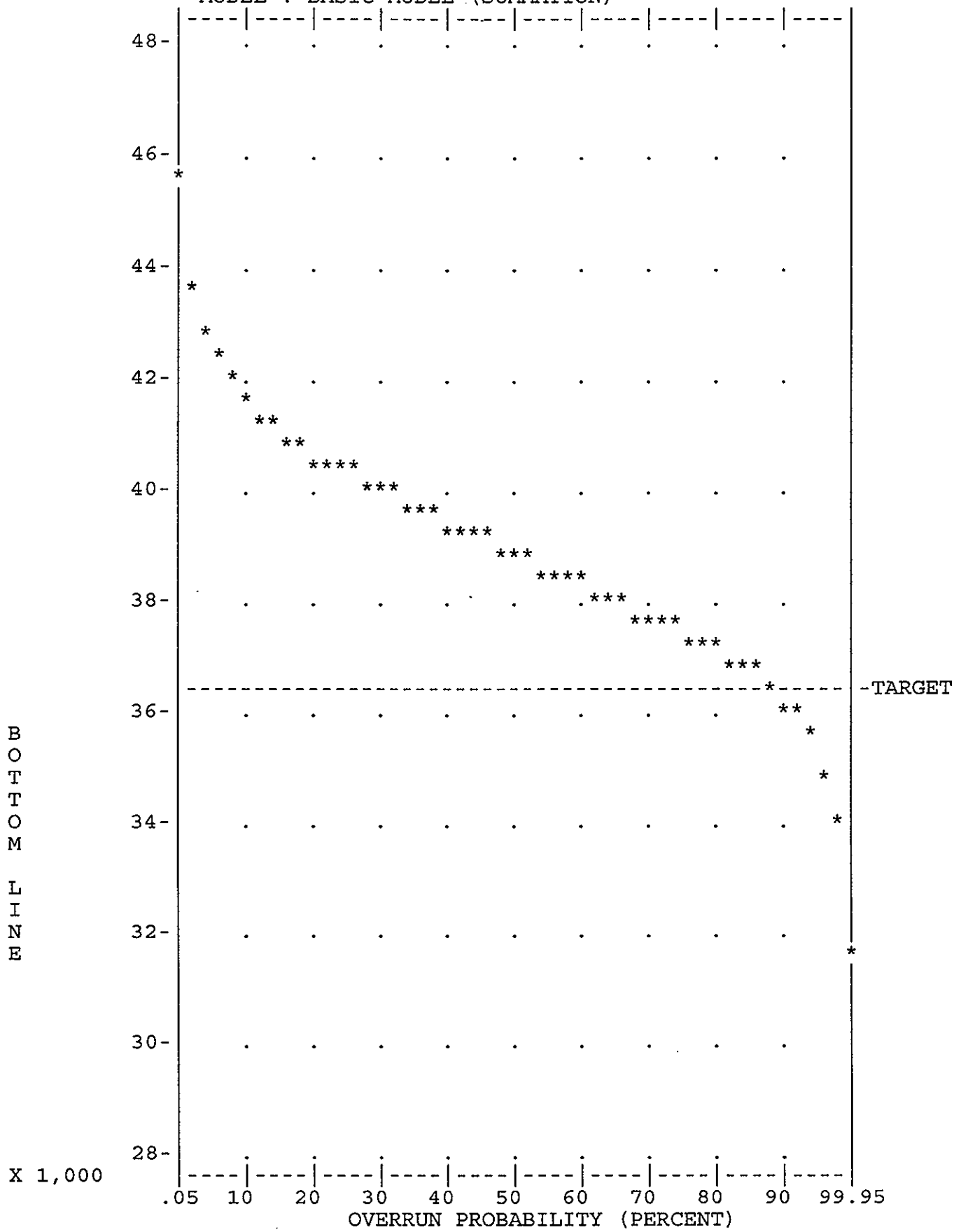
REP/PC (Ver 4.0) - MGMT REPORT 1 RANGE ESTIMATE : 07-17-96

DATA : No Sep Calc 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	30	1824	3876
5	Capital Treatment		2610	50	2088	4437
6	Capital Closure		152.00		152.00	152.00
7	Operations Waste Ret. & Transfer		4630	30	3704	7871
8	Operations Treatment		3233	50	2586	4364
9	M & M		0		0	0
10	Repository Fee		14630	10	10241	19019
	TOTAL EXPENSE (INPUT TO REP/PC)		36330		27725 (THEORETICALS)	50179

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

REP/PC (Ver 4.0) - MGMT REPORT 2 GRAPHICAL OVERRUN PROFILE : 07-17-96
DATA : No Sep Calc Case 07
MODEL : BASIC MODEL (SUMMATION)



REP/PC (Ver 4.0) - MGMT REPORT 3 GRAPHICAL PRIORITY PROFILE : 07-17-96

DATA : No Sep Calc Case 07
MODEL : BASIC MODEL (SUMMATION)

TOTAL EXPENSE	PROB OF OVERRUN	NET EFFECT OF FROZEN ELEMENTS
36330	88 PCT	0 = .0 PCT

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

REP/PC (Ver 4.0) - MGMT REPORT 4 CONTINGENCY PROFILE : 07-17-96

DATA : No Sep Calc Case 07
MODEL : BASIC MODEL (SUMMATION)

TO BE THIS CONFIDENT OF NOT HAVING COST OVERRUN		ADD THIS CONTINGENCY ABSOLUTE	RELATIVE	
100	PCT	13849	38.1	PCT
99.95	"	9327	25.7	"
95	"	6194	17.1	"
90	"	5314	14.6	"
85	"	4681	12.9	"
80	"	4257	11.7	"
75	"	3912	10.8	"
70	"	3596	9.9	"
65	"	3375	9.3	"
60	"	3052	8.4	"
55	"	2712	7.5	"
50	"	2440	6.7	"
45	"	2210	6.1	"
40	"	1907	5.3	"
35	"	1611	4.4	"
30	"	1314	3.6	"
25	"	1071	3.0	"
20	"	708	2.0	"
15	"	345	1.0	"
10	"	-208	-.6	"
5	"	-1145	-3.1	"
0.05	"	-4873	-13.4	"
0	"	-8605	-23.7	"

(ABOVE RESULTS DERIVED FROM 1000 SIMULATIONS)

51/105

FILENAME=C:\CASE08.OUT

07/22/96

10:42:06

Ex SHU Extensive Separations
(with Repository fee)

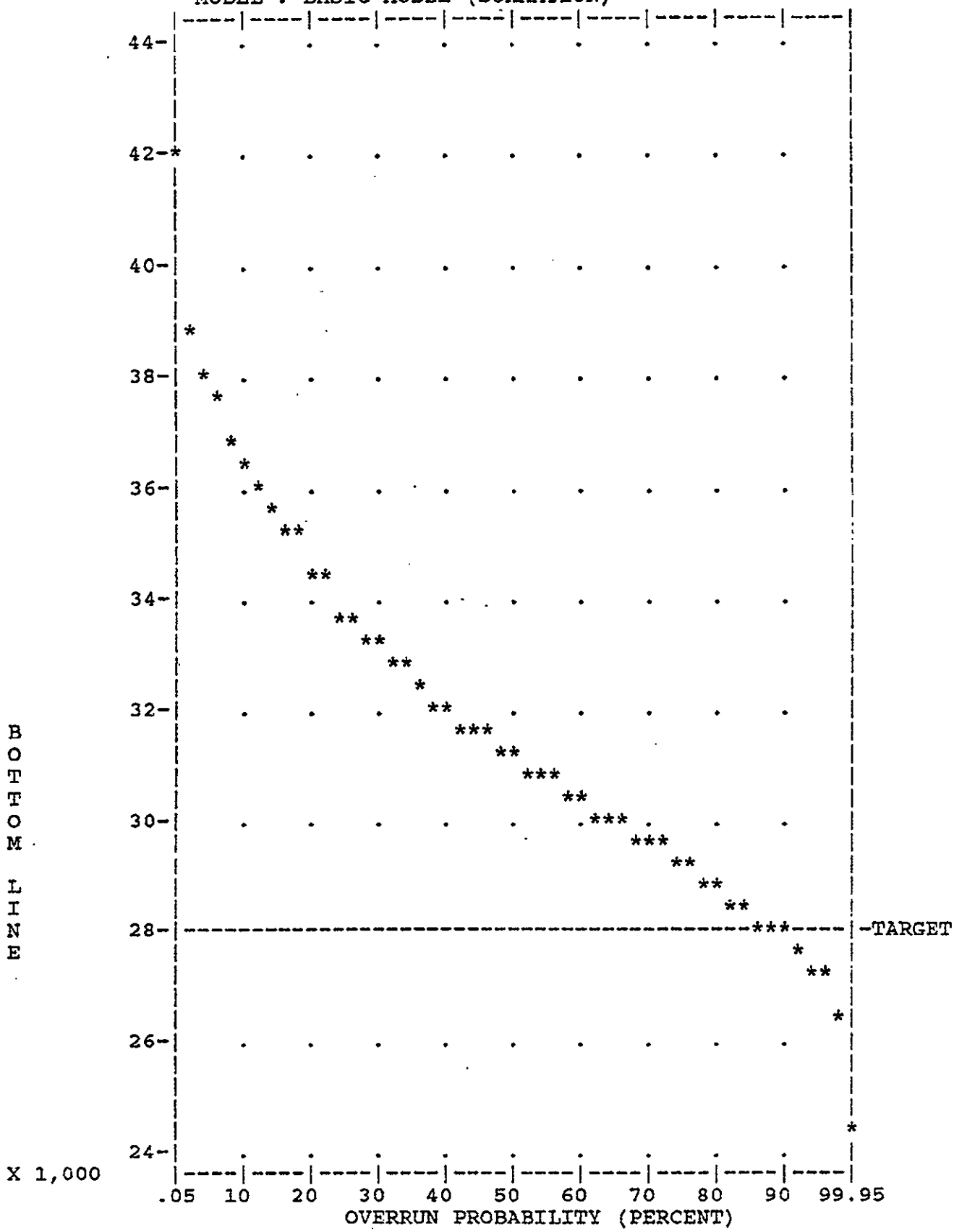
REP/PC (Ver 4.0) - MGMT REPORT 1 RANGE ESTIMATE : 07-22-96

DATA : Ext Sep 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	30	1824	3876
5	Capital Treatment		5202	20	4162	14305
6	Capital Closure		170.00		170.00	170.00
7	Operations Waste Ret. & Transfer		4820	30	3856	8194
8	Operations Treatment		5163	50	4130	6970
9	M & M		0		0	0
10	Repository Fee		270		270	270
	TOTAL EXPENSE (INPUT TO REP/PC)		27995		22782 (THEORETICALS)	45595

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

REP/PC (Ver 4.0) - MGMT REPORT 2 GRAPHICAL OVERRUN PROFILE : 07-22-96
DATA : Ext Sep Case 08
MODEL : BASIC MODEL (SUMMATION)



REP/PC (Ver 4.0) - MGMT REPORT 3 GRAPHICAL PRIORITY PROFILE : 07-22-96

DATA : Ext Sep Case 08
MODEL : BASIC MODEL (SUMMATION)

TOTAL EXPENSE	PROB OF OVERRUN	NET EFFECT OF FROZEN ELEMENTS
27995	88 PCT	0 = .0 PCT

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

REP/PC (Ver 4.0) - MGMT REPORT 4 CONTINGENCY PROFILE : 07-22-96

DATA : Ext Sep Case 08
MODEL : BASIC MODEL (SUMMATION)

TO BE THIS CONFIDENT OF NOT HAVING COST OVERRUN		ADD THIS CONTINGENCY ABSOLUTE	RELATIVE	
100	PCT	17600	62.9	PCT
99.95	"	14094	50.3	"
95	"	9739	34.8	"
90	"	8277	29.6	"
85	"	7498	26.8	"
80	"	6602	23.6	"
75	"	5585	20.0	"
70	"	5051	18.0	"
65	"	4527	16.2	"
60	"	3947	14.1	"
55	"	3542	12.7	"
50	"	3143	11.2	"
45	"	2736	9.8	"
40	"	2308	8.2	"
35	"	1924	6.9	"
30	"	1571	5.6	"
25	"	1181	4.2	"
20	"	859	3.1	"
15	"	250	.9	"
10	"	-144	-.5	"
5	"	-790	-2.8	"
0.05	"	-3490	-12.5	"
0	"	-5213	-18.6	"

(ABOVE RESULTS DERIVED FROM 1000 SIMULATIONS)

FILENAME=C:\CASE09.OUT

07/19/96

10:15:45

Ex Situ/In Situ Combo. |
(with Repository fee)

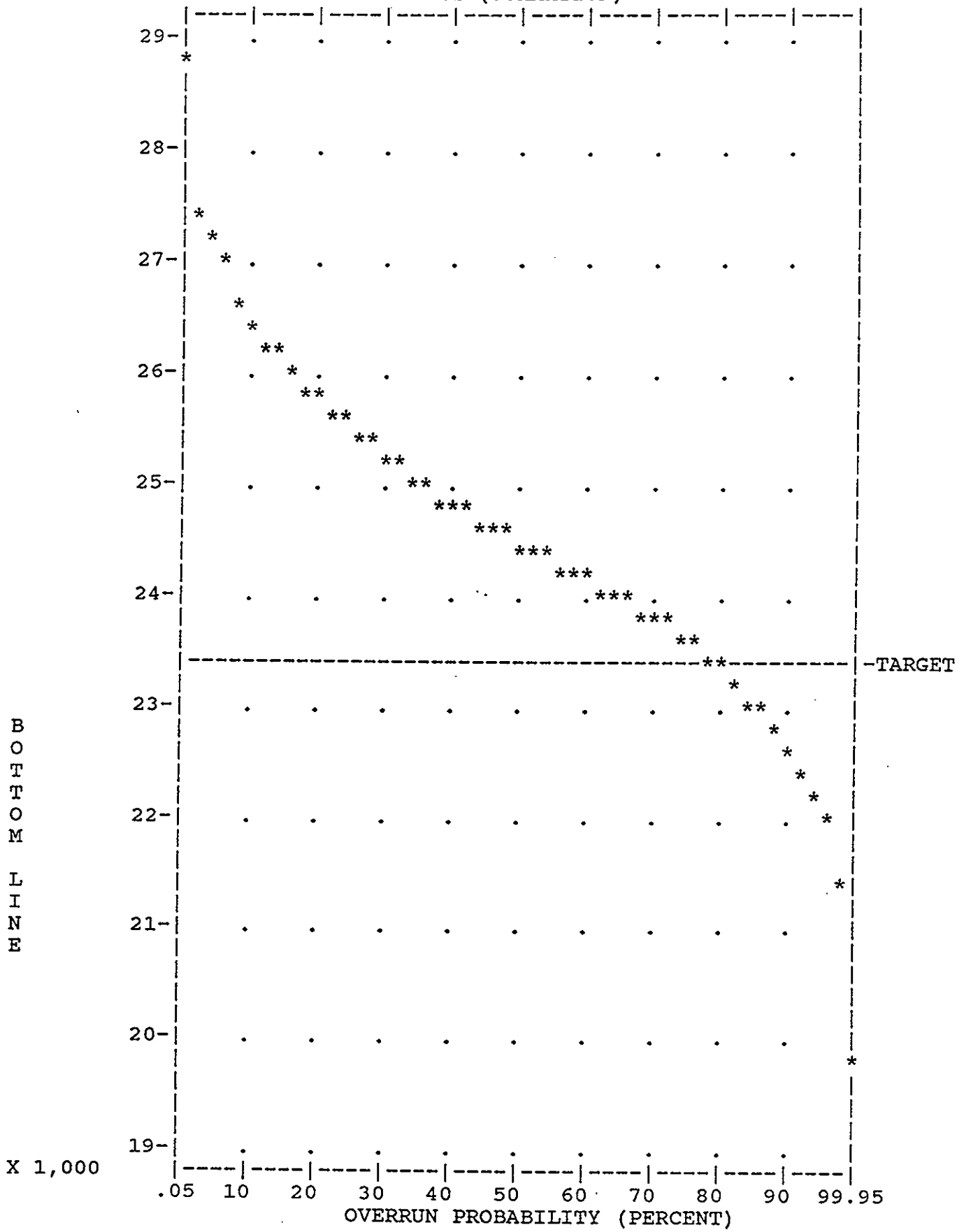
REP/PC (Ver 4.0) - MGMT REPORT 1 RANGE ESTIMATE : 07-19-96

DATA : ExSitu/InSitu Combo Case 09
MODEL : BASIC MODEL (SUMMATION)

NUM	ELEMENT	UNIT	TARGET	PROB+	LOW	HIGH
1	Current Operations		9142	50	7114	10970
2	R&D Waste Ret. & Transfer		186.00		186.00	186.00
3	R&D Treatment		630		630	630
4	Capital Waste Ret. & Transfer		1388	30	1110	2360
5	Capital Treatment		1926	30	1348	4333
6	Capital Closure		137.00		137.00	137.00
7	Operations Waste Ret. & Transfer		3166	30	2533	5382
8	Operations Treatment		3101	55	2170	3876
9	M & M		0		0	0
10	Repository Fee		3710	50	2968	4452
	TOTAL EXPENSE (INPUT TO REP/PC)		23386		18196 (THEORETICALS)	32326

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

REP/PC (Ver 4.0) - MGMT REPORT 2 GRAPHICAL OVERRUN PROFILE : 07-19-96
DATA : ExSitu/InSitu Combo Case 09
MODEL : BASIC MODEL (SUMMATION)



REP/PC (Ver 4.0) - MGMT REPORT 3 GRAPHICAL PRIORITY PROFILE : 07-19-96

DATA : ExSitu/InSitu Combo Case 09
MODEL : BASIC MODEL (SUMMATION)

TOTAL EXPENSE	PROB OF OVERRUN	NET EFFECT OF FROZEN ELEMENTS
23386	79 PCT	0 = .0 PCT

```
NUM ELEMENT                                UNIT     CORRECT        PROTECT

  1 Current Operations                                -------|++++++++
  5 Capital Treatment                           --------------|+
  7 Operations Waste Ret. & Transfer             -------------|+
  8 Operations Treatment                                  ---|++++
  4 Capital Waste Ret. & Transfer                       -----|+
 10 Repository Fee                                        ---|+++
    NET EFFECT OF FROZEN ELEMENTS                            |
```

REP/PC (Ver 4.0) - MGMT REPORT 4 CONTINGENCY PROFILE : 07-19-96

DATA : ExSitu/InSitu Combo Case 09
MODEL : BASIC MODEL (SUMMATION)

TO BE THIS CONFIDENT OF NOT HAVING COST OVERRUN		ADD THIS CONTINGENCY ABSOLUTE	RELATIVE	
100	PCT	8940	38.2	PCT
99.95	"	5423	23.2	"
95	"	3597	15.4	"
90	"	3068	13.1	"
85	"	2715	11.6	"
80	"	2381	10.2	"
75	"	2131	9.1	"
70	"	1841	7.9	"
65	"	1601	6.9	"
60	"	1425	6.1	"
55	"	1266	5.4	"
50	"	1103	4.7	"
45	"	918	3.9	"
40	"	753	3.2	"
35	"	571	2.4	"
30	"	421	1.8	"
25	"	208	.9	"
20	"	-62	-.3	"
15	"	-392	-1.7	"
10	"	-713	-3.0	"
5	"	-1254	-5.4	"
0.05	"	-3531	-15.1	"
0	"	-5190	-22.2	"

(ABOVE RESULTS DERIVED FROM 1000 SIMULATIONS)

6//105

FILENAME=C:\JUNCOMBO.OUT

07/19/96

10:17:09

Ex Sito/Insitu Combo 2
(with Repository fee)

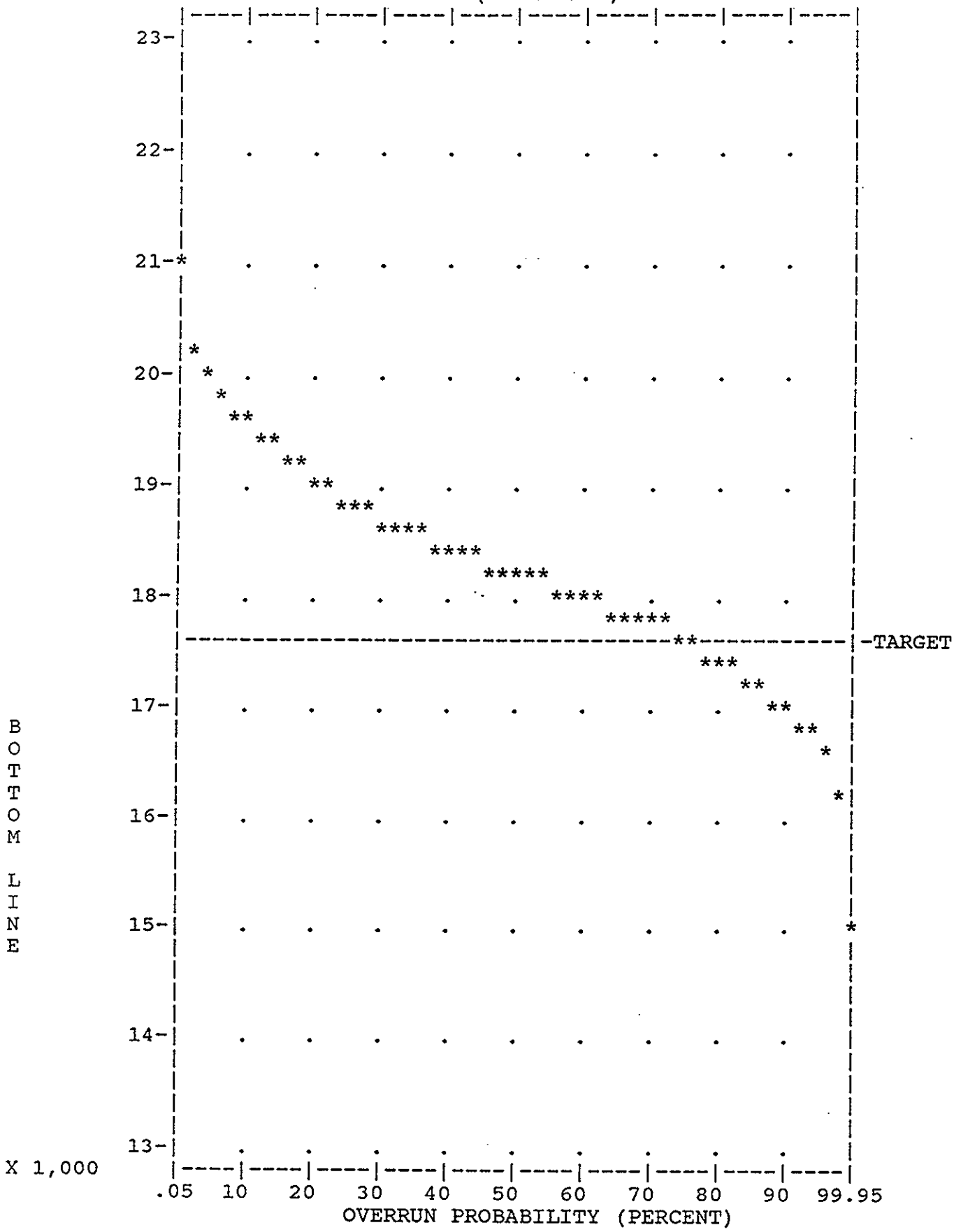
REP/PC (Ver 4.0) - MGMT REPORT 1 RANGE ESTIMATE : 07-19-96

DATA : junior combo
MODEL : BASIC MODEL (SUMMATION)

NUM	ELEMENT	UNIT	TARGET	PROB+	LOW	HIGH
1	current operations		9080	50	7264	10896
2	r&d		813		813	813
3	capital wr&t		970	30	776	1649
4	cap treat		1383	30	968	3118
5	cap closure		125.00		125.00	125.00
6	oper wr&t		952	30	762	1618
7	oper treat		2109	55	1476	2636
8	m&m		0		0	0
9	repository fee		2150	50	1720	2580
	TOTAL EXPENSE (INPUT TO REP/PC)		17582		13904 (THEORETICALS)	23435

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

REP/PC (Ver 4.0) - MGMT REPORT 2 GRAPHICAL OVERRUN PROFILE : 07-19-96
DATA : junior combo
MODEL : BASIC MODEL (SUMMATION)



REP/PC (Ver 4.0) - MGMT REPORT 3 GRAPHICAL PRIORITY PROFILE : 07-19-96

DATA : junior combo
MODEL : BASIC MODEL (SUMMATION)

TOTAL EXPENSE	PROB OF OVERRUN	NET EFFECT OF FROZEN ELEMENTS
17582	76 PCT	0 = .0 PCT

```
NUM ELEMENT                                UNIT     CORRECT        PROTECT

  1 current operations                          ---------|+++++++++
  4 cap treat                                 -------------|+
  7 oper treat                                           --|++++
  3 capital wr&t                                     -----|+
  6 oper wr&t                                        -----|+
  9 repository fee                                       --|++
    NET EFFECT OF FROZEN ELEMENTS                           |
```

REP/PC (Ver 4.0) - MGMT REPORT 4 CONTINGENCY PROFILE : 07-19-96

DATA : junior combo
MODEL : BASIC MODEL (SUMMATION)

TO BE THIS CONFIDENT OF NOT HAVING COST OVERRUN		ADD THIS CONTINGENCY ABSOLUTE	RELATIVE	
100	PCT	5853	33.3	PCT
99.95	"	3430	19.5	"
95	"	2288	13.0	"
90	"	2007	11.4	"
85	"	1725	9.8	"
80	"	1448	8.2	"
75	"	1241	7.1	"
70	"	1109	6.3	"
65	"	988	5.6	"
60	"	860	4.9	"
55	"	728	4.1	"
50	"	625	3.6	"
45	"	495	2.8	"
40	"	379	2.2	"
35	"	286	1.6	"
30	"	183	1.0	"
25	"	19	.1	"
20	"	-170	-1.0	"
15	"	-362	-2.1	"
10	"	-644	-3.7	"
5	"	-965	-5.5	"
0.05	"	-2592	-14.7	"
0	"	-3678	-20.9	"

(ABOVE RESULTS DERIVED FROM 1000 SIMULATIONS)

66/105

FILENAME=C:\CASE10.OUT

07/17/96

12:07:52

Phased Implementation
(with Repository fee)

REP/PC (Ver 4.0) - MGMT REPORT 1 RANGE ESTIMATE : 07-17-96

DATA : Phased Impl 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	30	1824	3876
5	Capital Treatment		5300	30	3180	10600
6	Capital Closure		211.00		211.00	211.00
7	Operations Waste Ret. & Transfer		4010	30	3208	6817
8	Operations Treatment		6608	60	3965	7599
9	M&M		0		0	0
10	Repository Fee		5280	50	4224	6336
	TOTAL EXPENSE (INPUT TO REP/PC)		32479		23682	45949
					(THEORETICALS)	

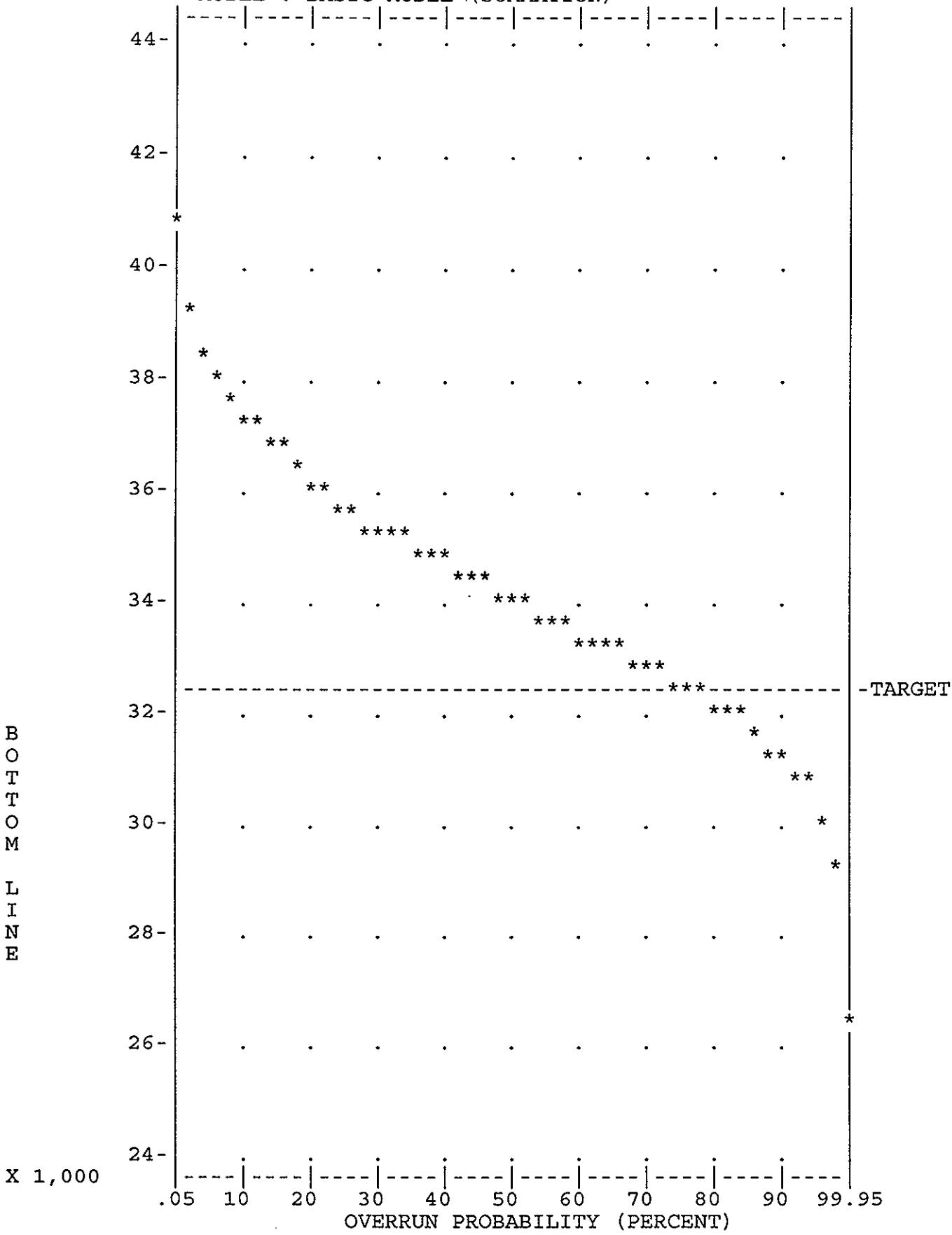
+ PROBABILITY THAT ACTUAL VALUE WILL BE EQUAL TO OR LESS THAN TARGET

68/105

REP/PC (Ver 4.0) - MGMT REPORT 2 GRAPHICAL OVERRUN PROFILE : 07-17-96

DATA : Phased Impl Case 10

MODEL : BASIC MODEL (SUMMATION)



REP/PC (Ver 4.0) - MGMT REPORT 3 GRAPHICAL PRIORITY PROFILE : 07-17-96

DATA : Phased Impl Case 10
MODEL : BASIC MODEL (SUMMATION)

TOTAL EXPENSE	PROB OF OVERRUN	NET EFFECT OF FROZEN ELEMENTS
32479	75 PCT	0 = .0 PCT

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

REP/PC (Ver 4.0) - MGMT REPORT 4 CONTINGENCY PROFILE : 07-17-96

DATA : Phased Impl Case 10
MODEL : BASIC MODEL (SUMMATION)

TO BE THIS CONFIDENT OF NOT HAVING COST OVERRUN		ADD THIS CONTINGENCY ABSOLUTE	RELATIVE	
100	PCT	13470	41.5	PCT
99.95	"	8396	25.9	"
95	"	5689	17.5	"
90	"	4809	14.8	"
85	"	4280	13.2	"
80	"	3677	11.3	"
75	"	3210	9.9	"
70	"	2784	8.6	"
65	"	2467	7.6	"
60	"	2134	6.6	"
55	"	1827	5.6	"
50	"	1485	4.6	"
45	"	1172	3.6	"
40	"	900	2.8	"
35	"	711	2.2	"
30	"	363	1.1	"
25	"	-36	-.1	"
20	"	-432	-1.3	"
15	"	-770	-2.4	"
10	"	-1324	-4.1	"
5	"	-2071	-6.4	"
0.05	"	-6155	-18.9	"
0	"	-8797	-27.1	"

(ABOVE RESULTS DERIVED FROM 1000 SIMULATIONS)

FILENAME=A:\CASE05NF.OUT

07/18/96

12:44:26

Ex Situ Intermediate Separations
(w/o Repository fee)

72/105

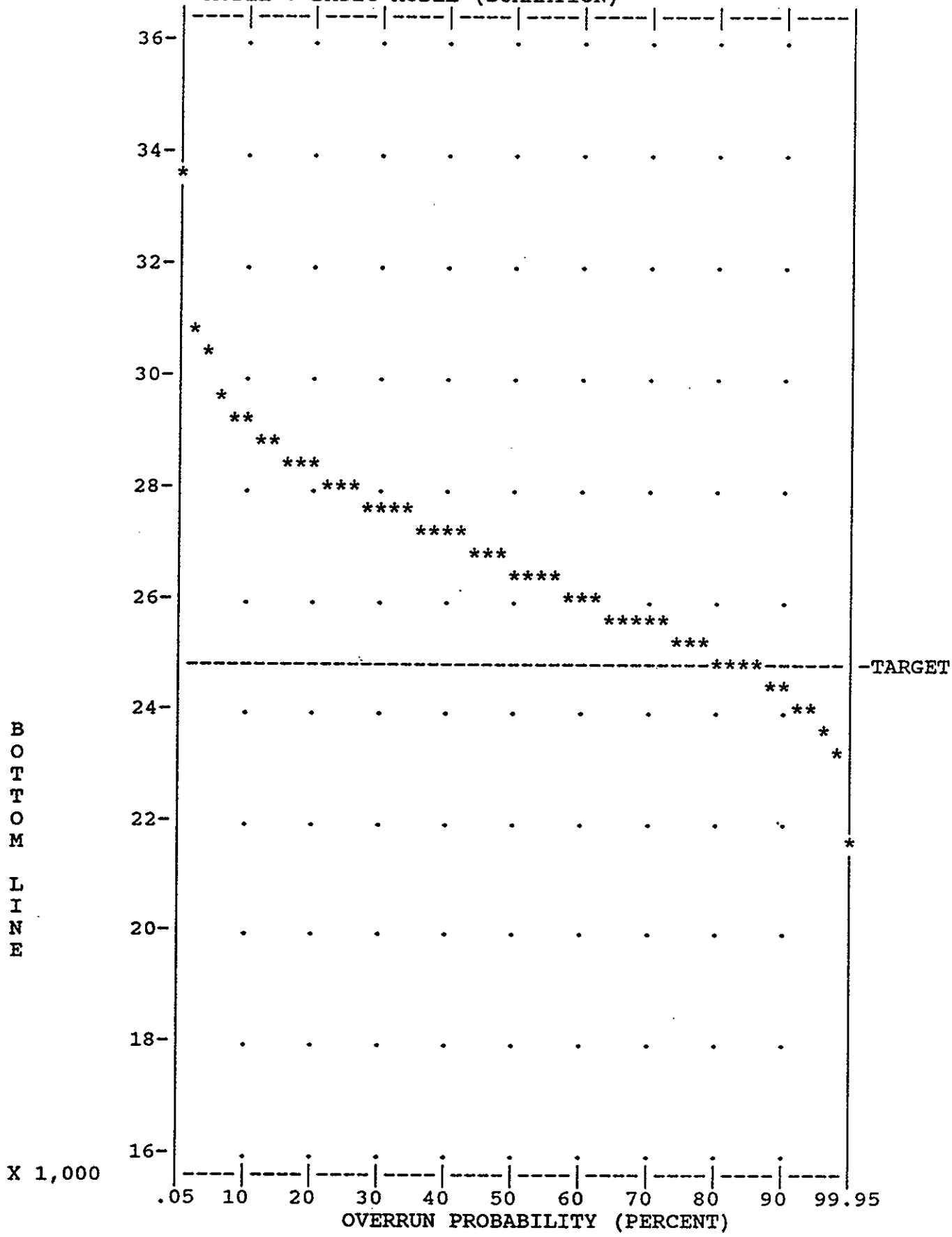
REP/PC (Ver 4.0) - MGMT REPORT 1 RANGE ESTIMATE : 07-18-96

DATA : Inter Sep 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	30	1824	3876
5	Capital Treatment		3600	40	2880	7200
6	Capital Closure		169.00		169.00	169.00
7	Operations Waste Ret. & Transfer		4820	30	3856	8194
8	Operations Treatment		4548	50	3638	6140
9	M & M		0		0	0
	TOTAL EXPENSE (INPUT TO REP/PC)		24837		20067 (THEORETICALS)	36719

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

REP/PC (Ver 4.0) - MGMT REPORT 2 GRAPHICAL OVERRUN PROFILE : 07-18-96
DATA : Inter Sep Case 05
MODEL : BASIC MODEL (SUMMATION)



REP/PC (Ver 4.0) - MGMT REPORT 3 GRAPHICAL PRIORITY PROFILE : 07-18-96

DATA : Inter Sep Case 05
MODEL : BASIC MODEL (SUMMATION)

TOTAL EXPENSE	PROB OF OVERRUN	NET EFFECT OF FROZEN ELEMENTS
24837	82 PCT	0 = .0 PCT

```
NUM ELEMENT                                UNIT     CORRECT        PROTECT

  7 Operations Waste Ret. & Transfer              -------------|++
  5 Capital Treatment                               -----------|++
  1 Current Operations                                     ----|++++
  8 Operations Treatment                                  -----|++
  4 Capital Waste Ret. & Transfer                        ------|+
    NET EFFECT OF FROZEN ELEMENTS                              |
```

75/105

REP/PC (Ver 4.0) - MGMT REPORT 4 CONTINGENCY PROFILE : 07-18-96

DATA : Inter Sep Case 05
MODEL : BASIC MODEL (SUMMATION)

TO BE THIS CONFIDENT OF NOT HAVING COST OVERRUN		ADD THIS CONTINGENCY ABSOLUTE	RELATIVE	
100	PCT	11882	47.8	PCT
99.95	"	8622	34.7	"
95	"	5113	20.6	"
90	"	4219	17.0	"
85	"	3745	15.1	"
80	"	3366	13.6	"
75	"	3056	12.3	"
70	"	2764	11.1	"
65	"	2537	10.2	"
60	"	2294	9.2	"
55	"	2002	8.1	"
50	"	1717	6.9	"
45	"	1471	5.9	"
40	"	1188	4.8	"
35	"	915	3.7	"
30	"	720	2.9	"
25	"	427	1.7	"
20	"	78	.3	"
15	"	-129	-.5	"
10	"	-475	-1.9	"
5	"	-950	-3.8	"
0.05	"	-3298	-13.3	"
0	"	-4770	-19.2	"

(ABOVE RESULTS DERIVED FROM 1000 SIMULATIONS)

FILENAME=A:\CASE06NF.OUT

07/18/9

12:45:5

Ex Situ No Separations Vit
(w/o Repository fee)

REP/PC (Ver 4.0) - MGMT REPORT 1 RANGE ESTIMATE : 07-18-96

DATA : No Sep Vitr 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	30	1824	3876
5	Capital Treatment		2610	50	2088	4437
6	Capital Closure		152.00		152.00	152.00
7	Operations Waste Ret. & Transfer		4630	30	3704	7871
8	Operations Treatment		5167	50	4134	6975
9	M & M		0		0	0
	TOTAL EXPENSE (INPUT TO REP/PC)		23634		19032 (THEORETICALS)	33771

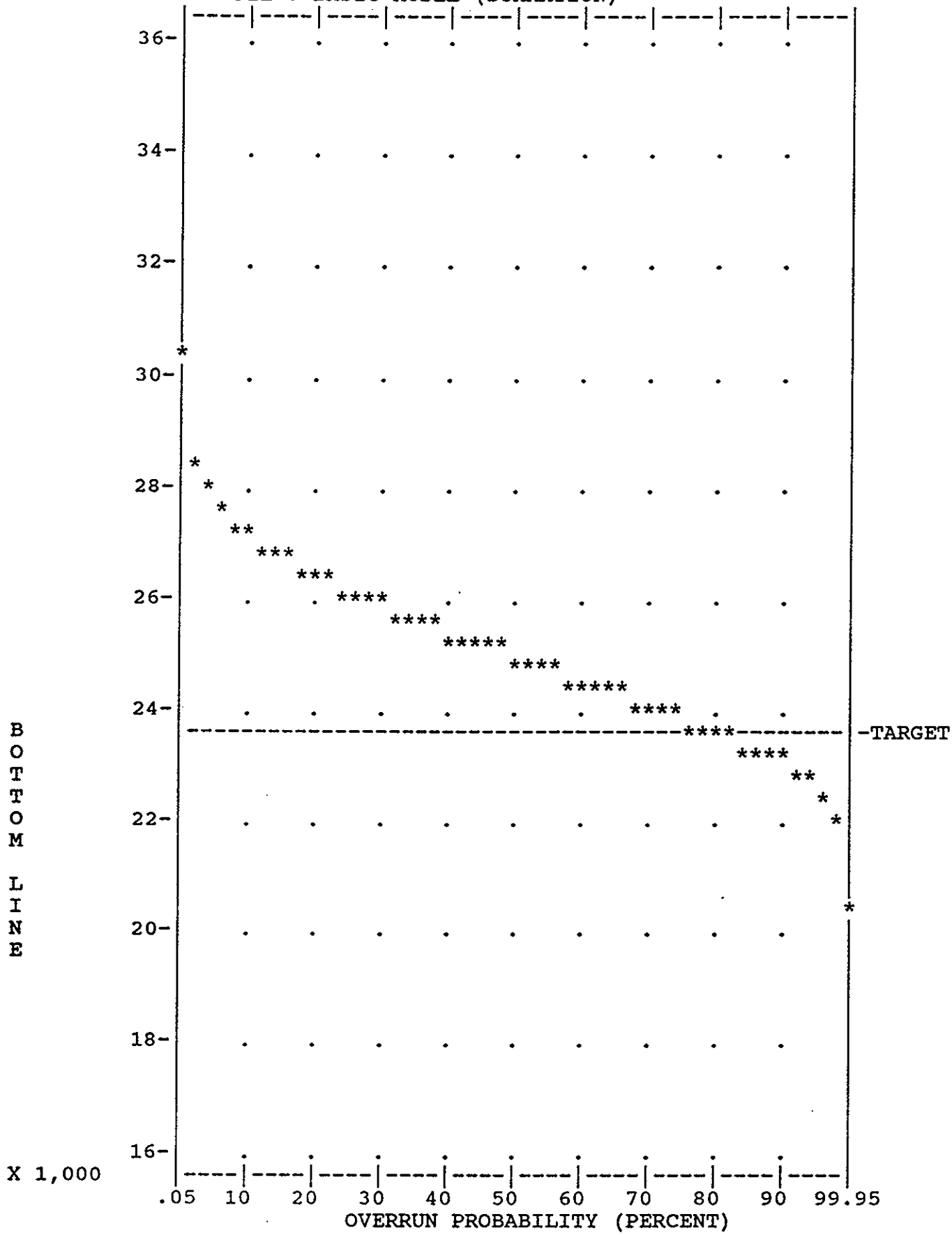
+ PROBABILITY THAT ACTUAL VALUE WILL BE EQUAL TO OR LESS THAN TARGET

78/105

REP/PC (Ver 4.0) - MGMT REPORT 2 GRAPHICAL OVERRUN PROFILE : 07-18-96

DATA : No Sep Vitr Case 06

MODEL : BASIC MODEL (SUMMATION)



79/105

REP/PC (Ver 4.0) - MGMT REPORT 3 GRAPHICAL PRIORITY PROFILE : 07-18-96

DATA : No Sep Vitr Case 06
MODEL : BASIC MODEL (SUMMATION)

TOTAL EXPENSE	PROB OF OVERRUN	NET EFFECT OF FROZEN ELEMENTS
23634	78 PCT	0 = .0 PCT

```
NUM ELEMENT                                UNIT     CORRECT        PROTECT

  7 Operations Waste Ret. & Transfer              -------------|++
  8 Operations Treatment                                 -----|+++
  1 Current Operations                                    ----|++++
  4 Capital Waste Ret. & Transfer                      -------|+
  5 Capital Treatment                                   ------|++
    NET EFFECT OF FROZEN ELEMENTS                            |
```

80/105

REP/PC (Ver 4.0) - MGMT REPORT 4 CONTINGENCY PROFILE : 07-18-96

DATA : No Sep Vitr Case 06
MODEL : BASIC MODEL (SUMMATION)

TO BE THIS CONFIDENT OF NOT HAVING COST OVERRUN		ADD THIS CONTINGENCY ABSOLUTE	RELATIVE	
100	PCT	10137	42.9	PCT
99.95	"	6754	28.6	"
95	"	4083	17.3	"
90	"	3558	15.1	"
85	"	3082	13.0	"
80	"	2741	11.6	"
75	"	2444	10.3	"
70	"	2185	9.3	"
65	"	1969	8.3	"
60	"	1746	7.4	"
55	"	1519	6.4	"
50	"	1299	5.5	"
45	"	1073	4.5	"
40	"	862	3.7	"
35	"	692	2.9	"
30	"	423	1.8	"
25	"	170	.7	"
20	"	-62	-.3	"
15	"	-337	-1.4	"
10	"	-604	-2.6	"
5	"	-988	-4.2	"
0.05	"	-3149	-13.3	"
0	"	-4602	-19.5	"

(ABOVE RESULTS DERIVED FROM 1000 SIMULATIONS)

Ex Situ No Separations - Calcination
(w/o Repository fee)

REP/PC (Ver 4.0) - MGMT REPORT 1 RANGE ESTIMATE : 07-18-96

DATA : No Sep Calc 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	30	1824	3876
5	Capital Treatment		2610	50	2088	4437
6	Capital Closure		152.00		152.00	152.00
7	Operations Waste Ret. & Transfer		4630	30	3704	7871
8	Operations Treatment		3233	50	2586	4364
9	M & M		0		0	0
	TOTAL EXPENSE (INPUT TO REP/PC)		21700		17484 (THEORETICALS)	31160

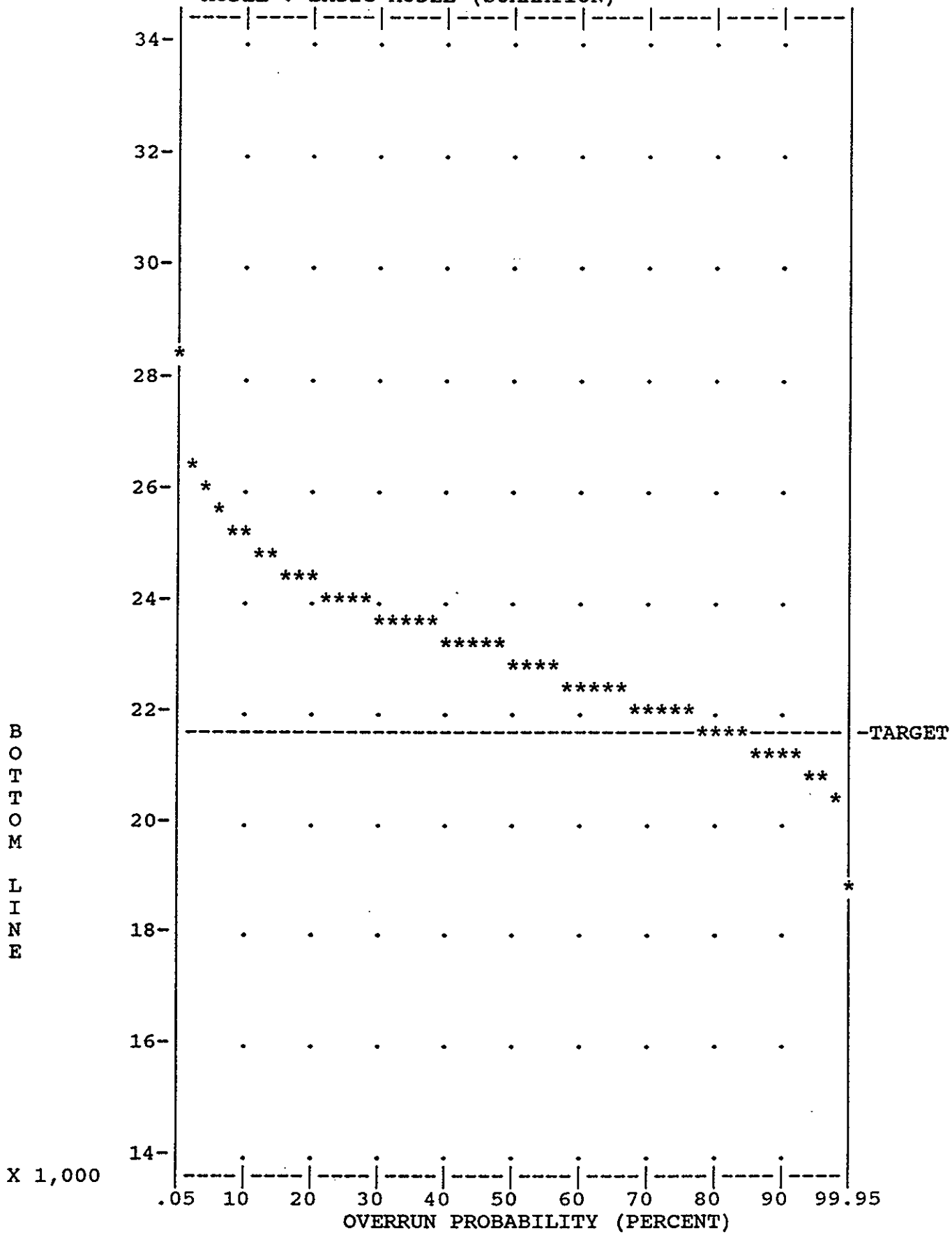
+ PROBABILITY THAT ACTUAL VALUE WILL BE EQUAL TO OR LESS THAN TARGET

83/105

REP/PC (Ver 4.0) - MGMT REPORT 2 GRAPHICAL OVERRUN PROFILE : 07-18-96

DATA : No Sep Calc Case 07

MODEL : BASIC MODEL (SUMMATION)



84/105

REP/PC (Ver 4.0) - MGMT REPORT 3 GRAPHICAL PRIORITY PROFILE : 07-18-96

DATA : No Sep Calc Case 07
MODEL : BASIC MODEL (SUMMATION)

TOTAL EXPENSE	PROB OF OVERRUN	NET EFFECT OF FROZEN ELEMENTS
21700	80 PCT	0 = .0 PCT

```
NUM ELEMENT                                UNIT     CORRECT        PROTECT

  7 Operations Waste Ret. & Transfer              -------------|++
  1 Current Operations                                    ----|++++
  4 Capital Waste Ret. & Transfer                      -------|+
  5 Capital Treatment                                   ------|++
  8 Operations Treatment                                   ---|++
    NET EFFECT OF FROZEN ELEMENTS                             |
```

REP/PC (Ver 4.0) - MGMT REPORT 4 CONTINGENCY PROFILE : 07-18-96

DATA : No Sep Calc Case 07
MODEL : BASIC MODEL (SUMMATION)

TO BE THIS CONFIDENT OF NOT HAVING COST OVERRUN		ADD THIS CONTINGENCY ABSOLUTE	RELATIVE	
100	PCT	9460	43.6	PCT
99.95	"	6659	30.7	"
95	"	3942	18.2	"
90	"	3322	15.3	"
85	"	2916	13.4	"
80	"	2593	12.0	"
75	"	2305	10.6	"
70	"	2092	9.6	"
65	"	1882	8.7	"
60	"	1677	7.7	"
55	"	1496	6.9	"
50	"	1274	5.9	"
45	"	1023	4.7	"
40	"	803	3.7	"
35	"	656	3.0	"
30	"	418	1.9	"
25	"	194	.9	"
20	"	9	.0	"
15	"	-255	-1.2	"
10	"	-532	-2.4	"
5	"	-924	-4.3	"
0.05	"	-3025	-13.9	"
0	"	-4216	-19.4	"

(ABOVE RESULTS DERIVED FROM 1000 SIMULATIONS)

Ex Situ Extensive Separations
(W/O Repository fee)

87/105

REP/PC (Ver 4.0) - MGMT REPORT 1 RANGE ESTIMATE : 07-18-96

DATA : Ext Sep 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	30	1824	3876
5	Capital Treatment		5202	20	4162	14305
6	Capital Closure		170.00		170.00	170.00
7	Operations Waste Ret. & Transfer		4820	30	3856	8194
8	Operations Treatment		5163	50	4130	6970
9	M & M		0		0	0
	TOTAL EXPENSE (INPUT TO REP/PC)		27725		22512 (THEORETICALS)	45325

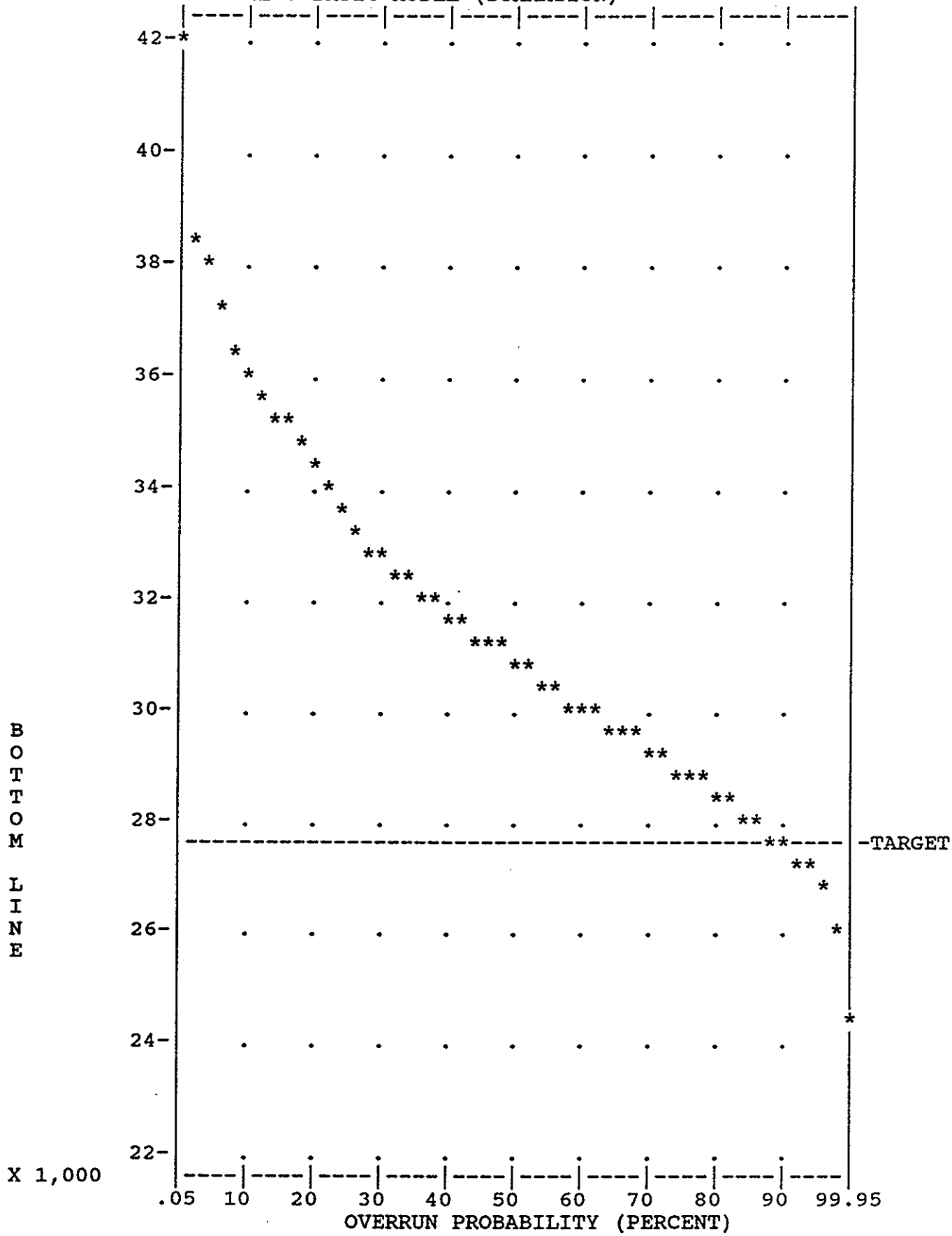
+ PROBABILITY THAT ACTUAL VALUE WILL BE EQUAL TO OR LESS THAN TARGET

88/105

REP/PC (Ver 4.0) - MGMT REPORT 2 GRAPHICAL OVERRUN PROFILE : 07-18-96

DATA : Ext Sep Case 08

MODEL : BASIC MODEL (SUMMATION)



REP/PC (Ver 4.0) - MGMT REPORT 3 GRAPHICAL PRIORITY PROFILE : 07-18-96

DATA : Ext Sep Case 08
MODEL : BASIC MODEL (SUMMATION)

TOTAL EXPENSE	PROB OF OVERRUN	NET EFFECT OF FROZEN ELEMENTS
27725	88 PCT	0 = .0 PCT

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

REP/PC (Ver 4.0) - MGMT REPORT 4 CONTINGENCY PROFILE : 07-18-96

DATA : Ext Sep Case 08
MODEL : BASIC MODEL (SUMMATION)

TO BE THIS CONFIDENT OF NOT HAVING COST OVERRUN		ADD THIS CONTINGENCY ABSOLUTE	RELATIVE	
100	PCT	17600	63.5	PCT
99.95	"	14094	50.8	"
95	"	9739	35.1	"
90	"	8277	29.9	"
85	"	7498	27.0	"
80	"	6602	23.8	"
75	"	5585	20.1	"
70	"	5051	18.2	"
65	"	4527	16.3	"
60	"	3947	14.2	"
55	"	3542	12.8	"
50	"	3143	11.3	"
45	"	2736	9.9	"
40	"	2308	8.3	"
35	"	1924	6.9	"
30	"	1571	5.7	"
25	"	1181	4.3	"
20	"	859	3.1	"
15	"	250	.9	"
10	"	-144	-.5	"
5	"	-790	-2.8	"
0.05	"	-3490	-12.6	"
0	"	-5213	-18.8	"

(ABOVE RESULTS DERIVED FROM 1000 SIMULATIONS)

FILENAME=C:\CASE09NF.OUT

91/105

07/19/96

10:16:24

Ex Situ/In Situ Combo 1
(w/o Repository fee)

REP/PC (Ver 4.0) - MGMT REPORT 1 RANGE ESTIMATE : 07-19-96

DATA : ExSitu/InSitu Combo Case 09
MODEL : BASIC MODEL (SUMMATION)

NUM	ELEMENT	UNIT	TARGET	PROB+	LOW	HIGH
1	Current Operations		9142	50	7114	10970
2	R&D Waste Ret. & Transfer		186.00		186.00	186.00
3	R&D Treatment		630		630	630
4	Capital Waste Ret. & Transfer		1388	30	1110	2360
5	Capital Treatment		1926	30	1348	4333
6	Capital Closure		137.00		137.00	137.00
7	Operations Waste Ret. & Transfer		3166	30	2533	5382
8	Operations Treatment		3101	55	2170	3876
9	M & M		0		0	0
	TOTAL EXPENSE (INPUT TO REP/PC)		19676		15228 (THEORETICALS)	27874

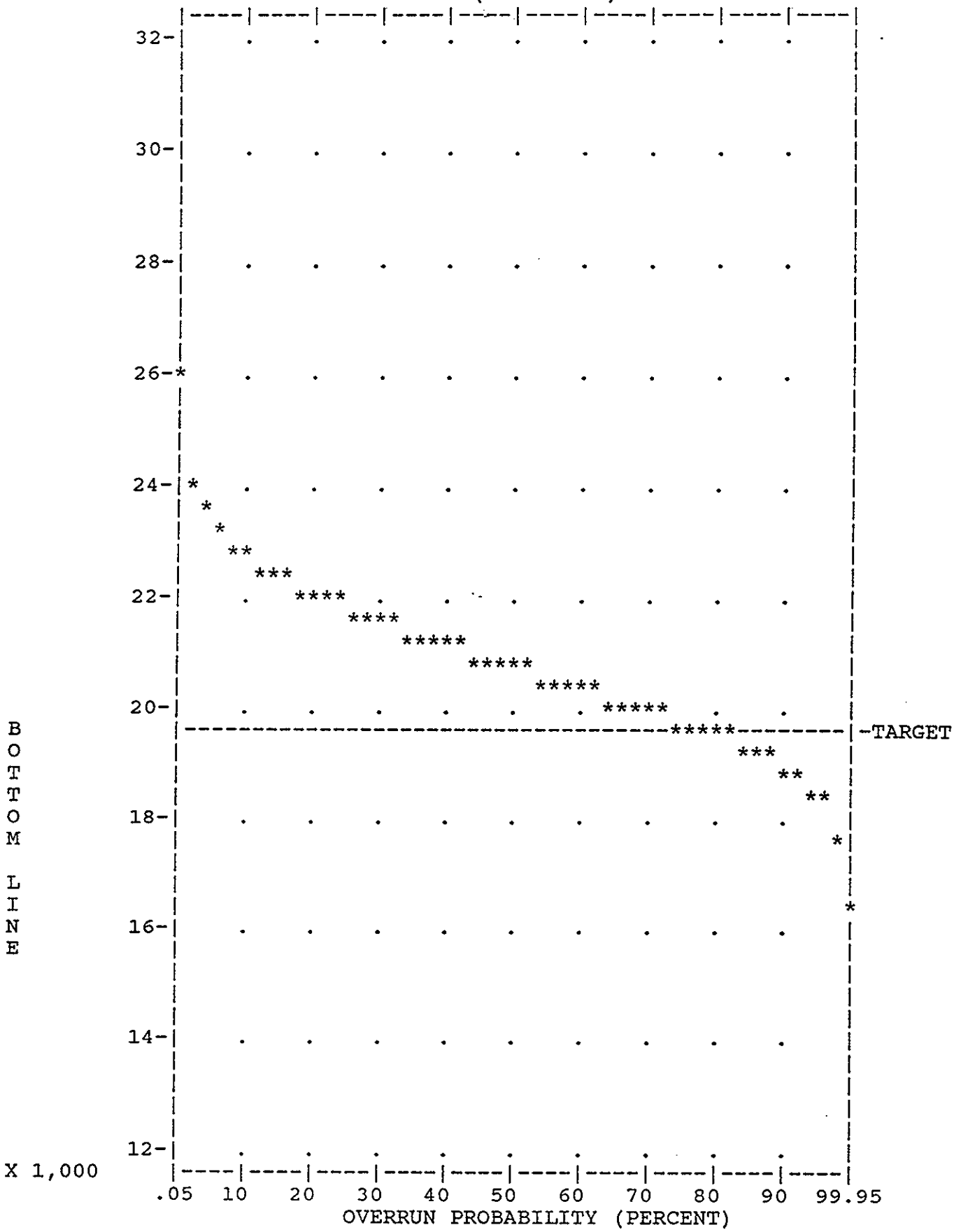
+ PROBABILITY THAT ACTUAL VALUE WILL BE EQUAL TO OR LESS THAN TARGET

93/105

REP/PC (Ver 4.0) - MGMT REPORT 2 GRAPHICAL OVERRUN PROFILE : 07-19-96

DATA : ExSitu/InSitu Combo Case 09

MODEL : BASIC MODEL (SUMMATION)



REP/PC (Ver 4.0) - MGMT REPORT 3 GRAPHICAL PRIORITY PROFILE : 07-19-96

DATA : ExSitu/InSitu Combo Case 09
MODEL : BASIC MODEL (SUMMATION)

TOTAL EXPENSE	PROB OF OVERRUN	NET EFFECT OF FROZEN ELEMENTS
19676	77 PCT	0 = .0 PCT

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

REP/PC (Ver 4.0) - MGMT REPORT 4 CONTINGENCY PROFILE : 07-19-96

DATA : ExSitu/InSitu Combo Case 09
MODEL : BASIC MODEL (SUMMATION)

TO BE THIS CONFIDENT OF NOT HAVING COST OVERRUN		ADD THIS CONTINGENCY ABSOLUTE	RELATIVE	
100	PCT	8198	41.7	PCT
99.95	"	6363	32.3	"
95	"	3590	18.3	"
90	"	2978	15.1	"
85	"	2560	13.0	"
80	"	2360	12.0	"
75	"	2099	10.7	"
70	"	1837	9.3	"
65	"	1596	8.1	"
60	"	1419	7.2	"
55	"	1270	6.5	"
50	"	1084	5.5	"
45	"	869	4.4	"
40	"	680	3.5	"
35	"	469	2.4	"
30	"	288	1.5	"
25	"	70	.4	"
20	"	-124	-.6	"
15	"	-377	-1.9	"
10	"	-724	-3.7	"
5	"	-1354	-6.9	"
0.05	"	-3357	-17.1	"
0	"	-4448	-22.6	"

(ABOVE RESULTS DERIVED FROM 1000 SIMULATIONS)

FILENAME=C:\JUNCOMNF.OUT

96/105

07/19/96

10:17:45

Ex Situ/In Situ Combo 2
(w/o Repository fee)

REP/PC (Ver 4.0) - MGMT REPORT 1 RANGE ESTIMATE : 07-19-96

DATA : junior combo
MODEL : BASIC MODEL (SUMMATION)

NUM	ELEMENT	UNIT	TARGET	PROB+	LOW	HIGH
1	current operations		9080	50	7264	10896
2	r&d		813		813	813
3	capital wr&t		970	30	776	1649
4	cap treat		1383	30	968	3118
5	cap closure		125.00		125.00	125.00
6	oper wr&t		952	30	762	1618
7	oper treat		2109	55	1476	2636
8	m&m		0		0	0
	TOTAL EXPENSE (INPUT TO REP/PC)		15432		12184 (THEORETICALS)	20855

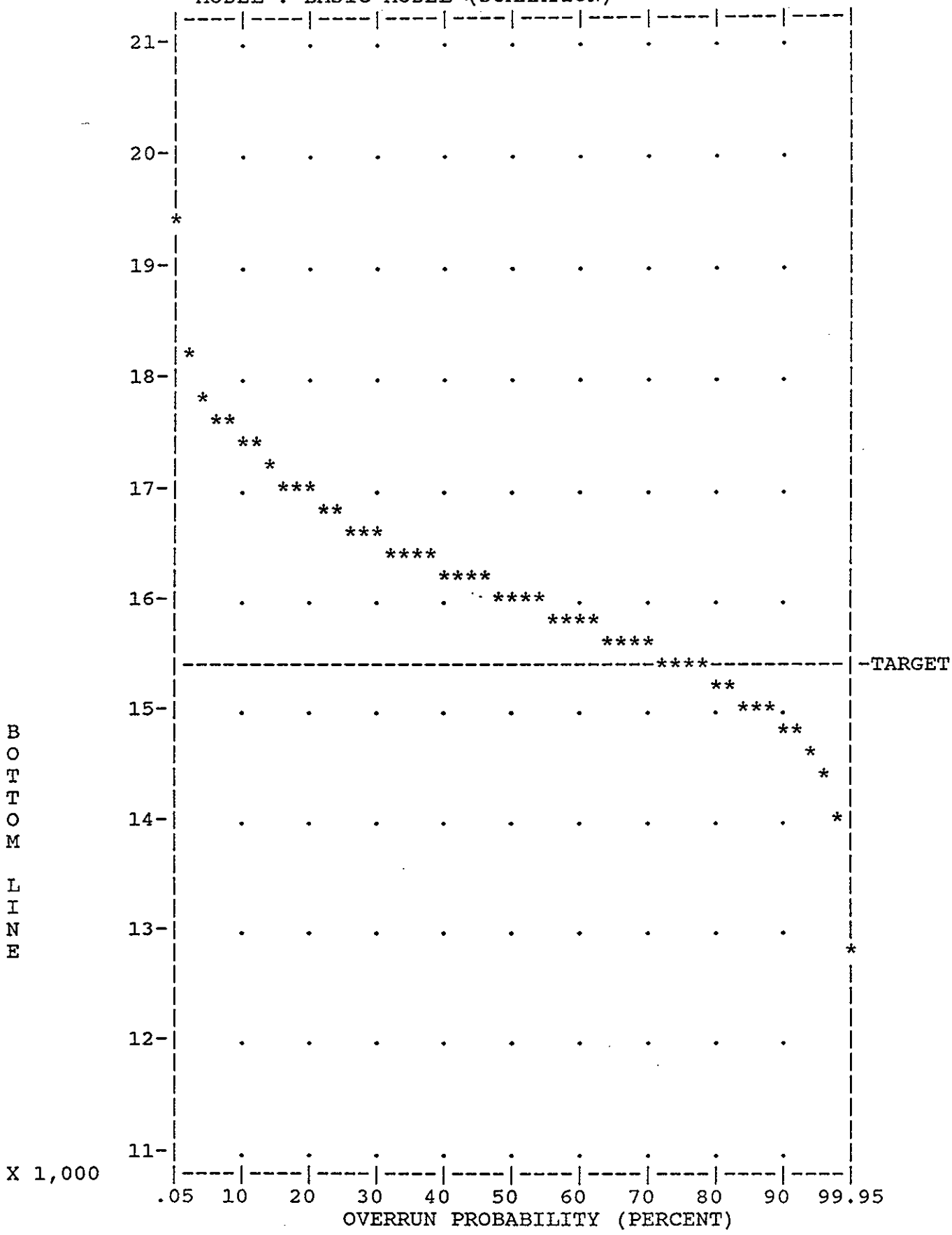
+ PROBABILITY THAT ACTUAL VALUE WILL BE EQUAL TO OR LESS THAN TARGET

98/105

REP/PC (Ver 4.0) - MGMT REPORT 2 GRAPHICAL OVERRUN PROFILE : 07-19-96

DATA : junior combo

MODEL : BASIC MODEL (SUMMATION)



REP/PC (Ver 4.0) - MGMT REPORT 3 GRAPHICAL PRIORITY PROFILE : 07-19-96

DATA : junior combo
MODEL : BASIC MODEL (SUMMATION)

TOTAL EXPENSE	PROB OF OVERRUN	NET EFFECT OF FROZEN ELEMENTS
15432	73 PCT	0 = .0 PCT

```
NUM ELEMENT                                UNIT     CORRECT        PROTECT

  1 current operations                           ---------|+++++++++
  4 cap treat                                ------------|+
  7 oper treat                                         --|++++
  3 capital wr&t                                   -----|+
  6 oper wr&t                                      -----|+
    NET EFFECT OF FROZEN ELEMENTS                       |
```

REP/PC (Ver 4.0) - MGMT REPORT 4 CONTINGENCY PROFILE : 07-19-96

DATA : junior combo
MODEL : BASIC MODEL (SUMMATION)

TO BE THIS CONFIDENT OF NOT HAVING COST OVERRUN		ADD THIS CONTINGENCY ABSOLUTE	RELATIVE	
100	PCT	5423	35.1	PCT
99.95	"	3990	25.9	"
95	"	2301	14.9	"
90	"	1968	12.8	"
85	"	1724	11.2	"
80	"	1474	9.6	"
75	"	1241	8.0	"
70	"	1099	7.1	"
65	"	958	6.2	"
60	"	819	5.3	"
55	"	713	4.6	"
50	"	558	3.6	"
45	"	458	3.0	"
40	"	346	2.2	"
35	"	220	1.4	"
30	"	85	.6	"
25	"	-40	-.3	"
20	"	-202	-1.3	"
15	"	-376	-2.4	"
10	"	-624	-4.0	"
5	"	-990	-6.4	"
0.05	"	-2536	-16.4	"
0	"	-3248	-21.0	"

(ABOVE RESULTS DERIVED FROM 1000 SIMULATIONS)

FILENAME=A:\CASE10NF.OUT

07/18/9

12:51:1

Phased Implementation
(w/o Repository fee)

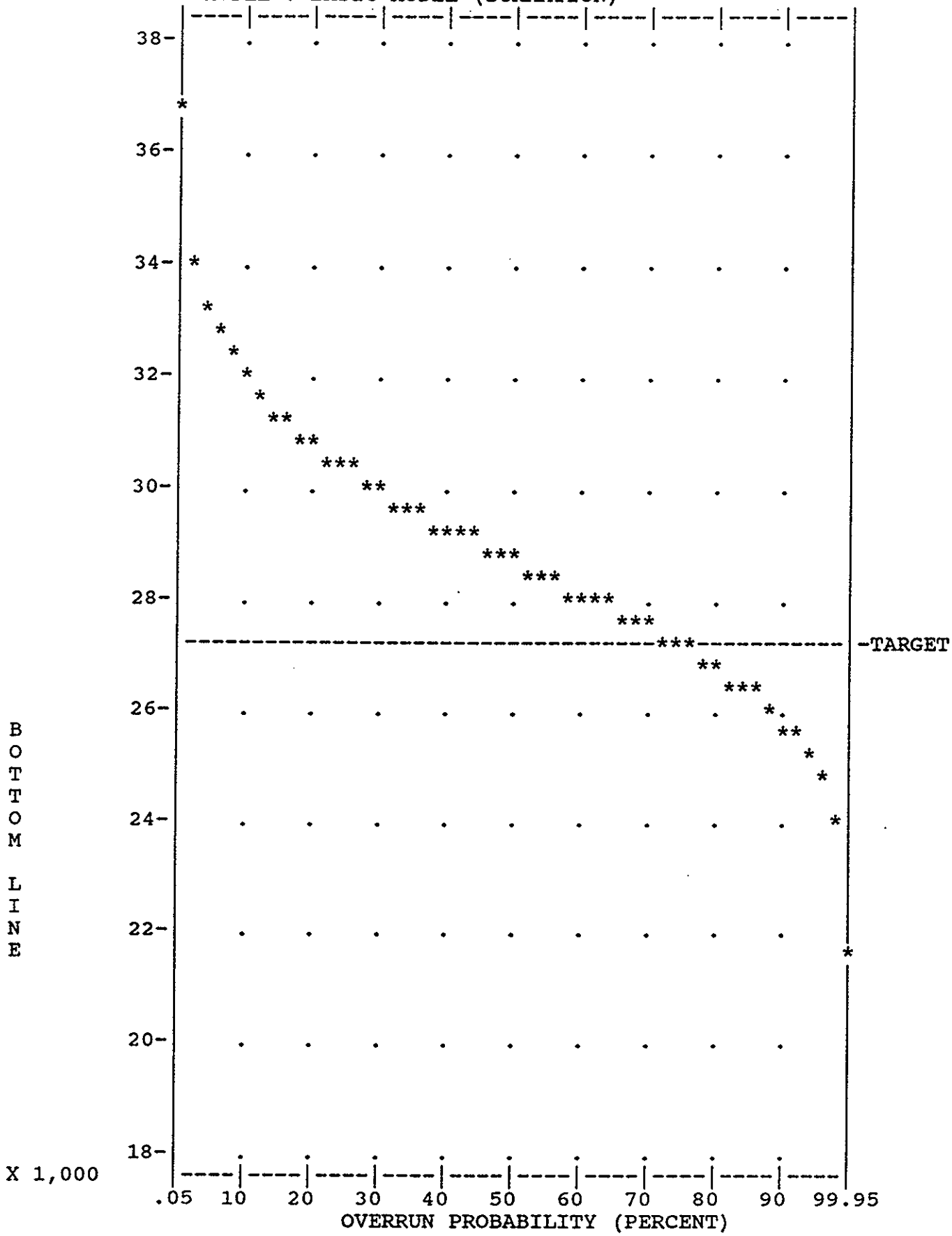
REP/PC (Ver 4.0) - MGMT REPORT 1 RANGE ESTIMATE : 07-18-96

DATA : Phased Impl 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	30	1824	3876
5	Capital Treatment		5300	30	3180	10600
6	Capital Closure		211.00		211.00	211.00
7	Operations Waste Ret. & Transfer		4010	30	3208	6817
8	Operations Treatment		6608	60	3965	7599
9	M&M		0		0	0
	TOTAL EXPENSE (INPUT TO REP/PC)		27199		19458	39613
					(THEORETICALS)	

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

REP/PC (Ver 4.0) - MGMT REPORT 2 GRAPHICAL OVERRUN PROFILE : 07-18-96
DATA : Phased Impl Case 10
MODEL : BASIC MODEL (SUMMATION)



REP/PC (Ver 4.0) - MGMT REPORT 3 GRAPHICAL PRIORITY PROFILE : 07-18-96

DATA : Phased Impl Case 10
MODEL : BASIC MODEL (SUMMATION)

TOTAL EXPENSE	PROB OF OVERRUN	NET EFFECT OF FROZEN ELEMENTS
27199	74 PCT	0 = .0 PCT

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

REP/PC (Ver 4.0) - MGMT REPORT 4 CONTINGENCY PROFILE : 07-18-96

DATA : Phased Impl Case 10
MODEL : BASIC MODEL (SUMMATION)

TO BE THIS CONFIDENT OF NOT HAVING COST OVERRUN		ADD THIS CONTINGENCY ABSOLUTE	RELATIVE	
100	PCT	12414	45.6	PCT
99.95	"	9659	35.5	"
95	"	5811	21.4	"
90	"	4718	17.4	"
85	"	4087	15.0	"
80	"	3568	13.1	"
75	"	3155	11.6	"
70	"	2719	10.0	"
65	"	2433	9.0	"
60	"	2078	7.6	"
55	"	1803	6.6	"
50	"	1471	5.4	"
45	"	1126	4.1	"
40	"	827	3.0	"
35	"	577	2.1	"
30	"	282	1.0	"
25	"	-68	-.2	"
20	"	-472	-1.7	"
15	"	-876	-3.2	"
10	"	-1449	-5.3	"
5	"	-2108	-7.7	"
0.05	"	-5431	-20.0	"
0	"	-7741	-28.5	"

(ABOVE RESULTS DERIVED FROM 1000 SIMULATIONS)

TWRS EIS
CALCULATION COVER SHEET

DISCIPLINE & TITLE Safety: Unit Liter Doses (ULDs) for Bounding Accident scenarios.

ORIGINATOR Michael Harker DATE 7-28-96

REVISION NO. _____

OBJECTIVE Calculate bounding ULDs for 70-year committment based on "supper tank" inventory

METHODOLOGY see attachment

ASSUMPTIONS Supper Tank inventory based on WHC-SD-WM-SARR-037, Rev. 0.

(Continue on another sheet if necessary)

SIGNATURE/DATE

Loretta Cron 8/28/96.
CHECKED/DATE

A.N

CALCULATION & RESULTS
ATTACHED

193

JACOBS\FORMS\CALCVR.SHT

ULDs FOR BOUNDING ACCIDENTS BASED ON 70-YEAR COMMITTMENT								
	liquids	solids						
SST	1.31E+06	2.30E+07						
DST	7.10E+05	6.45E+07						
AWF	1.39E+05	2.07E+08						
1 Ci/3.7E+10 Bq = conversion factor of				2.70E-11				
SST liquids					SST solids			
		units	dose			units	dose	
		conversio	conversion			conversio	conversion	
		factor	factor	ULD		factor	factor	ULD
isotopes	Bq/L	Ci/Bq	rem/Ci	rem	Bq/L	Ci/Bq	rem/Ci	rem
Co-60	9.53E+06	2.70E-11	2.01E+05	5.18E+01	4.20E+08	2.70E-11	2.01E+05	2.28E+03
Sr-90	1.05E+10	2.70E-11	2.05E+05	5.82E+04	1.60E+12	2.70E-11	2.05E+05	8.87E+06
Y-90	1.05E+10	2.70E-11	8.73E+03	2.48E+03	1.60E+12	2.70E-11	8.73E+03	3.78E+05
Cs-137	2.21E+10	2.70E-11	3.00E+04	1.79E+04	1.00E+11	2.70E-11	3.00E+04	8.11E+04
Eu-154	2.35E+09	2.70E-11	2.75E+05	1.75E+04	5.80E+09	2.70E-11	2.75E+05	4.31E+04
Np-237	0.00E+00	2.70E-11	8.32E+08	0.00E+00	3.00E+07	2.70E-11	8.32E+08	6.75E+05
Pu-238	9.21E+04	2.70E-11	4.55E+08	1.13E+03	1.90E+08	2.70E-11	4.55E+08	2.34E+06
Pu-239	3.62E+07	2.70E-11	5.29E+08	5.18E+05	4.40E+08	2.70E-11	5.29E+08	6.29E+06
Pu-241	2.57E+08	2.70E-11	1.11E+07	7.71E+04	3.20E+09	2.70E-11	1.11E+07	9.60E+05
Am-241	4.23E+07	2.70E-11	5.36E+08	6.13E+05	2.30E+08	2.70E-11	5.36E+08	3.33E+06
Cm-244	4.23E+05	2.70E-11	2.59E+08	2.96E+03	2.30E+06	2.70E-11	2.59E+08	1.61E+04
Total ULD				1.31E+06				2.30E+07
	1.31E+06	7.00E-01	9.15E+05		2.30E+07	3.00E-01	6.89E+06	
	70% liquids + 30% solids =			7.81E+06				
DST liquids					DST solids			
		units	dose			units	dose	
		conversio	conversion			conversio	conversion	
		factor	factor	ULD		factor	factor	ULD
isotopes	Bq/L	Ci/Bq	rem/Ci	rem	Bq/L	Ci/Bq	rem/Ci	rem
Co-60	6.97E+06	2.70E-11	2.01E+05	3.79E+01	1.50E+07	2.70E-11	2.01E+05	8.15E+01
Sr-90	4.59E+09	2.70E-11	2.05E+05	2.54E+04	5.20E+10	2.70E-11	2.05E+05	2.88E+05
Y-90	4.59E+09	2.70E-11	8.73E+03	1.08E+03	5.20E+10	2.70E-11	8.73E+03	1.23E+04
Cs-137	5.86E+10	2.70E-11	3.00E+04	4.75E+04	5.90E+10	2.70E-11	3.00E+04	4.78E+04
Eu-154	4.18E+07	2.70E-11	2.75E+05	3.11E+02	3.00E+08	2.70E-11	2.75E+05	2.23E+03
Np-237	2.30E+05	2.70E-11	8.32E+08	5.17E+03	8.10E+05	2.70E-11	8.32E+08	1.82E+04
Pu-238	1.78E+06	2.70E-11	4.55E+08	2.19E+04	7.20E+07	2.70E-11	4.55E+08	8.86E+05
Pu-239	7.65E+06	2.70E-11	5.29E+08	1.09E+05	1.60E+09	2.70E-11	5.29E+08	2.29E+07
Pu-241	1.84E+07	2.70E-11	1.11E+07	5.52E+03	3.80E+09	2.70E-11	1.11E+07	1.14E+06
Am-241	3.40E+07	2.70E-11	5.36E+08	4.93E+05	2.70E+09	2.70E-11	5.36E+08	3.91E+07
Cm-244	1.22E+05	2.70E-11	2.59E+08	8.54E+02	1.60E+07	2.70E-11	2.59E+08	1.12E+05
Total ULD				7.10E+05				6.45E+07
	7.10E+05	7.00E-01	4.97E+05		6.45E+07	3.00E-01	1.94E+07	

	70% liquids + 30% solids =			1.98E+07				
AWF liquids					AWF solids			
		units	dose			units	dose	
		conversio	conversion			conversio	conversion	
		factor	factor	ULD		factor	factor	ULD
isotopes	Bq/L	Ci/Bq	rem/Ci	rem	Bq/L	Ci/Bq	rem/Ci	rem
Co-60	7.71E+05	2.70E-11	2.01E+05	4.19E+00	4.90E+08	2.70E-11	2.01E+05	2.66E+03
Sr-90	5.60E+09	2.70E-11	2.05E+05	3.10E+04	2.90E+12	2.70E-11	2.05E+05	1.61E+07
Y-90	5.60E+09	2.70E-11	8.73E+03	1.32E+03	2.90E+12	2.70E-11	8.73E+03	6.84E+05
Cs-137	8.84E+10	2.70E-11	3.00E+04	7.17E+04	9.80E+10	2.70E-11	3.00E+04	7.95E+04
Eu-154	0.00E+00	2.70E-11	2.75E+05	0.00E+00	1.10E+10	2.70E-11	2.75E+05	8.18E+04
Np-237	9.20E+04	2.70E-11	8.32E+08	2.07E+03	9.90E+08	2.70E-11	8.32E+08	2.23E+07
Pu-238	2.75E+03	2.70E-11	4.55E+08	3.38E+01	6.70E+07	2.70E-11	4.55E+08	8.24E+05
Pu-239	1.20E+06	2.70E-11	5.29E+08	1.72E+04	4.40E+08	2.70E-11	5.29E+08	6.29E+06
Pu-241	3.39E+05	2.70E-11	1.11E+07	1.02E+02	1.70E+09	2.70E-11	1.11E+07	5.10E+05
Am-241	1.10E+06	2.70E-11	5.36E+08	1.59E+04	1.10E+10	2.70E-11	5.36E+08	1.59E+08
Cm-244	1.10E+04	2.70E-11	2.59E+08	7.70E+01	6.10E+07	2.70E-11	2.59E+08	4.27E+05
Total ULD				1.39E+05				2.07E+08
	1.39E+05	7.00E-01	9.76E+04		2.07E+08	3.00E-01	6.20E+07	
	70% liquids + 30% solids =			6.21E+07				
All liquids					All solids			
		units	dose			units	dose	
		conversio	conversion			conversio	conversion	
		factor	factor	ULD		factor	factor	ULD
isotopes	Bq/L	Ci/Bq	rem/Ci	rem	Bq/L	Ci/Bq	rem/Ci	rem
Co-60	9.53E+06	2.70E-11	2.01E+05	5.18E+01	4.90E+08	2.70E-11	2.01E+05	2.66E+03
Sr-90	1.05E+10	2.70E-11	2.05E+05	5.82E+04	2.90E+12	2.70E-11	2.05E+05	1.61E+07
Y-90	1.05E+10	2.70E-11	8.73E+03	2.48E+03	2.90E+12	2.70E-11	8.73E+03	6.84E+05
Cs-137	8.84E+10	2.70E-11	3.00E+04	7.17E+04	9.80E+10	2.70E-11	3.00E+04	7.95E+04
Eu-154	2.35E+09	2.70E-11	2.75E+05	1.75E+04	1.10E+10	2.70E-11	2.75E+05	8.18E+04
Np-237	2.30E+05	2.70E-11	8.32E+08	5.17E+03	9.90E+08	2.70E-11	8.32E+08	2.23E+07
Pu-238	1.78E+06	2.70E-11	4.55E+08	2.19E+04	1.90E+08	2.70E-11	4.55E+08	2.34E+06
Pu-239	3.62E+07	2.70E-11	5.29E+08	5.18E+05	1.60E+09	2.70E-11	5.29E+08	2.29E+07
Pu-241	2.57E+08	2.70E-11	1.11E+07	7.71E+04	3.80E+09	2.70E-11	1.11E+07	1.14E+06
Am-241	4.23E+07	2.70E-11	5.36E+08	6.13E+05	1.10E+10	2.70E-11	5.36E+08	1.59E+08
Cm-244	4.23E+05	2.70E-11	2.59E+08	2.96E+03	6.10E+07	2.70E-11	2.59E+08	4.27E+05
Total ULD				1.39E+06				2.25E+08

TWRS EIS
CALCULATION COVER SHEET

DISCIPLINE & TITLE Safety: ~~ULDs~~ Unit Liter Doses (ULDs) for Nominal Accidents Scenarios

ORIGINATOR Michael Hovkar DATE 7-28-96

REVISION NO. _____

OBJECTIVE Calculate nominal ULDs for 70-year commitment based on Total Reactor Products sent to the Tank Farms.

METHODOLOGY see attachment

ASSUMPTIONS Total Reactor Products based on WHC-SD-WM-SARR-037, Rev. 0

(Continue on another sheet if necessary)

SIGNATURE/DATE

Yvette Chou 8/27/96
CHECKED/DATE

CALCULATION & RESULTS
ATTACHED

JACOBS\FORMS\CALCVR.SHT

ULDs FOR NOMINAL ACCIDENTS - 70-YEAR COMMITTMENT							
BASED ON TOTAL REACTOR PRODUCTS							
	tank farm	dose	dose				
Nuclide	total	conversion					
	activity	factor					
	(Ci)	(rem/Ci)	(rem)				
Co-60	9.24E+03	2.01E+05	1.86E+09				
Sr-90	8.64E+07	2.01E+05	1.74E+13				
Y-90	8.64E+07	8.73E+03	7.54E+11				
Cs-137	7.16E+07	3.00E+04	2.15E+12				
Eu-154	2.32E+05	2.75E+05	6.38E+10				
Np-237	7.45E+01	8.32E+08	6.20E+10				
Pu-238	2.52E+03	4.55E+08	1.15E+12				
Pu-239	4.43E+04	5.29E+08	2.34E+13				
Pu-241	1.48E+05	1.11E+07	1.64E+12				
Am-241	5.18E+04	5.36E+08	2.78E+13				
Cm-244	4.04E+02	2.59E+08	1.05E+11				
	total		7.45E+13				
total tank farm volume =			2.16E+05	m3			
ULD (rem/L) = [total tank farm dose (rem)] / [total tank farm volume (m3)] x [m3/1000L]							
where :							
total tank farm dose = 7.45E+13 rem							
total tank farm volume = 2.16E+05 m3							
ULD =	7.45E+13	2.16E+05	1.00E+03	3.45E+05			

TWRS EIS
CALCULATION COVER SHEET

DISCIPLINE & TITLE Engineering / FEIS Summary of the tank inventory to the total curies in the 200 Areas and to past disposal inventories

ORIGINATOR Colin Henderson DATE 7/28/96

REVISION NO. 0

OBJECTIVE Develop a summary level comparison of the number of curies in the tanks to the total number of curies in the 200 Areas including wastes previously discharged

METHODOLOGY Using the attached historical perspective, decay the numbers to 1999 so they can be compared to the EIS inventory.

ASSUMPTIONS Noted, Historical Perspective attachment as marked is assumed to be accurate.

(Continue on another sheet if necessary)

C Henderson
SIGNATURE/DATE

PAW 8-2-96
CHECKED/DATE

CALCULATION & RESULTS
ATTACHED

JACOBS\FORMS\CALCVR.SHT

JACOBS ENGINEERING GROUP INC.

DATE _____ SUBJECT _____ SHEET NO. _____

BY _____ CHKD. _____ JOB NO. _____

Summary 200 Areas Waste Overview,
Data in Historical Perspective (TRAC-0151-VA)

Decay Date 12/89.

To Compare Against Appendix A Values for EIS.

decay to 12/31/99.

Since Cs-Ba / Sr-Y make up ~99% of the activity decay of these isotopes is sufficient for summary comparison.

decay EQUATION

$$N = N_0 e^{-\lambda t} \qquad \lambda = \frac{\ln 2}{t_{1/2}}$$

$t_{1/2}$ Cs 137 = 30.17 yrs.

$t_{1/2}$ Sr = 28.6 yrs.

Based on App A inventory

Tank = 177 MCi
Capsules = 68 MCi

Other = 6.6 MCi (Calculated from Historical Perspective data) See attached spreadsheet.

~252

decay of the liquids discharged to the ground, solids to ground, irradiated fuel storage and stored solids were taken from "Historical Perspective ....." and decayed from 12/89 to 12/99 to be consistent with TWRS EIS decay dates.

FORM 91-005-1 (4/81)

	Liquids To Ground		Solids to Ground		Irradiated Fuel Storage		Stored Solids	
	1989	1999	1989	1999	1989	1999	1989	1999
Cs-Ba	1093000	868645	2540000	2018626	1090000	866261	337000	267826
Sr-Y	40500	31783	2030000	1593092	884000	693740	275000	215813
sum, Ci	1133500	900428	4570000	3611717	1974000	1560001	612000	483638
total 1989, MCi		8.29						
total 12/31/99, MCi		6.56						

TWRS EIS
COMMUNICATION RECORD

Date of meeting or telephone conversation: 5/10/96
Participants or Attendees (with organization): Colin Henderson (JEG) Chris Chapman (VIT Inc., PNL retired) (Phone: 943-1867)
Subject(s) Discussed/Summary of Discussions: I requested information regarding amounts and types of waste that has been successfully vitrified PNL during development and demonstration activities. Approximately 72 MCi of Cs and Sr have been vitrified, using mainly capsules. Thirty-three or thirty-four canisters of vitrified HLW have been produced at curie loadings much higher than anticipated for any of the tank waste. These canisters currently are stored in the 300 Area. The PAMELA vitrification plant in Belgium was developed by the German government with technical support provided by USDOE Hanford Site personnel. The plant was built, operated for 8 years, and shut down when all of the waste was processed. This plant was very successful.
Issues/Concerns Identified: (Unresolved questions) Mr. Chapman provided the attached information regarding PNL vitrification experience and capabilities.
Required Actions: None
Prepared/Recorded By: Colin Henderson Date: 5/10/96
Distribution: C. C. Haass, DOE-RL, S7-51 Bob Lober, DOE-RL, S7-51 Participants

Historical Perspective of Radioactively Contaminated Liquid and Solid Wastes Discharged or Buried in the Ground at Hanford

April 1991

TRAC-0151-VA

Introduction

Since 1944 large quantities of liquids (primarily water) containing radionuclides and hazardous chemicals have been discharged to the ground surface or subsurface. Solid waste such as failed equipment, tools, and protective clothing containing radionuclides and hazardous materials have also been buried in the ground. While these activities have been reported in publicly available documents, the data have been summarized and assembled into this briefing package to present an historical perspective on when and where it came from, and how much there is. Emphasis has been given to the liquid waste that came from underground waste tanks and a report has been prepared on that portion of the liquid discharges.

This briefing focuses on the radionuclide content of the liquids and solids rather than on the chemical content as the records on radionuclides are much more complete. The material presented summarizes what we know today; more will be learned as old records are reviewed and site characterization proceeds.

Hanford cleanup is a large, complex problem involving almost 1,400 waste management units. A Hanford Federal Facility Agreement and Consent Order by the U.S. Environmental Protection Agency, the Washington State Department of Ecology and the Department of Energy establishes working relationships, a framework for permitting and milestones for cleanup. This briefing is one small piece of an ongoing effort to provide information to those who have an interest in Hanford cleanup. As additional information is gained it will also be made available.

Topics

- Material balance of Hanford Site radioactive material and waste

- Liquids discharged to ground
  - Background
  - Liquid disposal facilities
  - Quantities discharged
  - Tank wastes discharged to ground

- Solid waste buried in ground
  - Background
  - Solid waste burial facilities
  - Quantities buried

- Impact on environment

- On-going and future actions

Hanford Waste Management Units

(Sites that received radioactive and/or hazardous chemical waste)

Surplus Facilities (building)	77
Septic Tanks	96
Single- and Double-Shell Tanks and Ancillaries (catch tanks, diversion boxes, tank leaks*, etc.)	311
Other Treatment and Storage Units (existing & future)	130
Miscellaneous Underground Storage Tanks (such as gasoline tanks)	26
Unplanned Release or Spills Sites*	224
Waste Disposal Sites*	508
	1,372

*The radioactive liquid and solid waste sites described in this report are in these categories

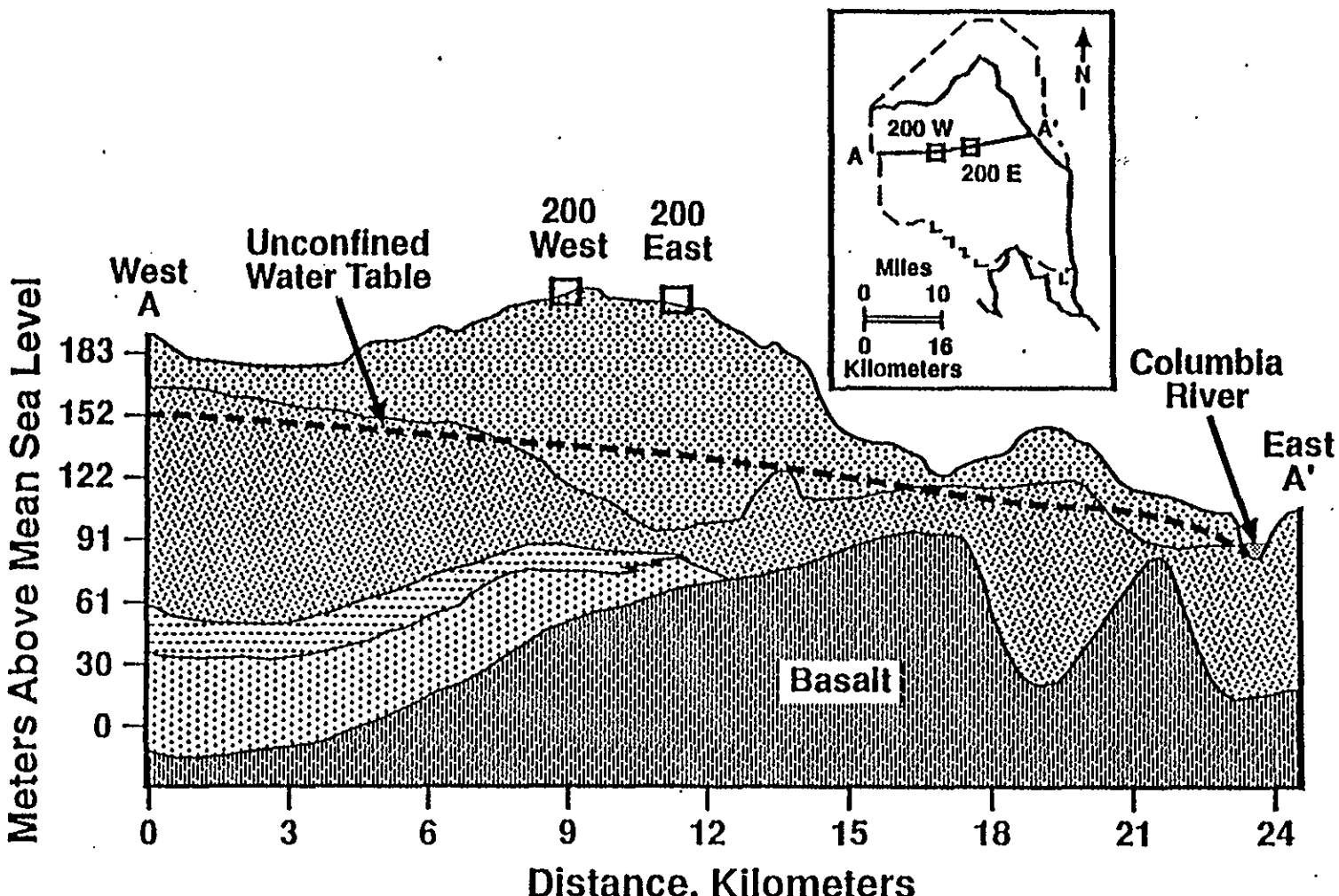
Primary Data Sources Have Been Available to Public - "This Is Not New Data"

- DOE/RW-0006, Rev 6, Oct 1990, Integrated Data Base for 1990
- WHC-EP-0141-2, Westinghouse Hanford Company Effluent Discharges and Solid Waste Management Report for Calendar Year 1989: 200/600 Areas
- WHC-EP-0125-2, Summary of Radioactive Solid Waste Received in the 200 Areas During Calendar Year 1989
- Hanford Site Waste Management Units Report, DOE/RL-88-30, Revision 1, January 1991
- ERDA-1538, Dec 1975, Waste Management Operations, Final Environmental Statement
- PNL-7346, Hanford Site Environmental Report for Calendar Year 1989
- WHC-MR-0132, June 1990, A History of the 200 Area Tank Farms

Primary Data Source - Continued

- Waste Information Data System (WIDS)
- DOE/EIS-0113, December 1987, Final Environmental Impact Statement, Disposal of Hanford Defense High-Level, Transuranic and Tank Waste
- Tank Farm Surveillance and Waste Status Summary Report for November 1990, WHC-EP-0182-32, January 1991
- Radioactive Contamination in Liquid Wastes Discharged to Ground at Separation Facilities, Semi Annual Reports (1954 - 58)
- WHC-EP-0087, October 1987, Estimates of Solid Waste Buried in 100 Area Burial Grounds

Geologic Cross Section of the Hanford Site



H9103018.3

Bases:

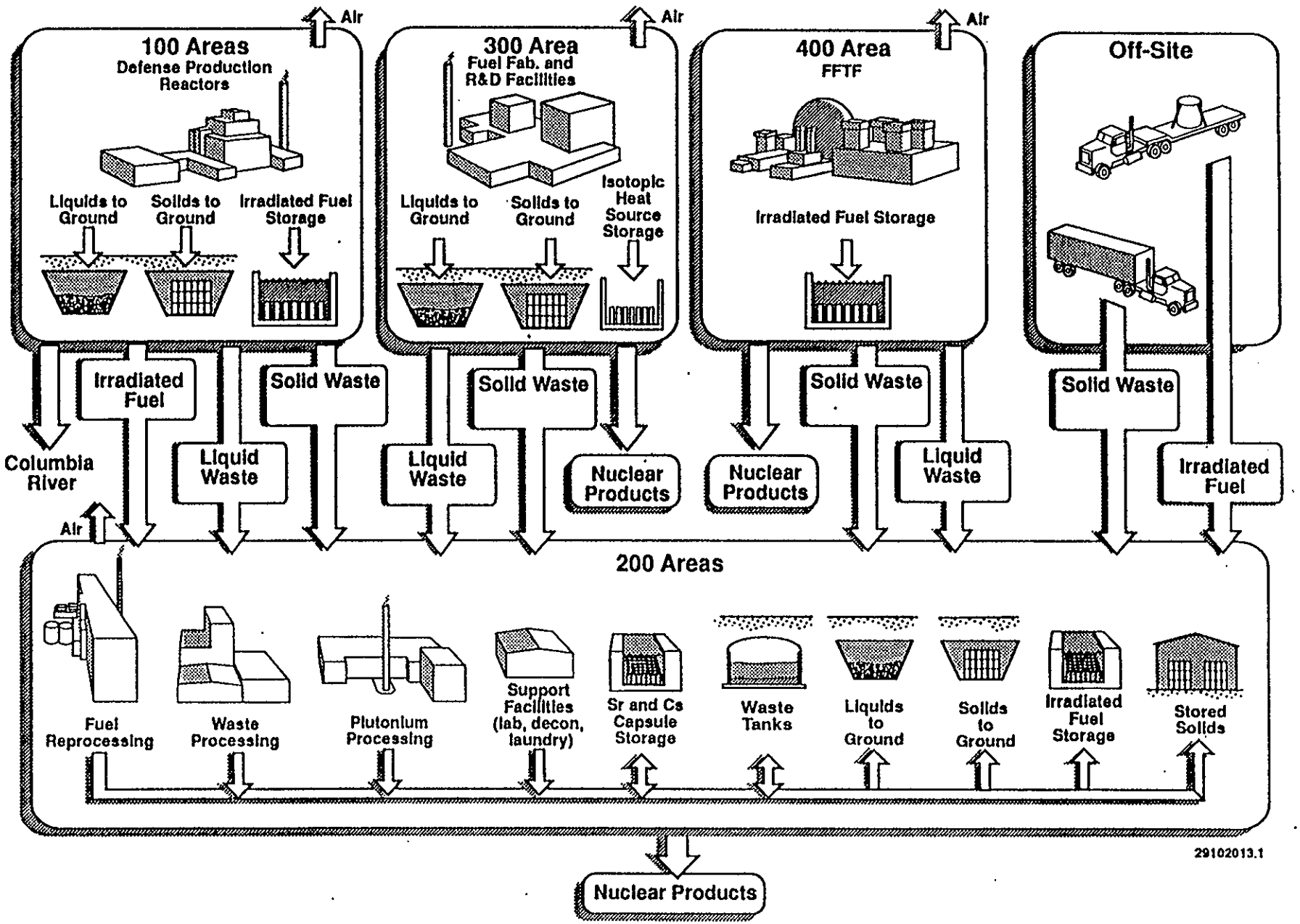
- All radioactive sites are included, sites which received only hazardous waste are not included
- Waste volumes and radionuclide inventories are as of December 1989 with radionuclides decayed to 1989
- Key radionuclides are those with half-lives long enough (greater than 10 years) and in quantities great enough to be of concern in waste disposal and cleanup
- Nuclear products shipped off-site, stored plutonium product and scrap, and facility contamination not included in inventories
- Early day records are not complete, solid waste volumes were not recorded until late 1950's and radionuclide inventories until late 1960's

Bases: - Continued

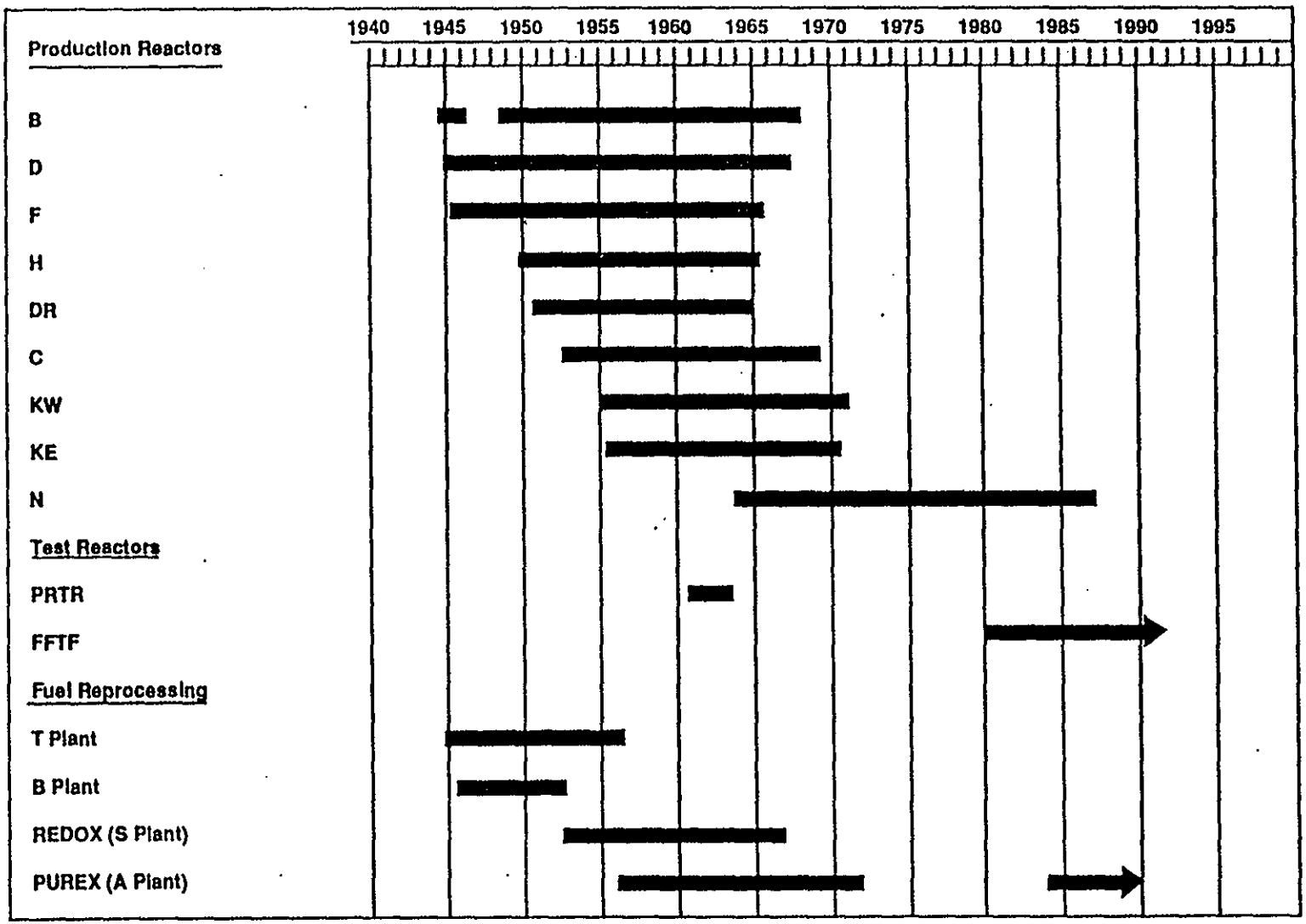
- Tritium, ^{99}Technetium and ^{129}Iodine are not included in most of the data bases. However, these isotopes were estimated by calculating quantity produced during fuel irradiation and distributing among waste types based on process knowledge. Distribution uncertainty is significant

- The numerical values presented come from a number of sources and are <u>estimates</u>. Different documents often have different estimates. However, the estimates used are adequate to provide perspective

Hanford Radioactive Material Flow Diagram



Major Plant Operating Periods



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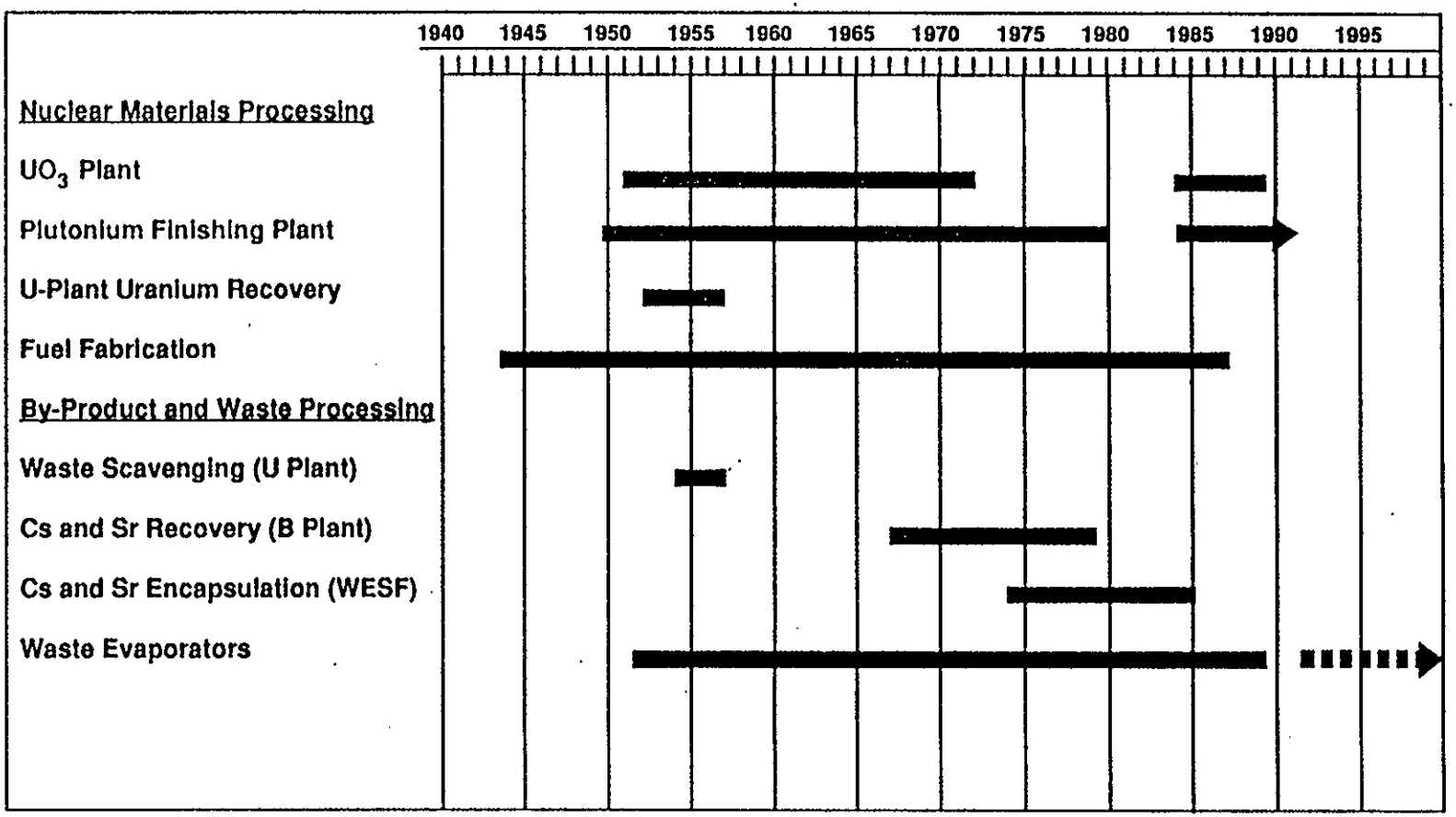
Major Plant Operating Periods (Cont.)



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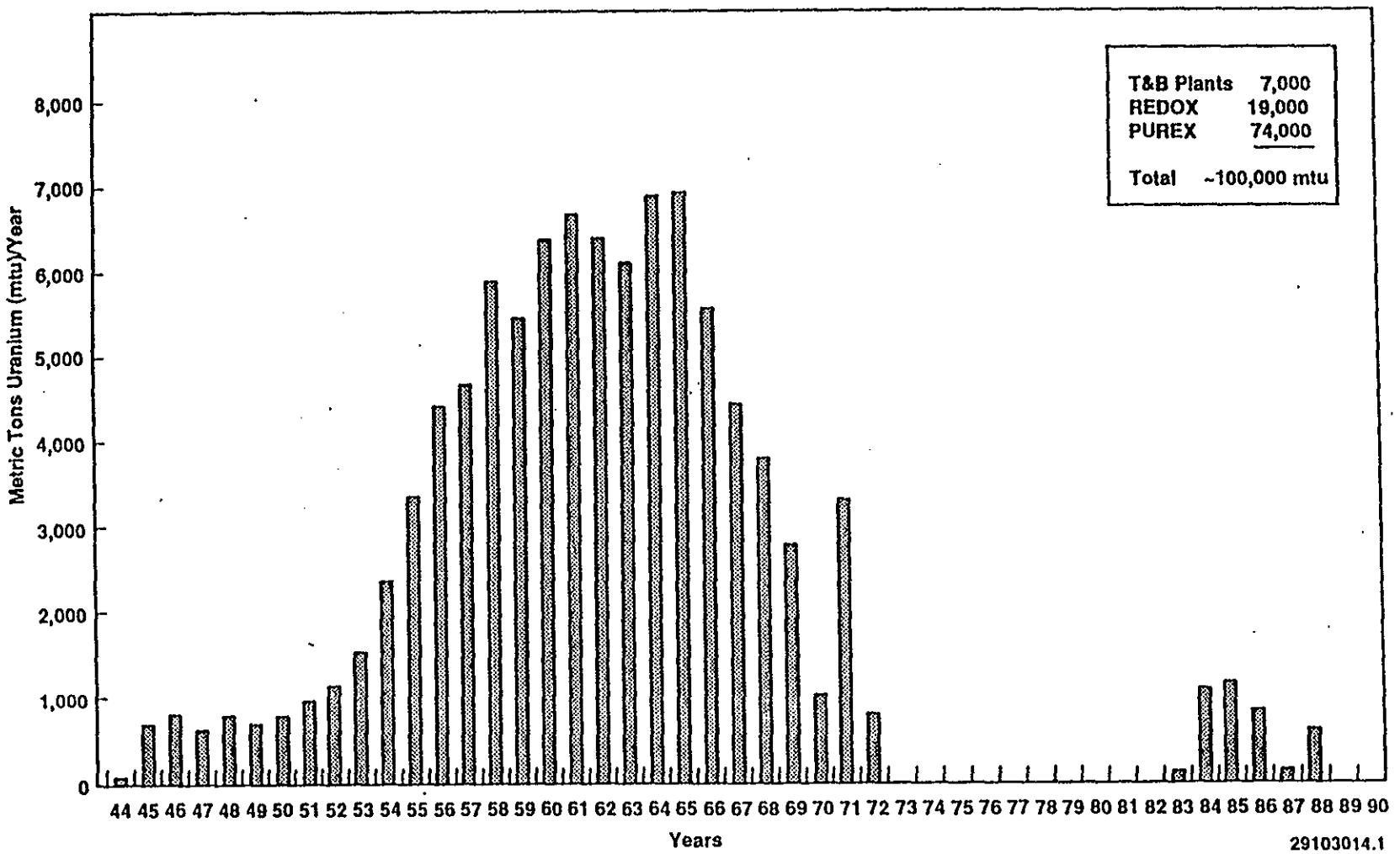
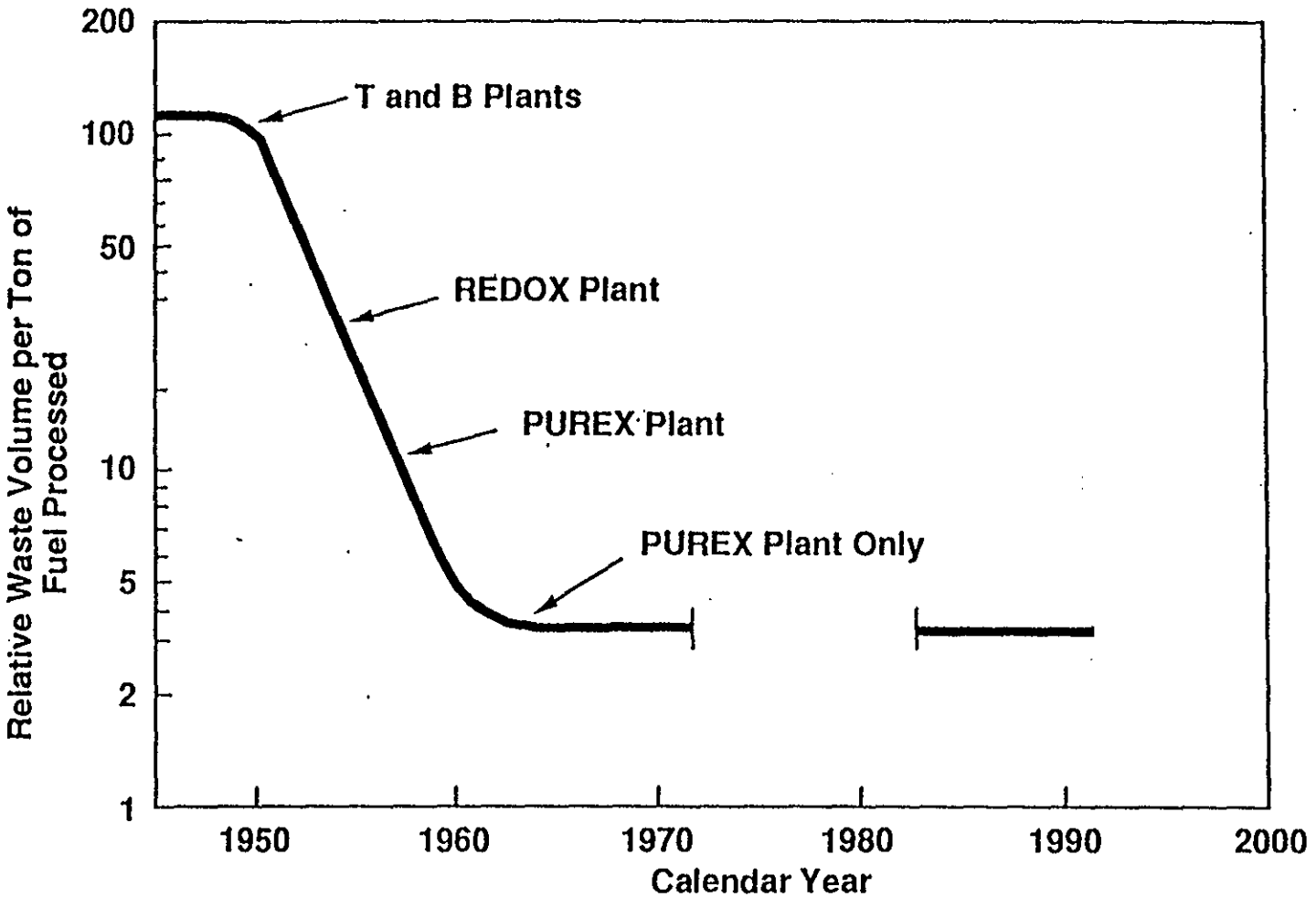
Fuel Reprocessed



Fuel Reprocessing Waste Volumes Decreased Significantly



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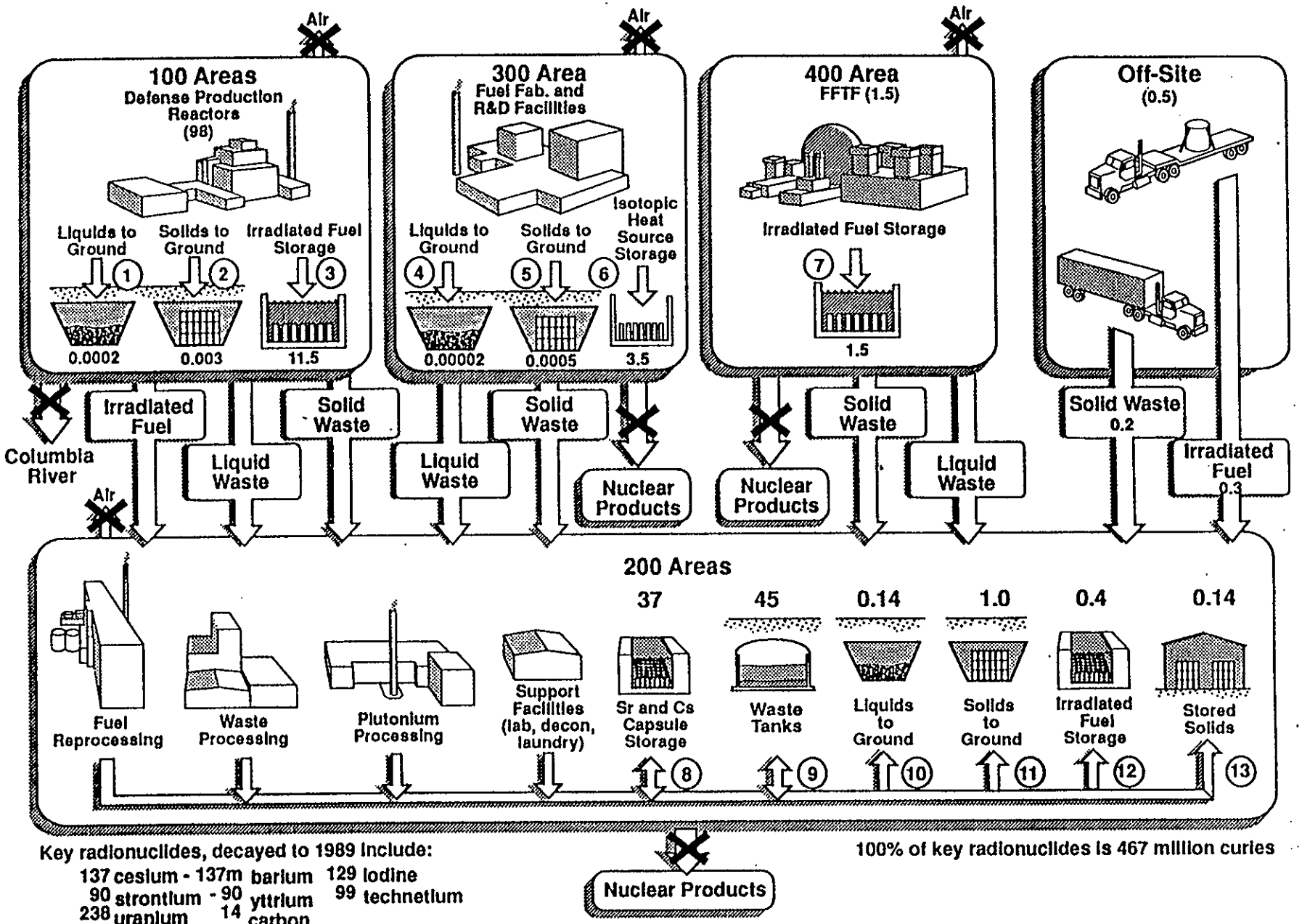
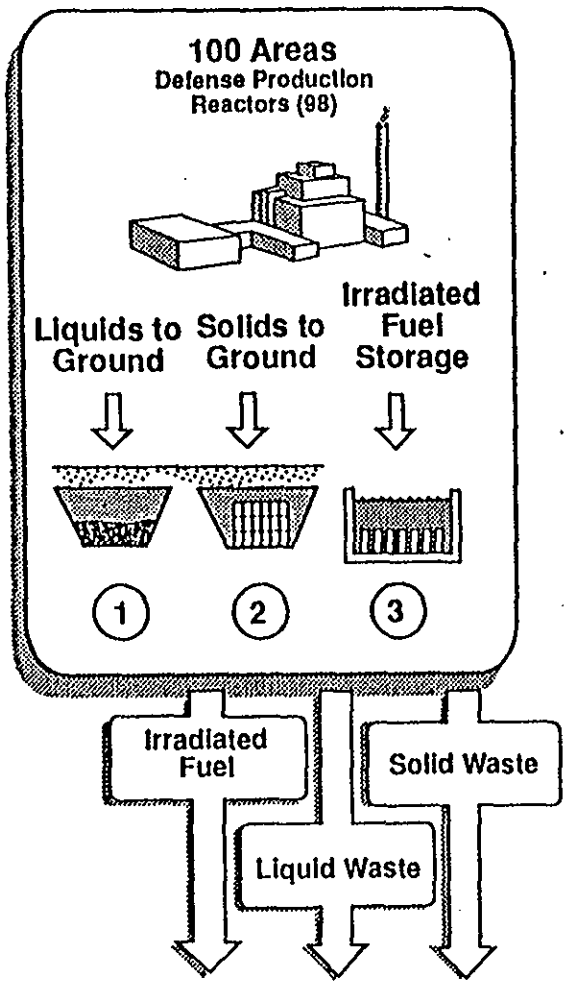
Hanford Radionuclides Material Balance (% of Key Radionuclides)



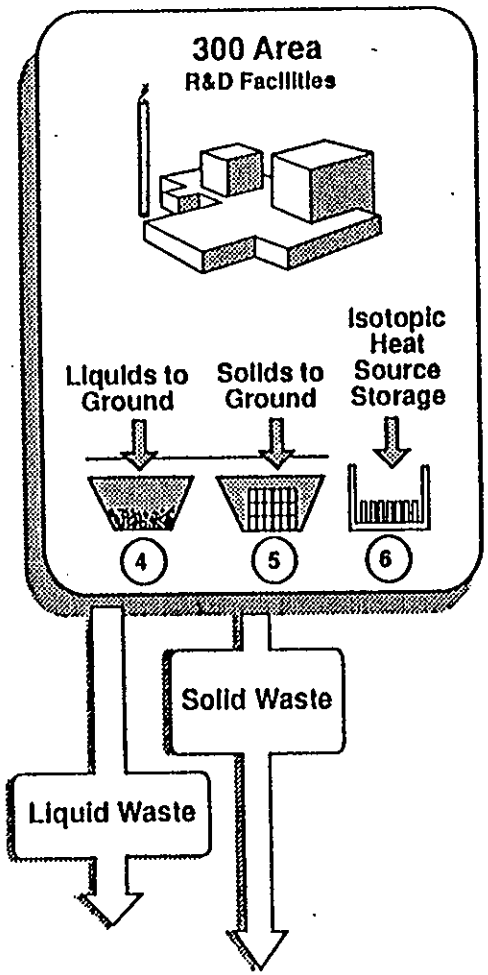
100 Area Inventories



	1 Liquids to Ground	2 Solids to Ground	3 Irradiated Fuel Storage
Volume (m^3)	300 Million (~80 Billion Gal)	87,000	186
Key Radionuclides (curies)			
Tritium	283	12,800	50,900
^{90} strontium^{90} yttrium	38	7	24,000,000
^{137} cesium ^{137m} barium	376	7	29,200,000
^{99} technetium	--	--	2,500
^{129} iodine	--	--	5
^{14} carbon	220	3	43
Uranium (Kgs)	2 (1930)	--	1,700 (2 Million)
^{241} americium	--	--	127,000
Plutonium (Kgs)	--	--	402,000 (3,980)
TOTAL (curies)	900	12,800	53,800,000

29102013.4

300 Area Inventories *

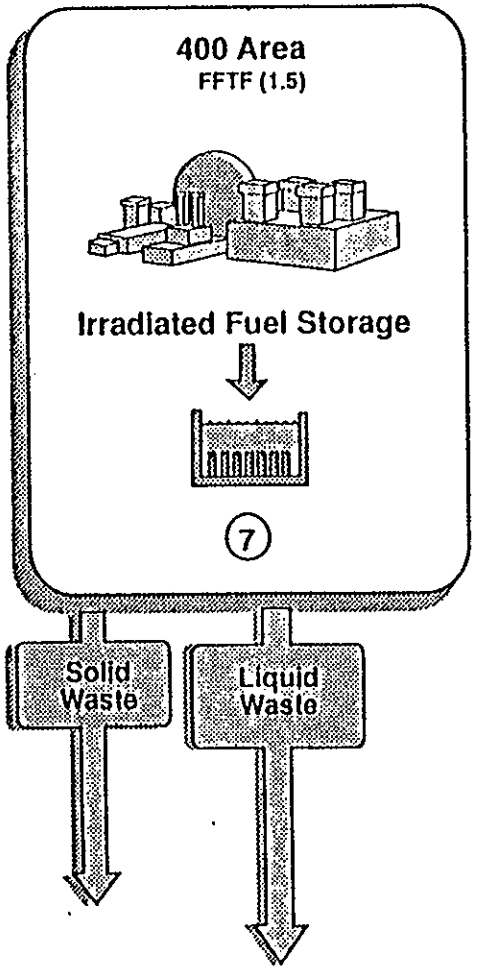


	4 Liquids to Ground	5 Solids to Ground	6 Isotopic Heat Source
Volume (m^3)	70 Million (~18 Billion Gal)	159,100	2.5
Key Radionuclides (curies)			
Tritium	--	--	--
^{90}strontium ^{90}yttrium	--	600	7,160,000
^{137}cesium ^{137m}barium	--	1200	9,282,000
^{99}technetium	--	--	--
^{129}iodine	--	--	--
^{14}carbon	--	--	--
Uranium (Kgs)	66 (82,000)	4 (5,300)	--
^{241}americium	--	17	--
Plutonium (Kgs)	--	470 (6.2)	--
TOTAL (curies)	~100	2300	16,442,000

* Includes Waste Sites in 600 Area North of 300 Area

29102013.6

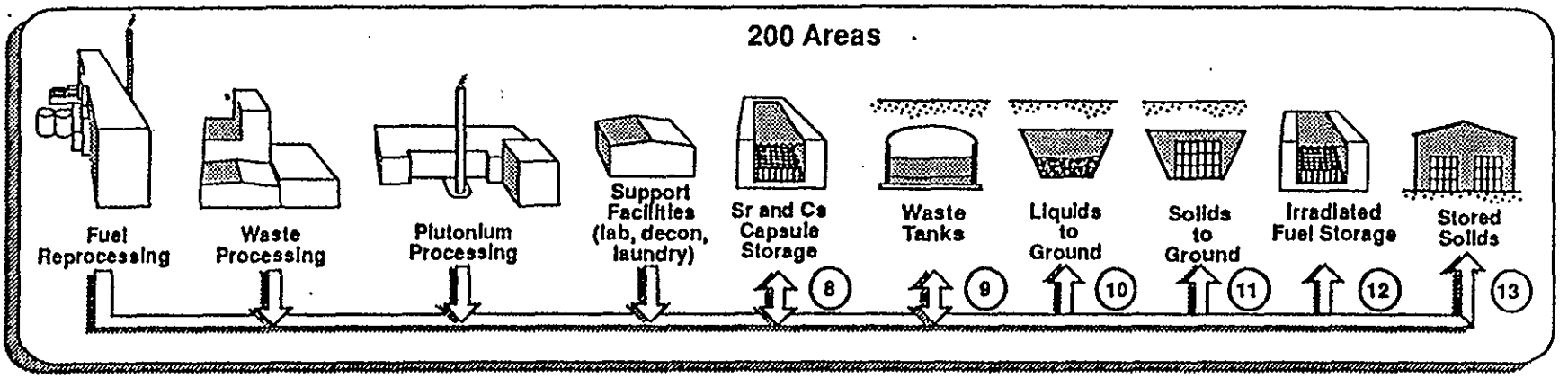
400 Area Inventories



	7 Irradiated Fuel
Volume (m^3)	2.3
Key Radionuclides (curies)	
Tritium	59,600
^{90}strontium ^{90}yttrium	1,790,000
^{137}cesium ^{137m}barium	4,880,000
^{99}technetium	330
^{129}iodine	1
^{14}carbon	3
Uranium (Kgs)	9 (10,900)
^{241}americium	46,000
Plutonium (Kgs)	284,000 (2,380)
TOTAL (curies)	7,060,000

29102013.7

200 Area Inventories



	8 Sr and Cs Capsule Storage	9 Waste Tanks	10 Liquids to Ground	11 Solids to Ground	12 Irradiated Fuel Storage	13 Stored Solids
Volume (m^3)	3.6	245,000 (64.7 Mil Gal)	1,310,000,000 (346 Bil Gal)	379,000	135	17,300
Key Radionuclides (curies)						
Tritium	—	26,000 ~~239,000~~	205,000 ~~423,000~~	312,000 ~~254,000~~	2,000 ~~16,000~~	400
^{90}strontium ^{90}yttrium	54,500,000	139,000,000	40,500	2,030,000	884,000	275,000
^{137}cesium ^{137m}barium	119,000,000	69,300,000	1,093,600 ~~194,600~~	2,540,000	1,090,000	337,000
^{99}technetium	—	32,200	960	—	900	—
^{129}iodine	—	50	9	—	—	—
^{14}carbon	—	5,000	—	6,300	—	4
Uranium (Kgs)	—	500 (1,440,000)	137 (143,000)	560 (585,000)	13 (16,000)	18 (19,000)
^{241}americium	—	98,500	3,800	990	4,600	1,350
Plutonium (Kgs)	—	31,900 (445)	13,600 (184)	27,000 (360)	12,800 (125)	37,300 (496)
TOTAL (curies)	173,500,000	208,700,000	~~677,000~~ 1,360,000	4,860,000	2,010,000	651,000

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Hazardous Chemicals

- Liquids and solids discharged and buried in ground contain hazardous chemicals, records on chemicals and quantities were not kept until the mid-1980's

- The greatest amount of hazardous chemicals were in 1945-58 liquid discharges rather than in solid waste

- Some estimates of the hazardous chemicals in the liquid discharges have been made based on process knowledge and volumes discharged

Liquid Discharged
To
The Ground

Background

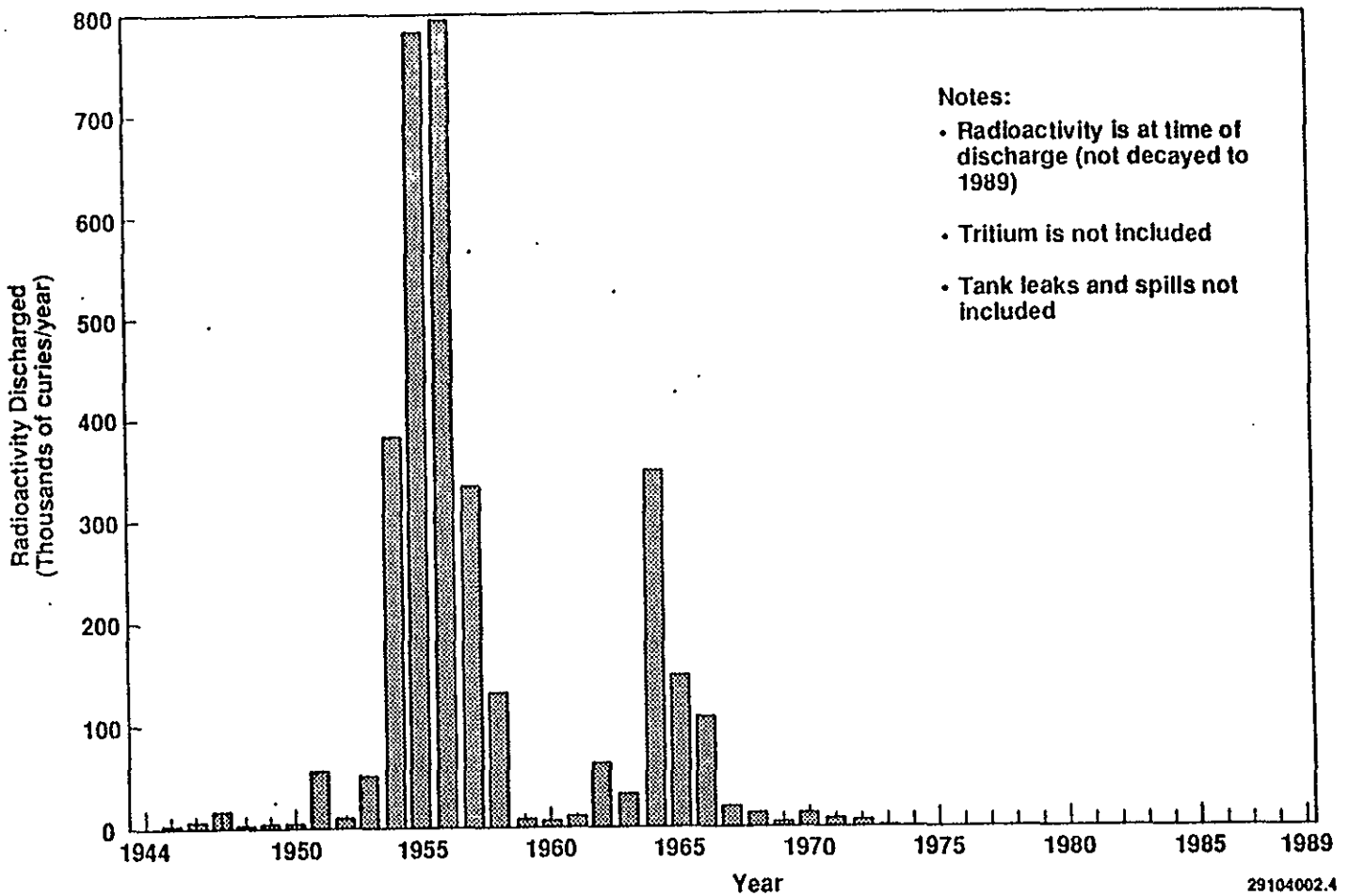
- The discharge of liquid effluents to the ground has been practiced at Hanford since operations began in 1944.
  - The methods used were common to other non-nuclear U.S. industrial waste practices at that time
  - Over the years the limits of acceptability became more stringent and practices changed
  - Significantly less contamination discharged now than in past
  - Discharge of last transuranic waste stream to ground was stopped in 1973

Background - Continued

- Two-thirds of the radioactivity from liquids discharged to the ground is tritiated water which has a 12.3 year half-life

- Upgrading liquid effluent control and treatment to Best Available Technology, will then discontinue discharges to contaminated sites

Radioactivity in Liquids Discharged to the Ground



Radioactive Liquid Disposal Facilities Included:

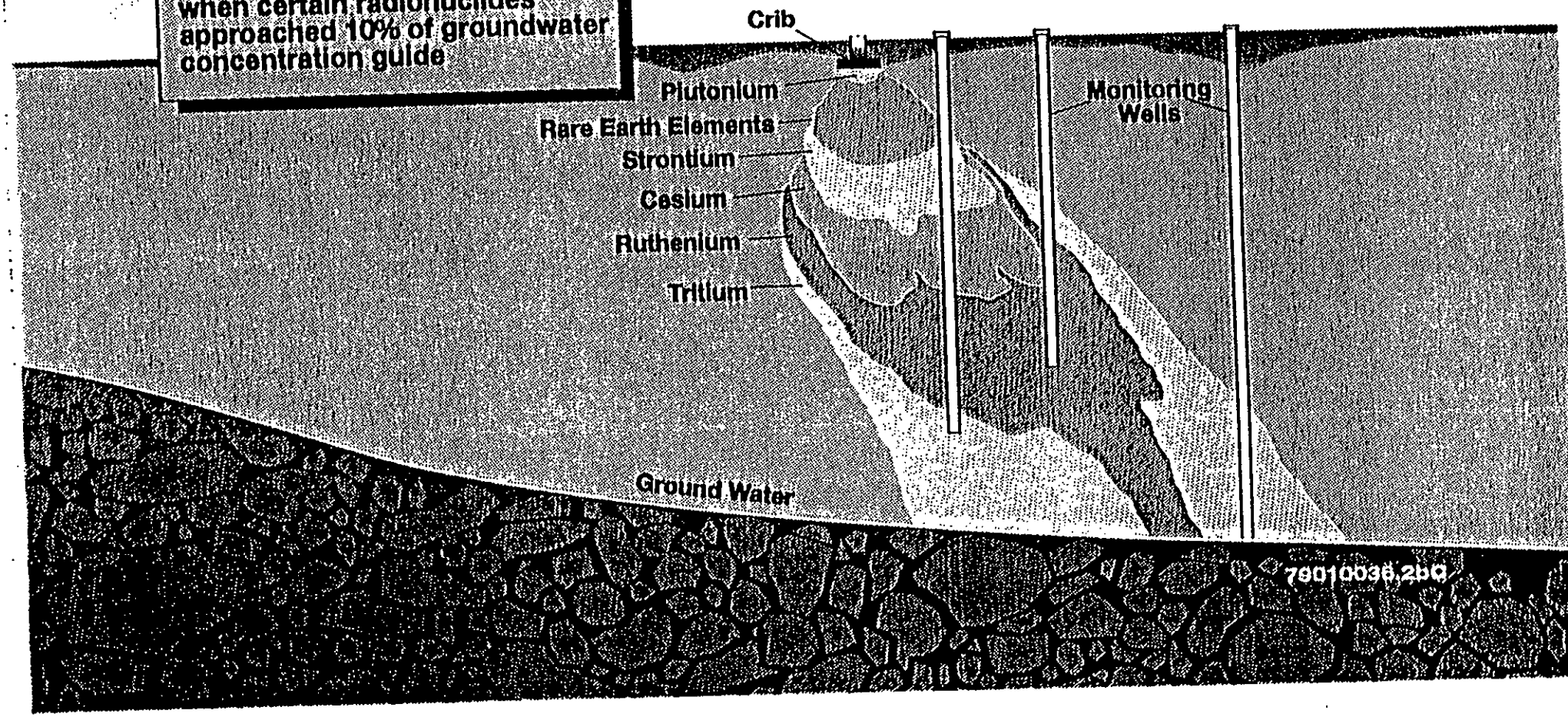
- Cribs
- Specific retention trenches
- Ponds, ditches and other trenches
- Reverse wells (injection wells)
- French drains

- Liquid also entered ground from leaks and spills

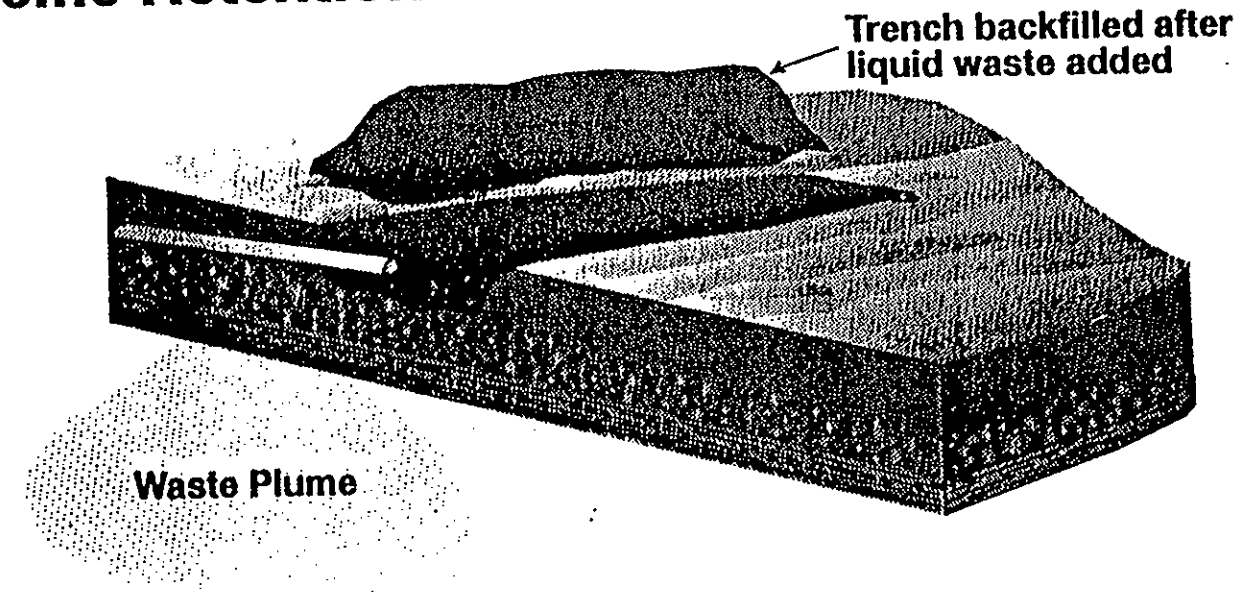
Crib

Use: Radioactive liquid waste disposal from wide variety of facilities
Use Period: 1944–Present
Utilized filtration and ion exchange properties of soils
Normally discontinued use when certain radionuclides approached 10% of groundwater concentration guide

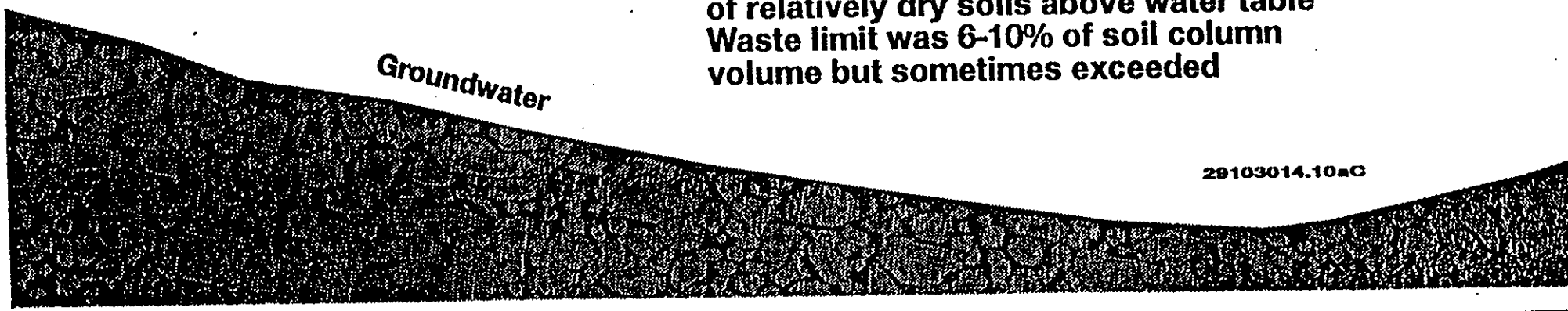
Typical Distribution of Radioisotopes Beneath 200 Area Cribs



Specific Retention Trenches



Use: Waste too radioactive for cribbing (i.e. high ^{60}cobalt), primarily from tank waste scavenging and fuels reprocessing plants
Use Period: 1944–1973
Utilized moisture retention capacity of relatively dry soils above water table
Waste limit was 6-10% of soil column volume but sometimes exceeded



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Ponds, Ditches and other Trenches

Use: Cooling Water and Steam Condensate

Use Period: 1944 to Present

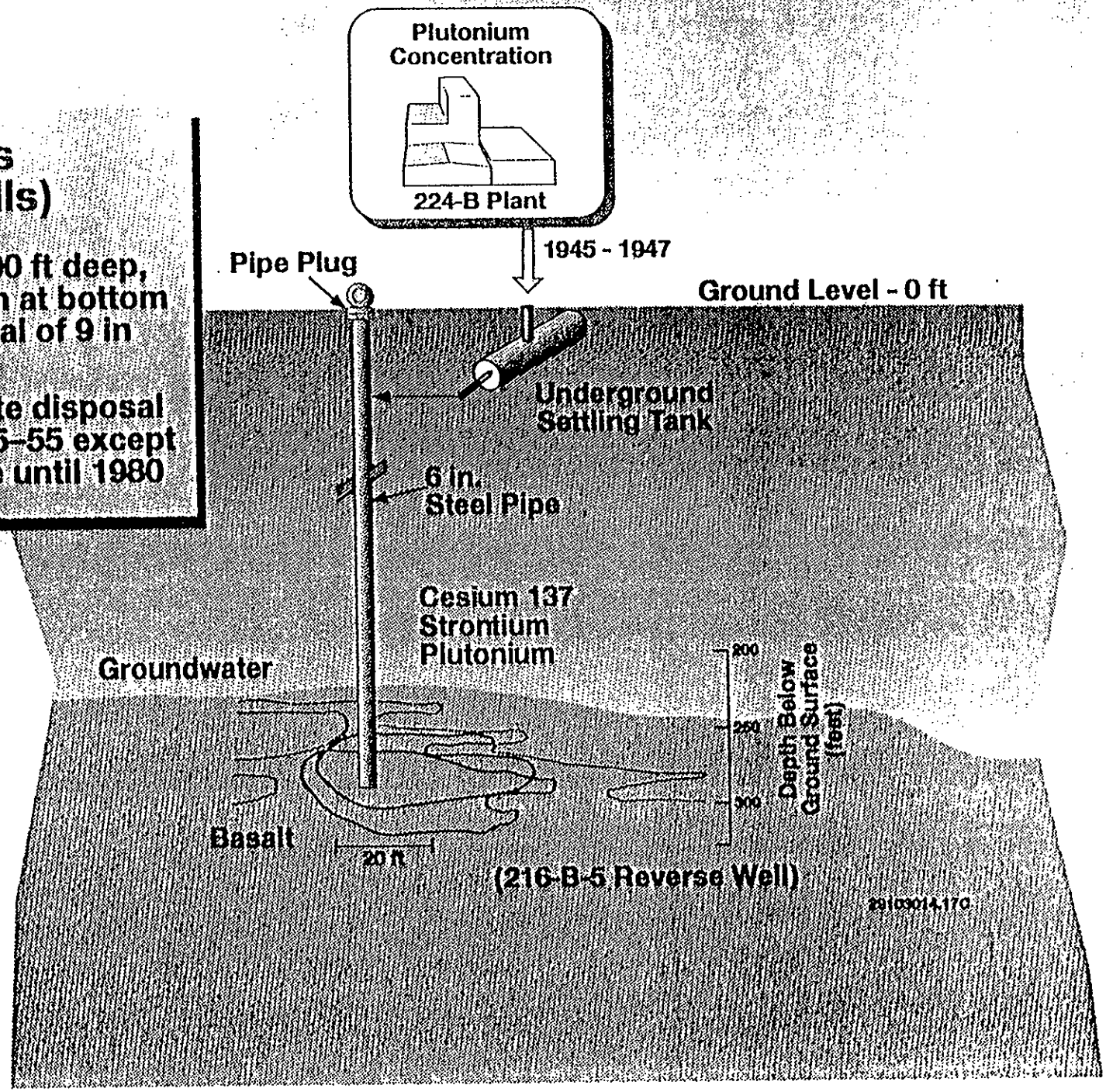
Water evaporated and percolated to groundwater. Occasional pipe leaks or equipment failures resulted in some contamination of water.

29103014.60

Reverse Wells (Injection Wells)

Drilled hole 40-300 ft deep, encasement open at bottom or perforated (total of 9 in 200 Areas)

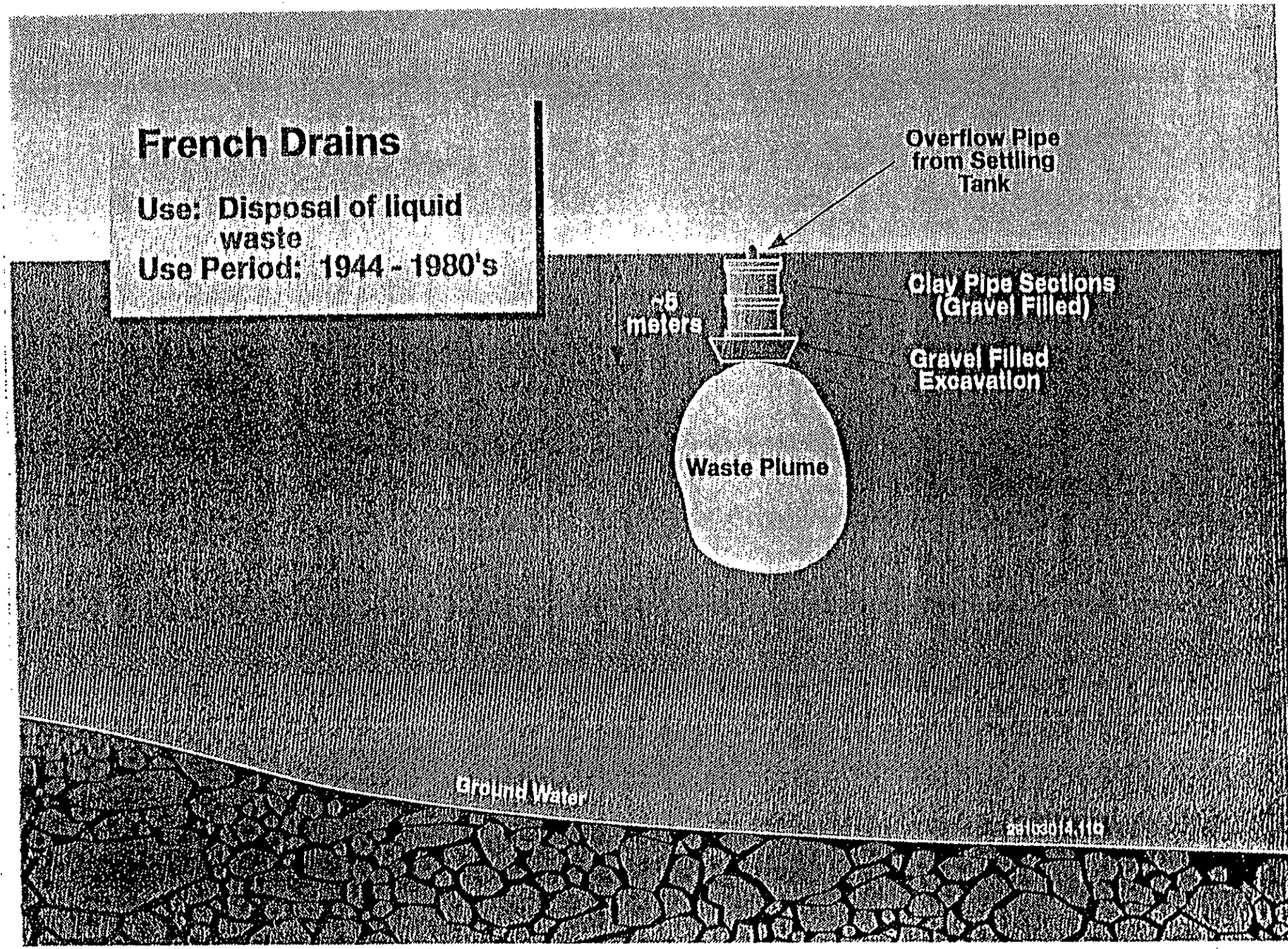
Use: Liquid waste disposal
Use Period: 1945–55 except one until 1980



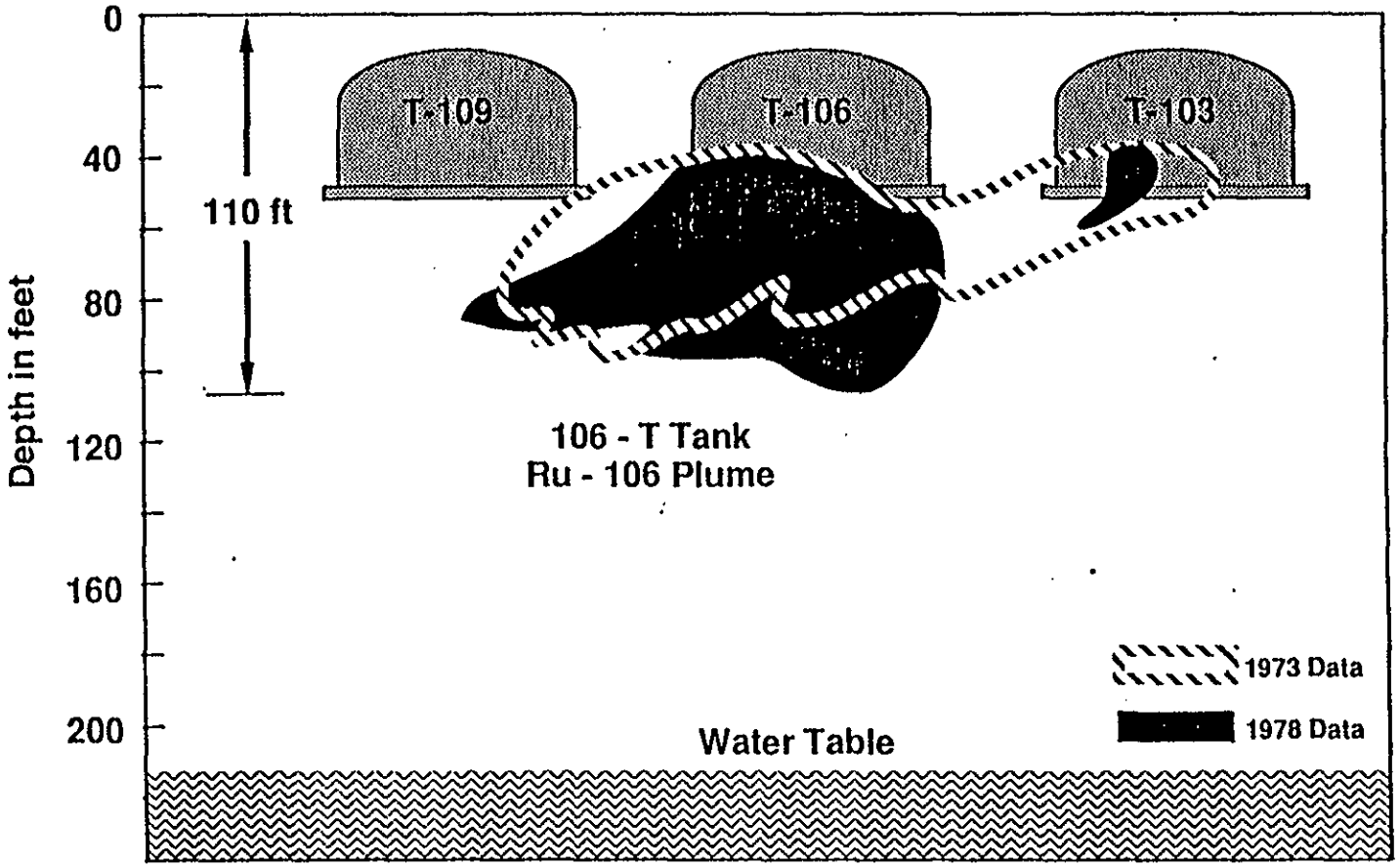
French Drains

Use: Disposal of liquid waste

Use Period: 1944 - 1980's



Leaks and Spills



- Single-shell tank leaks
  1956 - Present
- Pipeline leaks
- Spills on ground

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Location of Radioactive Liquid Discharges to Ground

	Number of Sites and Releases			
	100 Areas	200 Areas	300 Area	400 Area
Cribs	21	100	1	None
Specific Retention Trenches	0	45	0	None
Ponds, Ditches & Other Trenches	19	55	4	None
Reverse Wells	0	9	0	None
French Drains	12	29	0	None
Single-Shell Tank Leaks	0	66	0	None
Other Leaks & Spills Reported	23	205	30	None
Total Site	75	509	35	

NOTE: Facilities in 600 Area are included in nearest main Area

Summary

Liquid Waste Discharged to Ground
Radioactive Inventory Location

	Curies
100 Areas	900
200 Areas	1,360,000 ~~677,000~~
300 Area	~100
400 Area	0
Total	~~678,000~~* ≈ 1,370,000

*This is approximately ~~0.15~~ 0.3 % of total Site radioactivity

200 Areas

Liquid Discharges to Ground

	m3	Millions of Gal	Curies
Cribs	40 Million	10,500	~~468,000~~ 253,000
Specific Retention Trenches	185,000	49	51,900
Ponds, Ditches and Other Trenches	1,270 Million	335,000	7,200
Reverse Wells (Injection Wells)	85,000	22	520
French Drains	17,000	5	50
Single-Shell Tank Leaks	2,800	.75*	~~102,000~~ 1,000,000
- Cooling water leakage from Tanks*	200-3300	.05-.8	Unknown
Other Leaks & Spills Reported	360	0.1	47,300
Total	1,310 Million	346,000	~~677,000~~ 1,360,000

*50,000 - 800,000 gallons of cooling water leaked from 105-A Tank, records are being reviewed to determine which other tanks may have leaked cooling water and to estimate volume and radionuclide content

200 Area Liquid Discharges

Key Radionuclides	Curies	Kg's
Tritium (as tritiated water)	205,000 ~~423,000~~	
^{90}Sr-^{90}Y	40,500	
^{137}Cs-^{137m}Ba	1,093,000 ~~195,000~~	
^{99}Tc	960	
^{129}I	9	
^{14}C	-	
Uranium	137	143,000
^{241}Am	3,800	
Pu	13,600	184
Total	~~677,000*~~ 1,360,000	

*0.17% of total 200 Area waste radionuclide inventory

Chemicals in Liquids Discharged to Ground

Major Chemicals*	Estimated Amount (Metric Tonnes)		
	100 Areas	200 Areas	300 Area
Nitrate	< 100	50,000	1,900
Sodium	**	26,000	5,100
Phosphate	**	4,300	**
Sulfate	< 100	2,800	< 100
Ammonia	**	1,500	**
Fluoride	**	1,300	**

* All chemicals were either in a combined or ionic form when discharged

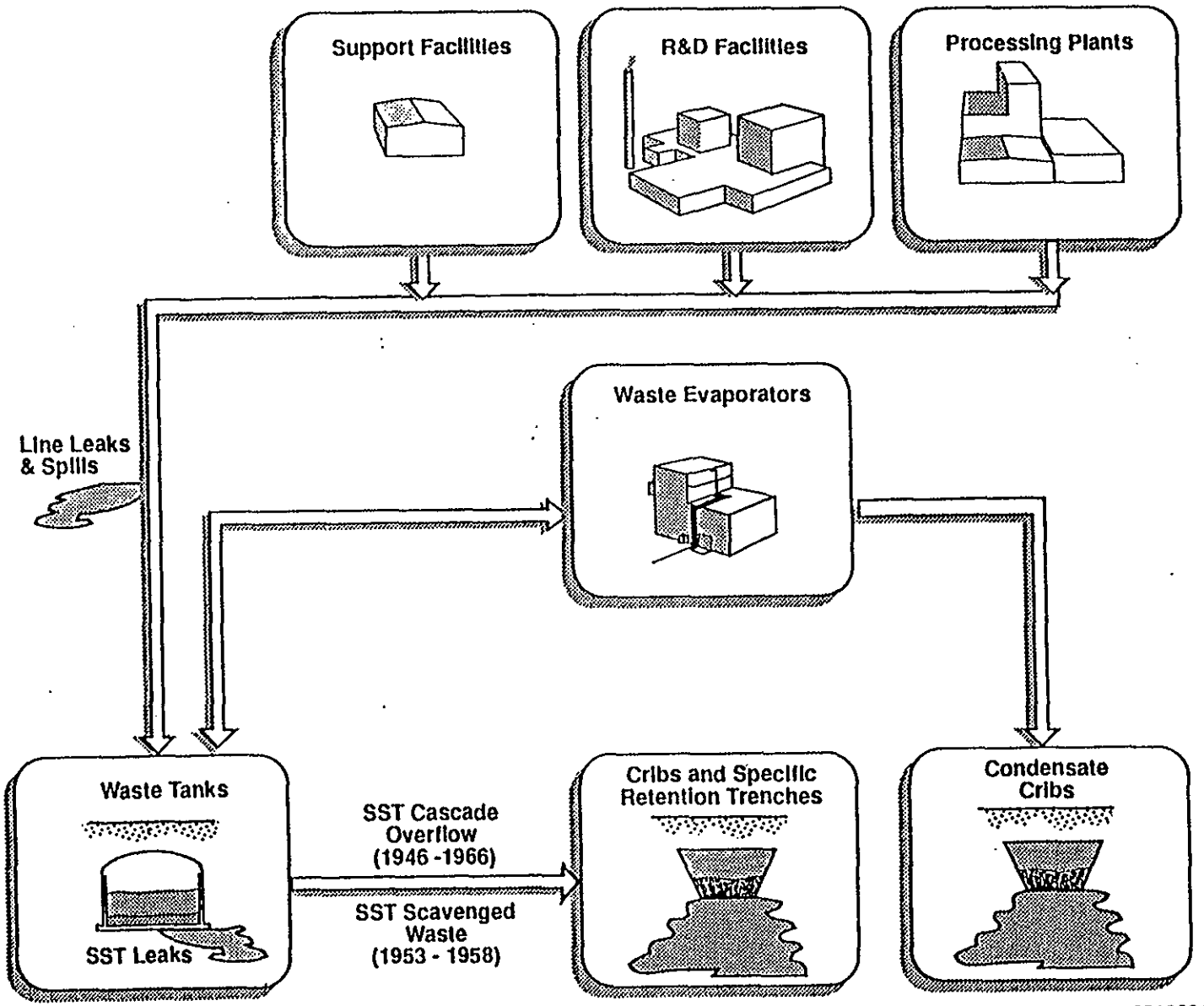
** None listed in data base

Many other chemicals also discharged to ground

Tank Wastes Discharged

To Ground

Tank Waste Discharged to Ground Radionuclide Flow Diagram



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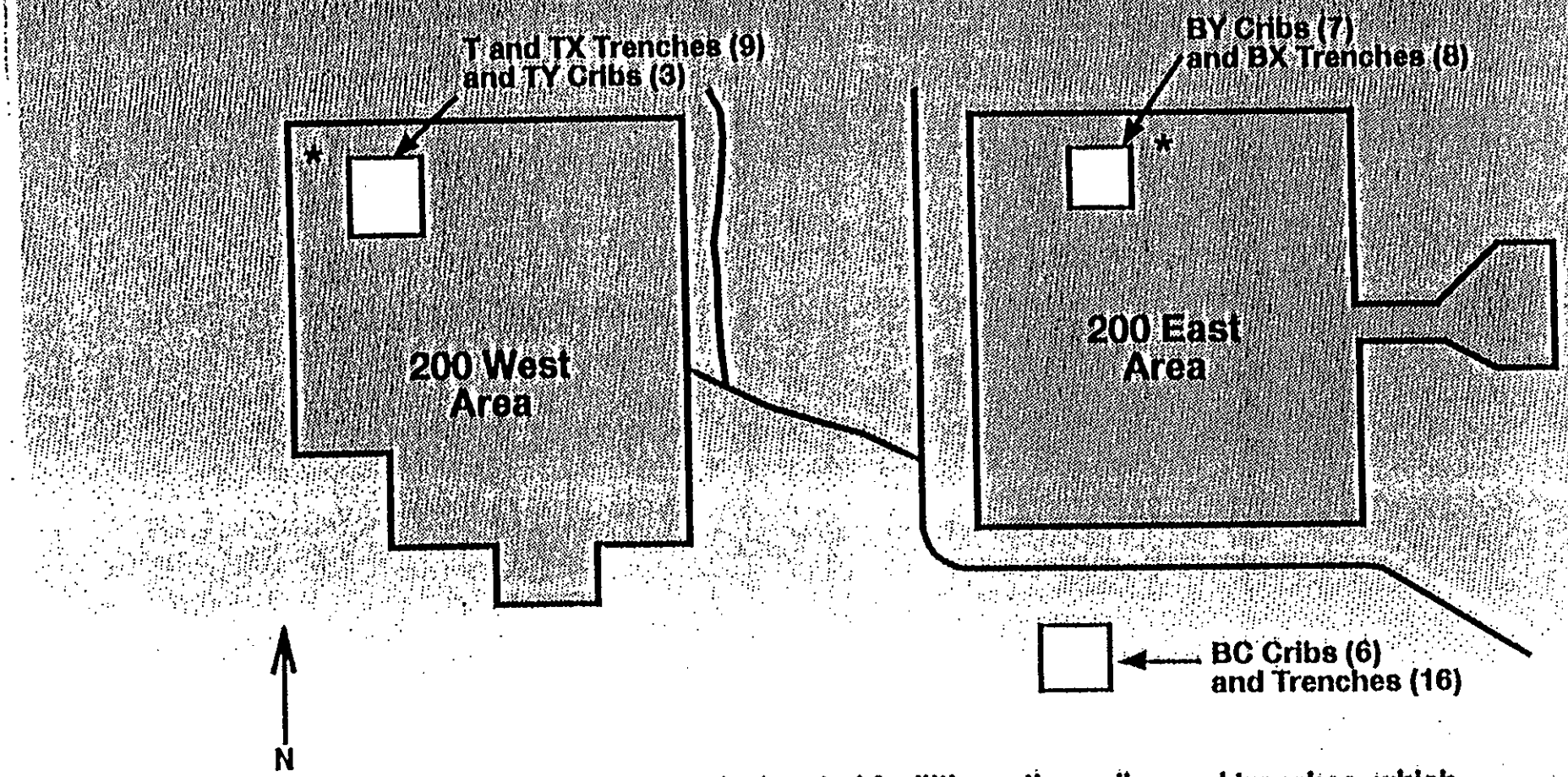
Sites Where Tank Wastes Discharged to Ground



* In addition to designated facilities, other cribs, and trenches which received tank wastes are located in these areas.

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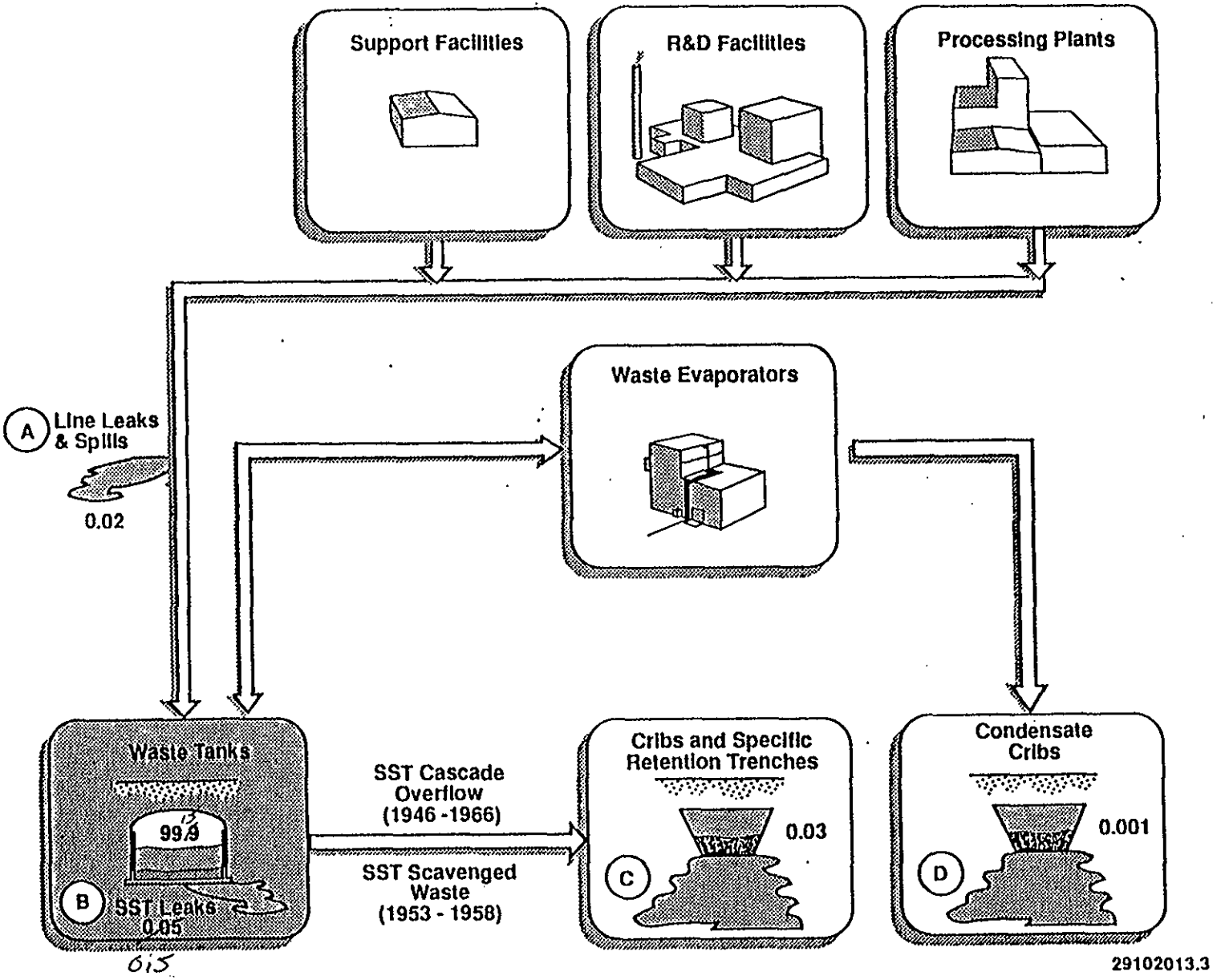
Tank Waste Discharged to Ground
Radionuclide Material Balance (Estimated % ofTotal Curies)



TANK WASTES DISCHARGED TO GROUND

Source	Time Period	Volume (Gallons)	Curies
• Fuel Reprocessing (B and T Plants)	1946-56	68,500,000	31,900
• Scavenged Uranium Recovery Wastes	1953-58	40,900,000	32,500
• Decontamination Facility and Laboratory Wastes	1960-66	11,200,000	700
	Total	121,000,000	65,100
• Evaporator Condensate	1951-89	197,000,000	<3,000

Tank Waste Discharged to Ground

	Remaining in Tanks	A Other Leaks & Spills	B Tank Leaks	C Cribs	C Specific Retention Trenches	D Condensate Cribs
			Direct Discharged			Evaporator Condensate
Volume (m^3) (Millions of Gal))	245,000 64.7	360 0.1	3,000-6,000 ~~0.8-1.5*~~ 0.6-0.9	348,000 92	109,000 29	746,000 197
Key Radionuclides (Curies)						
Tritium	239,000	-	-	930	4,100	1,800
^{90}Sr-^{90}Y	139,000,000	450	-	18,000	8,380	40
^{137}Cs-^{137m}Ba	69,300,000	46,800	~ 1,000,000* ~~102,000~~	5,930	26,100	900
^{99}Tc	32,200	-	-	170	760	-
^{129}I	50	-	-	0.6	1.2	-
^{14}C	5,000	-	-	-	-	-
Uranium (Kg's)	500 (1,440,000)	-	-	-	-	-
^{241}Am	98,500	-	-	150	6	40
Pu (Kg's)	31,900 (445)	-	-	530 (7.2)	21 (0.3)	60 (0.8)
Total (curies)	208,700,000	47,300	~ 1,000,000 ~~102,000~~	25,700	39,400	< 3,000

*This includes 50,000 - 800,000 gallons of cooling water leaked from 105-A Tank, records are being reviewed to determine which other tanks may have leaked cooling water and to estimate the volume and radionuclide content

65,150

* HIGH UNCERTAINTY

Solid Waste Buried

in

Ground

Background

- Radioactively contaminated solid waste has been disposed by burial in the ground since Hanford began operation in 1944. These wastes also contain large amounts of hazardous materials

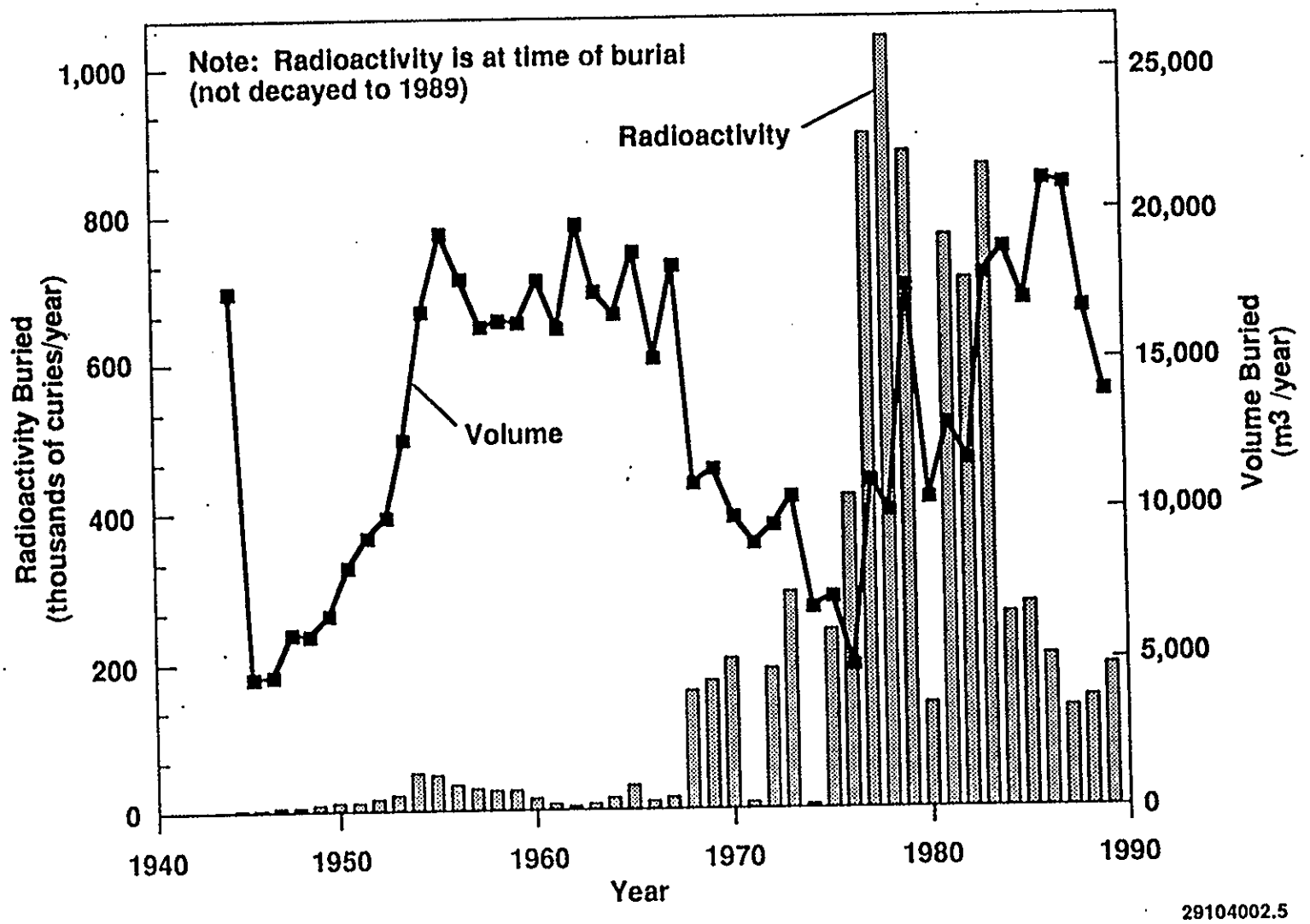
- Radioactive waste burials were stopped in the 300 Area in 1972 and in the 100 Areas in 1973

- Since 1970, waste suspected of containing transuranic nuclides was segregated and retrievably stored

- Over the years, improvements were made in waste packaging and trench backfilling

- Burial in an arid environment

Solid Waste Burials
Hanford Site



Solid Waste Burial Facilities Have Included:

- Unsegregated waste burial trenches (Pre-1970)
- Low-level waste burial trenches (Post-1970)

Unsegregated Waste Burial Trenches

Use: Disposal of Contaminated Solid Waste
Use Period: 1944 - 1970

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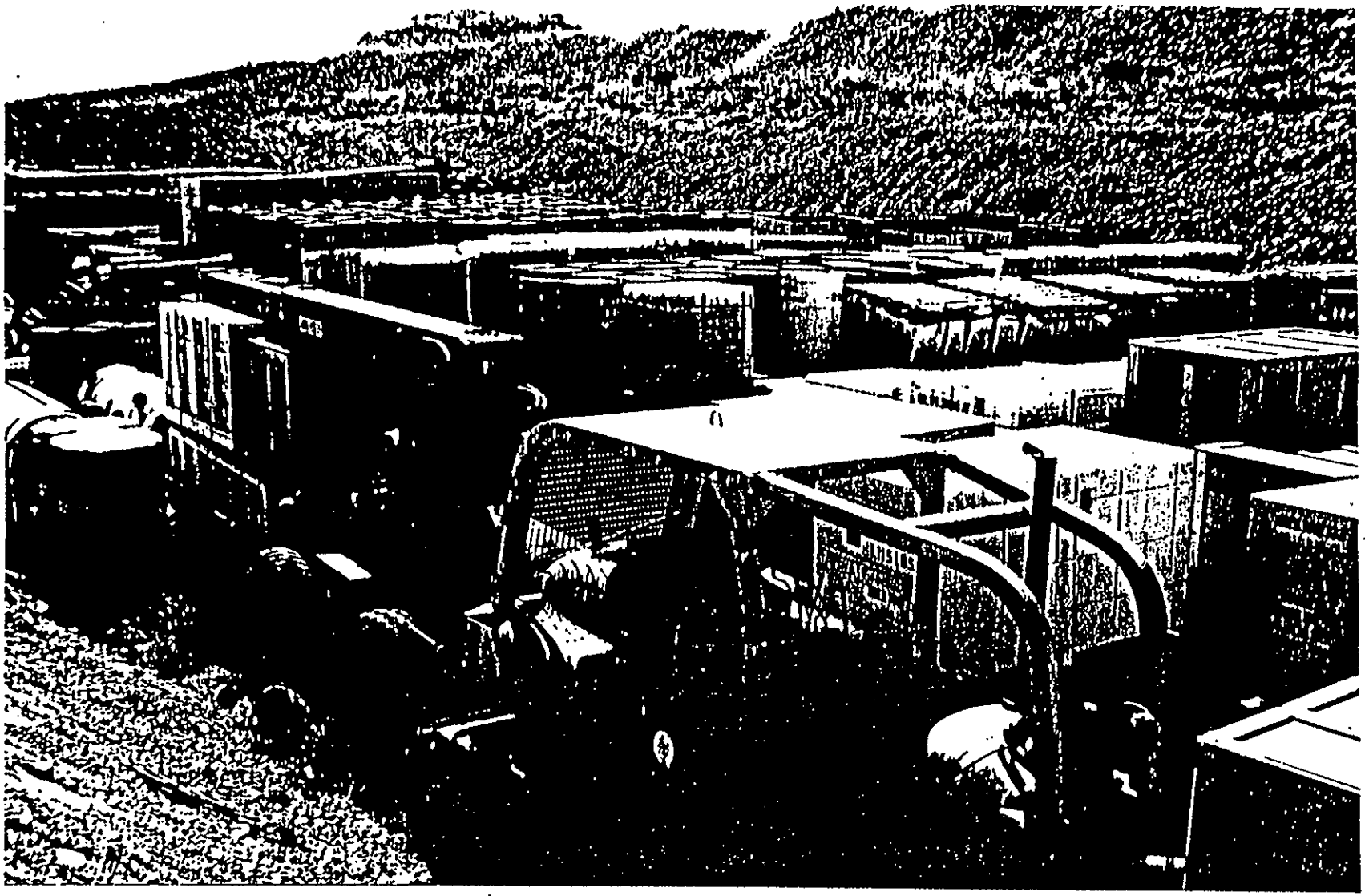
Low-Level Waste Burial Trenches



Use: Disposal of Solid Low-Level Waste
Use Period: 1970 - Present

29104002.2

Solid Waste Burial Facility Location

Hectares (Acres)

	100 Areas	200 Areas	300 Area	400 Area
• Unsegregated Waste Burial Trenches (Pre-1970)	31 (78)	63 (155)	26 (65)	None
• LLW Burial Trenches (Post-1970)	None	53 (131)	None	None
Total	31 (78)	116 (286)	26 (65)	None

NOTE: Facilities in 600 Area included in nearest main Area

Summary

Solid Waste Burial
Radioactive Inventory Location

	Volume (m^3)	Curies
100 Areas	87,000	12,800
200 Areas	379,000	4,870,000
300 Area	159,000	2,300
400 Area	None	None
Total	625,000	4,880,000*

*This is approximately 1 % of total Site radioactivity

200 Areas

Solid Waste Burial

	Volume (m^3)	Curies
• Unsegregated Waste Burial Trenches (Pre-1970)	143,000	147,000
• LLW Burial Trenches (Post-1970)	236,000	4,720,000
Total	379,000	4,870,000

200 Areas Solid Waste Burials

Key Radionuclides	Curies	Kgs
Tritium	254,000	
^{90}Sr-^{90}Y	2,030,000	
^{137}Cs-^{137m}Ba	2,540,000	
^{99}Tc		
^{129}I		
^{14}C	6,300	
Uranium	560	585,000
^{241}Am	990	
Pu	27,100	360
Total	4,870,000*	

*1.2% of 200 Area total waste radionuclide inventory

Impact on Environment - Current Status -

- Reported annually: PNL-7346, Hanford Site Environmental Report for Calendar Year 1989, May 1990

  - Certain radionuclides and hazardous chemicals exceeded drinking water standards in ground water on-site near operating areas

  - Columbia River water concentrations remained extremely low at all locations, well below standards

  - Radionuclides in air, food stuffs, wildlife, soil and vegetation in area surrounding Site remained well below standards

  - Potential maximum radiation dose to public individual was 0.05 mrem in 1989

Ongoing and Future Actions
Liquid Discharged to Ground

- Continue upgrading liquid effluent control and treatment systems to Best Available Technology and discontinue discharges to contaminated sites
- Continue surface stabilization and radiation area reduction
- Remediate past practice sites in accordance with RCRA/CERCLA
  - All sites are listed in TPA, first ones have been prioritized (200-BP-1 operable unit with 10 cribs and 3 spills is first)
  - RCRA/CERCLA process is to characterize site, develop remediation alternatives, regulatory agency holds public hearings and selects remediation alternative, and then site is remediated

Ongoing and Future Actions - Continued

Liquid Discharged to Ground

- Expedited response actions being taken on 2 sites:
  - 300 Area Process Trench, and
  - 200 West Area carbon tetrachloride in ground

Ongoing and Future Actions - Continued

Solid Waste Buried in Ground

- Disposal of low-level solid waste by shallow-land burial will continue on 200 Area Plateau
  - Improvements continue to be made in packaging and burial methods
- Remediate past practice burial sites in accordance with RCRA/CERCLA, all sites listed in TPA
  - RCRA/CERCLA process is same as described for liquid discharge sites
  - Expedited response action being taken on 618-9 Burial Site which contains drums of hexone

Ongoing and Future Actions - Continued

- Accelerate remediation of specific sites
- Develop new technology so that cleanup can be done better, faster, safer and cheaper. Examples at Hanford are:
  - In situ vitrification
  - Underground storage tank integrated demonstration
  - Integrated demonstration for remediation of volatile organic compounds
  - Robotics technology demonstration

Closing

- Primary source data available to public - "This is Not New Data"
- Since 1944, large volumes of water, other liquids and solid waste containing radionuclides and hazardous chemicals have been discharged or buried in the ground
- Extensive environmental monitoring program indicates dose to public is very low today and the ongoing remedial investigations will determine what cleanup actions are needed for the long-term
- Dose reconstruction program determining dose to public from past releases

Closing - Continued

- The complex job of cleaning up Hanford is just underway. It will continue for many years and will be costly
  - The public, Indian Nations, state, EPA and DOE will <u>all</u> participate in this effort

TWRS EIS
CALCULATION COVER SHEET

DISCIPLINE & TITLE Engineering / Revised DATA FOR Risk (Appendix D) in Support of Final EIS

ORIGINATOR Colin Henderson DATE 7/28/96

REVISION NO. 0

OBJECTIVE Revise DEIS App. D DATA for Final EIS based on changes to operating schedules, Addition of DST I-129 inventory, and other updated information on Emissions

METHODOLOGY Existing data tables marked up to reflect current information

ASSUMPTIONS Changes in Schedule to agree with schedules developed for FEIS. Additional I-129 Inventory Added to operating emissions. Revised I-129 operating emissions developed based on additional 22 Ci of I-129 in the DSTs.

(Continue on another sheet if necessary)

J.C. Henderson
SIGNATURE/DATE

PRW 8-1-96
CHECKED/DATE

CALCULATION & RESULTS
ATTACHED

JACOBS\FORMS\CALCVR.SHT

Table D.4.3.1. Atmospheric Radiological Emissions for In Situ Fill and Cap Alternative

Continued Operations				Treatment Operations			
Tank Farm Emissions		Evaporator Emissions		DST Evaporator Emissions		Gravel Fill Emissions	
Contaminants	Ci/yr Released	Contaminants	Ci/yr Released	Contaminants	Ci/yr Released	Contaminants	Ci/yr Released
Total Alpha[1]	2.88E-08	Total Alpha[1]	2.10E-05	Total Alpha[1]	1.04E-4 ~~1.04E-04~~	Total Alpha[1]	8.74 ~~9.83~~E-11
Total Beta[2]	7.91E-07	Total Beta[2]	1.20E-05	Total Beta[2]	~~8.04~~E-05	Total Beta[2]	2.39 ~~2.69~~E-09
^{90}Sr	1.81E-05			6.04E-5		^{90}Sr	2.59 ~~2.91~~E-08
^{137}Cs	5.38E-05					^{137}Cs	1.61 ~~1.81~~E-07
^{129}I	4.60E-05					^{129}I	1.40 ~~1.57~~E-07

Notes:
[1] Total alpha is assumed to be Pu-239.
[2] Total beta is assumed to be Sr-90.

Table D.4.3.2 Atmospheric Transport Parameters for In Situ Fill and Cap Alternative

	Continued Operations		Treatment Operations	
	Tank Farms	Evaporator 1	Evaporator 2	In Situ Fill and Cap
Stack height in m (ft)	Ground	6.70 (22)	6.70 (22)	Ground
Stack radius in m (ft)	N/A	0.53 (1.7)	0.53 (1.7)	N/A
Stack flow rate in m^3/sec (ft^3/sec)	N/A	10 (353)	10 (353)	N/A
Stack temperature in °C (°F)	N/A	46 (117)	46 (117)	N/A
Noninvolved worker MEI location in m (ft) ESE	100 (328)	200 (656)	200 (656)	100 (328)
Public MEI location in km (mi) ESE	22 (14)	22 (14)	22 (14)	22 (14)
Chi/Q for noninvolved worker - population in s/m^3	1.60E-03	4.00E-04	4.00E-04	1.60E-03
Chi/Q for noninvolved worker - MEI in s/m^3	4.00E-04	2.50E-06	2.50E-06	4.00E-04
Chi/Q for general public - population in s/m^3	2.90E-03	1.60E-03	1.60E-03	2.90E-03
Chi/Q for general public - MEI in s/m^3	6.60E-08	3.90E-08	3.90E-08	6.60E 08

Notes:
ESE = East-southeast

D.4.3.1.3 Exposure

The radiological exposure for the alternative is presented in Table D.4.3.3. The table shows the exposure each receptor would receive from every component. The sum of the components is shown in the last column for each population and MEI receptor except for the MEI worker. The MEI worker is not summed, but is represented by the component with the highest MEI dose.

Table D.4.3.3 Summary of Anticipated Radiological Exposure for In Situ Fill and Cap Alternative

Radiological Dose (person-rem)[5]									
Receptor	Construction (2 yrs)	Continued Operations[1] 12 (~~19 yrs~~)	Retrieval	Treatment[2] 9 (~~8 yrs~~)	Disposal	Transportation	Monitoring and Maintenance	Closure ~~and~~ Monitoring ~~(100 yrs)~~	Total
Worker - Population	1.90E+00	2.97E+02	N/A	2.23E+02	N/A	N/A	N/A	1.13E+01	5.33E+02
Worker - MEI[3,4]	1.00E+00	9.50E+00	N/A	4.00E+00	N/A	N/A	N/A	1.50E+01	1.50E+01
Noninvolved Worker - Population	0.00E+00	1.45E-03	N/A	4.00E-02	N/A	N/A	N/A	0.00E+00	4.15E-02
Noninvolved Worker - MEI	0.00E+00	7.61E-05	N/A	2.50E-04	N/A	N/A	N/A	0.00E+00	2.50E-04
General Public - Population	0.00E+00	6.90E-02	N/A	1.70E-01	N/A	N/A	N/A	0.00E+00	2.39E-01
General Public - MEI	0.00E+00	1.85E-06	N/A	4.10E-06	N/A	N/A	N/A	0.00E+00	4.10E-04

Notes:
[1] Continued operations include tank farm and Evaporator 1.
[2] Treatment includes gravel fill and Evaporator 2.
[3] Worker MEI is assumed to work for 30 years.
[4] Total for the MEI represents the highest single exposure.
[5] MEI receptor dose noted in rem.

Table D.4.4.1 · Atmospheric Radiological Emissions for In Situ Vitrification Alternative

Continued Operations				Treatment Operations			
Tank Farm Emissions		Evaporator Emissions		DST Evaporator Emissions		In Situ Vitrification Emissions	
Contaminants	Ci/yr Released	Contaminants	Ci/yr Released	Contaminants	Ci/yr Released	Contaminants	Ci/yr Released
Total Alpha[1]	2.88E-08	Total Alpha[1]	2.10E-05	Total Alpha[1]	1.40 ~~1.04~~E-04	Am-241	2.0E-7 ~~1.90E-06~~
Total Beta[2]	7.91E-07	Total Beta[2]	1.20E-05	Total Beta[2]	8.04E-05	C-14	1.06E3 ~~1.10E+03~~
Sr-90	1.81E-05					Cs-137	7.0E-5 ~~6.20E-04~~
Cs-137	5.38E-05					I-129	7.60 ~~3.20E+00~~
I-129	4.60E-05					Pu-239	6.6E-8 ~~6.00E-07~~
						Ru-106	7.6E-14 ~~6.80E-13~~
						Sm-151	1.26E-06 ~~1.14E-05~~
						Sr-90	9.40E-04
						Tc-99	6.4E-8 ~~5.80E-07~~
						Zr-93	7.80E-9 ~~7.00E-08~~

Notes:
[1] Total alpha is assumed to be Pu-239.
[2] Total beta is assumed to be Sr-90.

these are for 5 yrs of ISV operation

Table D.4.4.2 Atmospheric Transport Parameters for In Situ Vitrification Alternative

	Continued Operations		Treatment Operations	
	Tank Farms	Evaporator 1	Evaporator 2	In Situ Vitrification
Stack height in m (ft)	Ground	6.70 (22)	6.70 (22)	30.5 (100)
Stack radius in m (ft)	N/A	0.53 (1.7)	0.53 (1.7)	0.33 (108)
Stack flow rate in m^3/sec(ft^3/sec)	N/A	10 (353)	10 (353)	4.3 (151)
Stack temperature in °C (°F)	N/A	46 (117)	46 (117)	93 (199)
Noninvolved worker MEI location in m (ft) ESE	100 (328)	200 (656)	200 (656)	300 (984)
Public MEI location in km (mi) ESE	22 (14)	22 (14)	22 (14)	22 (14)
Chi/Q for noninvolved worker - population in s/m^3	1.60E-03	4.00E-04	4.00E-04	2.00E-04
Chi/Q for noninvolved worker - MEI in s/m^3	4.00E-04	2.50E-06	2.50E-06	2.30E-07
Chi/Q for general public - population in s/m^3	2.90E-03	1.60E-03	1.60E-03	1.10E-03
Chi/Q for general public - MEI in s/m^3	6.60E-08	3.90E-08	3.90E-08	2.40E-08

Notes:
ESE = East-southeast

The calculated Chi/Q values for the evaporator operation were 2.50E-06 sec/m³ for the noninvolved worker MEI and 3.90E-08 sec/m³ for the general public MEI. For the noninvolved worker population of 10,900 occupying an area between 100 m (330 ft) from the source and the Hanford Site boundary, the population-weighted Chi/Q value was 4.0E-04 sec/m³. For the general public population of 376,000 occupying an area outside the Hanford Site boundary within an 80 km (50 mi) radius centered on the 200 Areas, the population-weighted Chi/Q value was 1.6E-03 sec/m³. For the vitrification operation, the Chi/Q values were 2.30E-07 sec/m³ for the noninvolved worker MEI, 2.4E-08 sec/m³ for the general public MEI, 2.00E-04 sec/m³ for the noninvolved worker population, and 1.10E-03 sec/m³ for the general public population.

D.4.4.1.3 Exposure

The radiological exposure for the alternative is presented in Table D.4.4.3. The table shows the exposure each receptor would receive from every component. The sum of the components are shown in the last column for each population and MEI receptor except for the MEI worker. The MEI worker is not summed, but is represented by the component with the highest MEI dose.

Table D.4.4.3 Summary of Anticipated Radiological Exposure for In Situ Vitrification Alternative

	Radiological Dose (person-rem)[5]							
Receptor	Construction (~~18~~ yrs) 17	Continued Operations[1] 16 (~~19~~ yrs)	Retrieval	Treatment[2] (~~9~~ yrs) 13 *	Storage and Disposal	Monitoring and Maintenance 100 yrs	Post Closure ~~and~~ Monitoring (~~100~~ yrs) 185	Total
Worker - Population	8.00E+01	2.77E+02	N/A	1.19E+03	N/A	N/A	9.55E+00	1.57E+03
Worker - MEI[3,4]	9.00E+00	9.50E+00	N/A	4.50E+00	N/A	N/A	1.50E+01	1.50E+01
Noninvolved Worker - Population	0.00E+00	1.45E-03	N/A	4.04E-02	N/A	N/A	0.00E+00	4.18E-02
Noninvolved Worker - MEI	0.00E+00	7.61E-05	N/A	2.52E-04	N/A	N/A	0.00E+00	2.52E-04
General Public - Population	0.00E+00	6.90E-02	N/A	1.71E-01	N/A	N/A	0.00E+00	2.40E-01
General Public - MEI	0.00E+00	1.85E-06	N/A	4.13E-06	N/A	N/A	0.00E+00	4.13E-06

Notes:
[1] Continued Operations include tank farm and Evaporator 1.
[2] Treatment includes in situ vitrification and Evaporator 2.
[3] Worker MEI is assumed to work for 30 years.
[4] Total for the worker - MEI represents the highest single exposure.
[5] MEI receptor dose is noted in rem.

* 5 yrs actual Vitrification

D.4.5 EX SITU INTERMEDIATE SEPARATIONS ALTERNATIVE

This section presents the anticipated remediation risk associated with the Ex Situ Intermediate Separations alternative for tank waste, as outlined in Appendix B.

The radiological and toxicological risk for this alternative was based on the air emissions and direct exposure from construction, continued operations (including tank farm and evaporator operations), retrieval, separations and treatment, storage and disposal (including transporting vitrified HLW to an offsite national HLW repository), monitoring and maintenance, and closure and monitoring.

D.4.5.1 Radiological Risk

Latent cancer fatality risk to the worker, noninvolved worker, and the general public could result from direct exposure and atmospheric emissions from the components associated with this alternative. The risk was determined by analyzing the radiological source term, the transport mechanism, exposure, and the risk associated with the exposure as discussed in the following subsections.

D.4.5.1.1 Source Term

The source term used for the noninvolved worker and general public was the atmospheric radiological emissions presented in Table D.4.5.1 (WHC 1995j and Jacobs 1996). They also would receive a direct exposure dose from the vitrified HLW as it is being transported to a national HLW repository. The workers would receive a combined dose from the air emissions and from direct exposure from radiation fields in the work place.

Table D.4.5.1 Atmospheric Radiological Emissions for Ex Situ Intermediate Separations Alternative

Continued Operations				Retrieval Emissions		Separation and Vitrification Emissions[3]	
Tank Farm Emissions		Evaporator Emissions 1					
Contaminants	Ci/yr Released	Contaminants	Ci/yr Released	Contaminants	Ci/yr Released	Contaminants	Ci/yr Released
Total Alpha [1]	2.88E-08	Total Alpha[1]	2.10E-05	Sr-90	5.48 ~~5.00~~E-04	Am-241	2.94 ~~3.08~~E-03
Total Beta [2]	7.91E-07	Total Beta[2]	1.20E-05	Cs-137	2.19 2.00E-03	C-14	2.97 ~~2.21~~E+02
Sr-90	1.81E-05			I-129	4.38 ~~4.00~~E-03	Cs-137	1.39 ~~1.49~~E+00
Cs-137	5.38E-05					I-129	2.11 ~~2.13~~E+00
I-129	4.60E-05					Pu-239,240	9.5 ~~6.7~~E-04
						Ru-106	1.06E-6 ~~4.8E-07~~
						Sm-151	1.72 ~~1.43~~E-02
						Sr-90	1.5 ~~1.4~~E+00
						Tc-99	8.90 ~~8.46~~E-04
						Zr-93	1.00E-2 ~~8.29E-03~~

Notes:
[1] Total alpha is assumed to be Pu-239.
[2] Total beta is assumed to be Sr-90.
3 Based on 18 yrs of Operations, Annual Average

(18 YRS [50 YRS 5])

Table D.4.5.3 Summary of Anticipated Radiological Exposure for Ex Situ Intermediate Separations Alternative

Radiological Dose (person-rem)[2]									
Receptor	Construction (19 yrs)	Continued Operations[1] (29 yrs) 25	Retrieval (23 yrs) 21	Separations and Treatment 18 (20 yrs) 19	Storage and Disposal	Transportation (18 YRS)	Monitoring and Maintenance 18 (100 yrs)	Closure and Monitoring (100 yrs) 124/100	Total
Worker - Population	1.12E+01	3.94E+02	4.42E+03	2.98E+03	N/A	N/A	8.40E-01	1.34E+01	7.82E+03
Worker - MEI[3,4]	9.50E+00	1.45E+01	1.30E+01	1.20E+01	N/A	N/A	1.45E+01	1.50E+01	1.50E+01
Noninvolved Worker - Population	0.00E+00	1.58E-03	9.10E-03	9.10E-01	N/A	3.65E+03	0.00E+00	0.00E+00	3.65E+03
Noninvolved Worker - MEI	0.00E+00	7.93E-05	2.40E-03	5.30E-04	N/A	N/A	0.00E+00	0.00E+00	2.46E-03
General Public - Population	0.00E+00	8.00E-02	2.30E+00	3.10E+02	N/A	1.76E+02	0.00E+00	0.00E+00	4.88E+02
General Public - MEI	0.00E+00	2.19E-06	7.50E-05	6.70E-03	N/A	N/A	0.00E+00	0.00E+00	6.70E-03

Notes:
[1] Continued operations include tank farm and Evaporator 1.
[2] MEI receptor dose is noted in rem.
[3] Worker MEI is assumed to work for 30 years.
[4] Total for the MEI represents the highest single exposure.
5 POTENTIAL FOR 50 YRS INTERIM STORAGE

delete

Table D.4.6.1 Atmospheric Radiological Emissions for Ex Situ No Separations Alternative

Continued Operations				Retrieval Emissions		Vitrification/Calcination Emissions	
Tank Farm Emissions		Evaporator Emissions					
Contaminants	Ci/yr Released	Contaminants	Ci/yr Released	Contaminants	Ci/yr Released	Contaminants	Ci/yr Released 4
Total Alpha [1]	2.88E-08	Total Alpha [1]	2.10E-05	Sr-90	~~5.00E-04~~ 29	Am-241	~~5.30E-03~~ 3.75
Total Beta [2]	7.91E-07	Total Beta [2]	1.20E-05	Cs-137	~~2.00E-03~~ 12	C-14 [3]	~~5.80E+01~~ 3.81E+02
Sr-90	1.81E-05			I-129	~~4.00E-03~~ 24	Cs-137	~~1.80E+00~~ 2.45
Cs-137	5.38E-05					I-129	~~3.60E+00~~ 2.71
I-129	4.60E-05					Pu-239 240,241	~~1.20E-03~~ 3.89
						Ru-106	~~8.30E-07~~ 60
						Sm-151	~~2.50E-02~~ 68
						Sr-90	~~2.50E+00~~ 3.88
						Tc-99	~~1.50E-03~~ 1.15
						Zr-93	~~1.40E-02~~ 1.50E-2

Notes:

[1] Total alpha is assumed to be Pu-239.

[2] Total beta is assumed to be Sr-90.

[3] C-14 emissions are reduced for the calcination.

4. Annual average based on 4 yrs treatment operations.

Table D.4.6.2 Atmospheric Transport Parameters for Ex Situ No Separations Alternative

Transport Parameters	Continued Operations		Retrieval	Vitrification or Calcination
	Tank Farms	Evaporator 1		
Stack height in m (ft)	Ground	6.70 (22)	Ground	55 (180)
Stack radius in m (ft)	N/A	0.53 (1.7)	N/A	0.88 (2.9)
Stack flow rate in m^3/sec (ft^3/sec)	N/A	10 (353)	N/A	33 (1,165)
Stack temperature in °C (°F)	N/A	46 (117)	N/A	160 (320)
Noninvolved worker MEI location in m (ft) ESE	100 (328)	200 (656)	100 (328)	800 (2,625)
Public MEI location in km (mi) ESE	22 (14)	22 (14)	22 (14)	22 (14)
Chi/Q for noninvolved worker - population in s/m^3	1.60E-03	4.00E-04	1.60E-03	5.00E-05
Chi/Q for noninvolved worker - MEI in s/m^3	4.00E-04	2.50E-06	4.00E-04	2.90E-08
Chi/Q for general public - population in s/m^3	2.90E-03	1.60E-03	2.90E-03	5.00E-04
Chi/Q for general public - MEI in s/m^3	6.60E-08	3.90E-08	6.60E-08	7.70E-09

Notes:

ESE = East-southeast

(20 YRS [50 YRS[5]])

Table D.4.6.3 Summary of Anticipated Radiological Exposure for Ex Situ No Separations Alternative (Vitrification)

Receptor	Radiological Dose (person-rem)[2]								
	Construction (5 yrs) 19	Continued Operations[1] (24 yrs) 23	Retrieval (18 yrs) 17	Treatment (15 yrs) 14	Storage and Disposal	Transportation (20 yrs.)	Monitoring and Maintenance 20 (54 yrs)	Post Closure and Monitoring 100 (100 yrs)	Total
Worker - Population	1.12E+01	2.81E+02	4.20E+03	3.78E+02	N/A	N/A	7.56E+00	1.13E+01	4.89E+03
Worker - MEI[3,4]	2.50E+00	1.20E+01	9.50E+00	7.00E+00	N/A	N/A	1.50E+00	1.50E+01	1.50E+01
Noninvolved Worker - Population	0.00E+00	1.51E-03	6.70E-03	1.00E+00	N/A	9.35E+03	0.00E+00	0.00E+00	9.35E+03
Noninvolved Worker - MEI	0.00E+00	7.08E-05	1.70E-03	5.90E-04	N/A	N/A	0.00E+00	0.00E+00	1.70E-03
General Public - Population	0.00E+00	7.40E-02	1.70E+00	3.10E+02	N/A	4.48E+01	0.00E+00	0.00E+00	3.57E+02
General Public - MEI	0.00E+00	2.02E-06	5.50E-05	6.70E-03	N/A	N/A	0.00E+00	0.00E+00	6.70E-03

Notes:
[1] Continued operations include tank farm and Evaporator 1.
[2] MEI receptor dose is noted in rem.
[3] Worker MEI is assumed to work for 30 years.
[4] Total for the MEI represents the highest single exposure.

5 POTENTIAL FOR 50 YRS INTERIM STORAGE

(20 YRS [50 YRS 5])

Table D.4.6.16 Summary of Anticipated Radiological Exposure for No Separations (Calcination) Alternative

Receptor	Radiological Dose (person-rem)[2]								
	Construction (5 yrs) 19	Continued Operations[1] (24 yrs) 23	Retrieval (18 yrs) 17	Treatment (Calcination) (15 yrs) 14	Storage and Disposal	Transportation (20 YRS)	Monitoring and Maintenance 30 (54 yrs)	Post Closure ~~and~~ Monitoring (100 yrs) 100	Total
Worker - Population	1.10E+01	2.81E+02	4.20E+03	3.78E+02	N/A	N/A	7.56E+00	1.13E+01	4.89E+03
Worker - MEI[3, 4]	2.50E+00	1.20E+01	9.50E+00	7.00E+00	N/A	N/A	1.50E+01	1.50E+01	1.50E+01
Noninvolved Worker - Population	0.00E+00	1.51E-03	6.70E-03	9.00E-01	N/A	2.95E+03	0.00E+00	0.00E+00	2.95E+03
Noninvolved Worker - MEI	0.00E+00	7.08E-05	1.70E-03	5.20E-04	N/A	N/A	0.00E+00	0.00E+00	1.70E-03
General Public - Population	0.00E+00	7.40E-02	1.70E+00	2.20E+02	N/A	1.41E+02	0.00E+00	0.00E+00	3.63E+02
General Public - MEI	0.00E+00	2.02E-06	5.50E-05	4.80E-03	N/A	N/A	0.00E+00	0.00E+00	4.80E-03

Notes:
[1] Continued operations include tank farm and Evaporator 1
[2] MEI receptor dose is noted in rem
[3] Worker MEI is assumed to work for 30 years
[4] Total for the MEI represents the highest single exposure
5 potential for 50 yrs interim storage

Table D.4.7.1 Atmospheric Radiological Emissions for Ex Situ Extensive Separations Alternative

Continued Operations				Retrieval Emissions		Separation and Vitrification Emissions	
Tank Farm Emissions		Evaporator Emissions					
Contaminants	Ci/yr Released	Contaminants	Ci/yr Released	Contaminants	Ci/yr Released	Contaminants	Ci/yr[3] Released
Total Alpha[1]	2.88E-08	Total Alpha[1]	2.10E-05	Sr-90	5.00E-04	Am-241	2.74 2.40E-03
Total Beta[2]	7.91E-07	Total Beta[2]	1.20E-05	Cs-137	2.00E-03	C-14	2.81 2.50E+02
Cs-137	5.38E-05			I-129	4.00E-03	Cs-137	8.94E-1 5.70E+01
I-129	4.60E-05					I-129	2.50 1.90E+00
Sr-90	1.81E-05					Pu-239	8.42 8.90E-04
						Ru-106	1.06-9 1.70E-07
						Sr-90	1.42E00 1.10E-02
						Tc-99	8.42E-04 2.30E-01
						Zr-93	1.05E-04 5.50E-04

Notes:
[1] Total alpha is assumed to be Pu-239
[2] Total beta is assumed to be Sr-90
3. ~~Based on 19 yr~~ Annual Average based on 19 yrs Separations & Treatment

Table D.4.7.2 Atmospheric Transport Parameters for Ex Situ Extensive Separations Alternative

Transport Parameters	Continued Operations		Retrieval	Separation and Vitrification
	Tank Farms	Evaporator 1		
Stack height in m (ft)	Ground	6.70 (22)	Ground	55 (180)
Stack radius in m (ft)	N/A	0.53 (1.7)	N/A	.88 (2.9)
Stack flow rate in m^3/sec (ft^3/sec)	N/A	10 (353)	N/A	33 (1,165)
Stack temperature in °C (°F)	N/A	46 (117)	N/A	160 (320)
Noninvolved worker MEI location in m (ft) ESE	100 (328)	200 (656)	100 (328)	800 (2,625)
Public MEI location in km (mi) ESE	22 (14)	22 (14)	22 (14)	22 (14)
Chi/Q for noninvolved worker - population in s/m^3	1.60E-03	4.00E-04	1.60E-03	5.00E-05
Chi/Q for noninvolved worker - MEI in s/m^3	4.00E-04	2.50E-06	4.00E-04	2.90E-08
Chi/Q for general public - population in s/m^3	2.90E-03	1.60E-03	2.90E-03	5.00E-04
Chi/Q for general public - MEI in s/m^3	6.60E-08	3.90E-08	6.60E-08	7.70E-09

Notes:
ESE = East-southeast

(2. YRS [50 YRS 5])

Table D.4.7.3 Summary of Anticipated Radiological Exposure for Ex Situ Extensive Separations Alternative, Tank Waste

Radiological Dose (person-rem)[1]									
Receptor	Construction ~~(20 yrs)~~ ~~18~~ 18	Continued Operations[1] ~~(30 yrs)~~ 26 ~~20~~	Retrieval ~~(25 yrs)~~ 20 ~~20~~	Separations and Treatment ~~(20 yrs)~~ 19 ~~18~~	Storage and Disposal	Transportation (3YRS)	Monitoring and Maintenance ~~(10 yrs)~~	Closure ~~and~~ Monitoring ~~(100 yrs)~~ 120 ~~100~~	Total
Worker - Population	1.12E+01	3.02E+02	4.42E+03	3.26E+03	N/A	N/A	8.40E-01	1.54E+01	8.01E+03
Worker - MEI[2,4]	1.00E+01	1.50E+01	1.15E+01	1.05E+01	N/A	N/A	8.00E+00	1.50E+01	1.50E+01
Noninvolved Worker - Population	0.00E+00	1.59E-03	8.10E-03	7.40E-01	N/A	1.72E+02	0.00E+00	0.00E+00	1.73E+02
Noninvolved Worker -MEI	0.00E+00	1.66E-04	2.10E-03	4.20E-04	N/A	N/A	0.00E+00	0.00E+00	2.10E-03
General Public - Population	0.00E+00	8.10E-02	2.10E+00	2.50E+02	N/A	8.50E+00	0.00E+00	0.00E+00	2.61E+02
General Public - MEI	0.00E+00	2.20E-06	6.70E-05	5.50E-03	N/A	N/A	0.00E+00	0.00E+00	5.50E-03

Notes:
[1] Continued operations include tank farm and Evaporator 1
[2] MEI receptor dose is noted in rem
[3] Worker MEI is assumed to work for 30 years
[4] Total for the MEI represents the highest single exposure
5 Potential for 50 yrs interim storage

Table D.4.8.1 Atmospheric Radiological Emissions for Ex Situ/In Situ Combination Alternative

Continued Operations				Treatment (gravel fill)				Retrieval Emissions[2]		Separation and Vitrification Emissions[4]	
Tank Farm Emissions[1]		Evaporator Emissions[1]		Evaporator Emissions		Gravel and Fill Emissions[3]					
Contaminants	Ci/yr Released	Contaminants	Ci/yr Released	Contaminants	Ci/yr Released	Contaminants	Ci/yr Released	Contaminants	Ci/yr Released	Contaminants	Ci/yr Released
Total Alpha[4]	~~2.88E-08~~ 3.21	Total Alpha[4]	2.10E-05	Total Alpha[4]	~~1.04E-04~~ 1.40	Total Alpha[4]	~~4.92E-11~~ 5.47	^{90}Sr	5.00E-04 95	^{241}Am	~~3.08E-03~~ 3.42
Total Beta[5]	7.91E-07	Total Beta[5]	1.20E-05	Total Beta[5]	~~8.04E-05~~ 8.03	Total Beta[5]	~~1.34E-09~~ 1.49	^{137}Cs	2.00E-03 30	^{14}C	~~2.24E+02~~ 2.46
^{90}Sr	1.81E-05					^{90}Sr	~~1.45E-08~~ 1.61	^{129}I	4.00E-03 60	^{137}Cs	~~1.49E+00~~ 1.66
^{137}Cs	5.38E-05					^{137}Cs	~~9.01E-08~~ 1.00E-07			^{129}I	~~2.15E+00~~ 1.94
^{129}I	4.60E-05					^{129}I	~~7.85E-08~~ 8.72			^{239}Pu	~~6.74E-04~~ 7.46
										^{106}Ru	~~4.83E-07~~ 5.37
										^{151}Sm	~~1.43E-02~~ 1.59
										^{90}Sr	~~1.47E+00~~ 1.63
										^{99}Tc	~~8.46E-04~~ 9.4
										^{93}Zr	~~8.29E-03~~ 9.21

Notes:
[1] Percentage of inventory retrieved for Ex Situ Intermediate Separations alternative
[2] Based on the percentage of inventory times the air release
[3] Percentage of inventory not retrieved for Ex Situ Intermediate Separations alternative
[4] Total alpha is assumed to be Pu-239
[5] Total beta is assumed to be Sr-90

See DAP

^{131}I 34.8 = (38)(0.916)
1.8 =

(17 YRS [50 YRS 6])

Table D.4.8.3 Summary of Anticipated Radiological Exposure for Ex Situ/In Situ Combination Alternative

Receptor	Radiologic Dose (person-rem)[5]								
	Construction ~~(20 yrs)~~ ~~16~~ 18	Continued Operations[1] ~~(29 yrs)~~ 26	Retrieval ~~(23 yrs)~~ 20 ~~20~~	Separations and Treatment[2] ~~(20 yrs)~~ ~~16~~ 18	Storage and Disposal	Transportation (18 YRS)	Monitoring and Maintenance ~~(100 yrs)~~	Post Closure ~~and~~ Monitoring ~~(100 yrs)~~ 124 yrs	Total
Worker - Population	7.50E+00	3.94E+02	2.64E+03	2.00E+03	N/A	N/A	8.40E-01	1.29E+01	5.06E+03
Worker - MEI[3,4]	1.00E+01	1.45E+01	1.30E+01	1.20E+01	N/A	N/A	1.50E+01	1.50E+01	1.50E+01
Noninvolved Worker - Population	N/A	1.58E-03	7.70E-03	8.20E-01	N/A	1.83E+03	N/A	N/A	1.83E+03
Noninvolved Worker - MEI	N/A	1.63E-04	2.10E-03	6.30E-04	N/A	N/A	N/A	N/A	2.10E-03
General Public - Population	N/A	8.00E-02	2.10E+00	2.60E+02	N/A	8.80E+01	N/A	N/A	3.50E+02
General Public - MEI	N/A	2.19E-06	6.80E-05	6.00E-03	N/A	N/A	N/A	N/A	6.00E-03

Notes:
[1] Continued operations include tank farm and Evaporator 1
[2] Separations and Treatment include Separations, Vitrification, Gravel Fill, and Evaporator 2
[3] Worker MEI is assumed to work for 30 years
[4] Total for the MEI represents the highest single exposure
[5] MEI receptor dose is noted in rem
6 Potential for 50 yrs interim storage

Table D.4.8.1 Atmospheric Radiological Emissions for Ex Situ/In Situ Combination Alternative

Continued Operations				Treatment (gravel fill)				Retrieval Emissions[2]		Separation and Vitrification Emissions[6]	
Tank Farm Emissions[1]		Evaporator Emissions[1]		Evaporator Emissions		Gravel and Fill Emissions[3]					
Contaminants	Ci/yr Released	Contaminants	Ci/yr Released	Contaminants	Ci/yr Released	Contaminants	Ci/yr Released	Contaminants	Ci/yr Released	Contaminants	Ci/yr Released
Total Alpha[4]	2.88E-08	Total Alpha[4]	2.10E-05	Total Alpha[4]	1.04E-04	Total Alpha[4]	4.92E-11	^{90}Sr	5.00E-04	^{241}Am	2.26 ~~3.08E-03~~
Total Beta[5]	7.91E-07	Total Beta[5]	1.20E-05	Total Beta[5]	8.04E-05	Total Beta[5]	1.34E-09	^{137}Cs	2.00E-03	^{14}C	2.67 ~~2.21E+02~~
^{90}Sr	1.81E-05					^{90}Sr	1.45E-08	^{129}I	4.00E-03	^{137}Cs	1.22 ~~1.49E+00~~
^{137}Cs	5.38E-05					^{137}Cs	9.01E-08			^{129}I	1.90 ~~2.13E+00~~
^{129}I	4.60E-05					^{129}I	7.85E-08			^{239}Pu, 240	5.89 ~~6.71E-04~~
										^{106}Ru	3.92E-10 ~~4.83E-07~~
										^{151}Sm	1.28E-02 ~~1.43E-02~~
										^{90}Sr	1.05 ~~1.49E+00~~
										^{99}Tc	8.01 ~~8.46E-04~~
										^{93}Zr	6.70 ~~8.29E-03~~

Notes:
[1] Percentage of inventory retrieved for Ex Situ Intermediate Separations alternative
[2] Based on the percentage of inventory times the air release
[3] Percentage of inventory not retrieved for Ex Situ Intermediate Separations alternative
[4] Total alpha is assumed to be Pu-239
[5] Total beta is assumed to be Sr-90
6 Annual Average based on 18 yrs Operations

(18 YRS [50 YRS 6])

Table D.4.8.3 (b) Summary of Anticipated Radiological Exposure for Ex Situ/In Situ Combination Alternative

Receptor	Radiologic Dose (person-rem)[5]								
	Construction (20 yrs) 18	Continued Operations[1] (29 yrs) 25	Retrieval (23 yrs) 20	Separations and Treatment[2] (20 yrs) 18	Storage and Disposal	Transportation (18 yrs)	Monitoring and Maintenance (100 yrs)	Closure and Monitoring (100 yrs)	Total
Worker - Population	7.50E+00	3.94E+02	2.64E+03	2.00E+03	N/A	N/A	8.40E-01	1.29E+01	5.06E+03
Worker - MEI[3,4]	1.00E+01	1.45E+01	1.30E+01	1.20E+01	N/A	N/A	1.50E+01	1.50E+01	1.50E+01
Noninvolved Worker - Population	N/A	1.58E-03	7.70E-03	8.20E-01	N/A	1.83E+03	N/A	N/A	1.83E+03
Noninvolved Worker - MEI	N/A	1.63E-04	2.10E-03	6.30E-04	N/A	N/A	N/A	N/A	2.10E-03
General Public - Population	N/A	8.00E-02	2.10E+00	2.60E+02	N/A	8.80E+01	N/A	N/A	3.50E+02
General Public - MEI	N/A	2.19E-06	6.80E-05	6.00E-03	N/A	N/A	N/A	N/A	6.00E-03

Notes:
[1] Continued operations include tank farm and Evaporator 1
[2] Separations and Treatment include Separations, Vitrification, Gravel Fill, and Evaporator 2
[3] Worker MEI is assumed to work for 30 years
[4] Total for the MEI represents the highest single exposure
[5] MEI receptor dose is noted in rem

6 POTENTIAL FOR 50 YRS INTERIM STORAGE

Table D.4.9.1 Atmospheric Radiological Emissions for Phase 1

Continued Operations				Separations and Treatment			
Tank Farm Emissions		Evaporator Emissions		Separations and LAW Vitrification		Separations and LAW/HLW Vitrification	
Contaminants	Ci/yr Released	Contaminants	Ci/yr Released	Contaminants	Ci/yr Released	Contaminants	Ci/yr Released
Total Alpha[1]	2.88E-08	Total Alpha[1]	2.10E-05	^{241}Am	3.26 ~~9.15~~E-07	^{241}Am	2.40 ~~5.03~~E-04
Total Beta[2]	7.91E-07	Total Beta[2]	1.20E-05	^{14}C	4.00E+01 ~~1.12E+02~~	^{14}C	7.00E+01 ~~1.18E+02~~
^{129}I	4.60E-05			^{137}Cs	1.87 ~~5.24~~E-03	^{137}Cs	1.73 ~~2.91~~E-01
^{137}Cs	5.38E-05			^{239}Pu	7.90E-08 ~~2.21E-07~~	^{239}Pu	2.63 ~~4.42~~E-04
^{90}Sr	1.81E-05			^{90}Sr	7.20E-05 ~~2.02E-04~~	^{90}Sr 0.16	~~2.67E-01~~ ~~4.48E-01~~
				^{99}Tc	9.83E-7 ~~2.75E-06~~	^{99}Tc 1.05E-5	~~9.00E-06~~ ~~2.79E-05~~
				^{129}I	12.76 ~~5.76E~~ ~~2.06E-02~~	^{129}I 0.5	~~2.85E-02~~ ~~12.76~~

Notes:
[1] Total alpha is assumed to be ^{239}Pu
[2] Total beta is assumed to be ^{90}Sr

22 10.22

10% of 20/200 (int Seq)

Table D.4.9.2 Atmospheric Transport Parameters for Phase 1

Transport Parameters	Continued Operations		Treatment
	Tank Farm Emissions	Evaporator Emissions	Separation and Vitrification
Stack height in m (ft)	Ground	6.70 (22)	45.7 (150)
Stack radius in m (ft)	N/A	0.53 (1.7)	0.50 (1.6)
Stack flow rate in m^3/sec (ft^3/sec)	N/A	10 (353)	10.8 (381)
Stack temperature in °C (°F)	N/A	46 (117)	65.6 (150)
Noninvolved worker MEI location in m (ft) ESE	100 (328)	200 (656)	400 (1312)
Public MEI location in km (mi) ESE	22 (14)	22 (14)	22 (14)
Chi/Q for noninvolved worker - population in s/m^3	1.60E-03	4.00E-04	1.20E-04
Chi/Q for noninvolved worker - MEI in s/m^3	4.00E-04	2.50E-06	9.40E-08
Chi/Q for general public - population in s/m^3	2.90E-03	1.60E-03	8.00E-04
Chi/Q for general public - MEI in s/m^3	6.60E-08	3.90E-08	1.50E-08

Notes:
ESE = East-southeast

The calculated Chi/Q values for ground releases from the tank farms were calculated by the GENII computer code to be 4.00E-04 sec/m^3 for the noninvolved worker MEI and 6.60E-08 sec/m^3 for the general public MEI. For the noninvolved worker population of 10,900 occupying an area between 100 m (330 ft) from the source and the Hanford Site boundary, the population-weighted Chi/Q value was 1.60E-03 sec/m^3. For the general public population of 376,000 occupying an area outside the

Table D.4.9.3 Summary of Anticipated Radiological Exposure for Phase 1

	Dose (person-rem) [2]								
Receptor	Construction and D&D 4 (5 yrs)	Continued Operations [1] (10 yrs)	Retrieval (10 yrs)	Separations and Treatment [2] (10 yrs)	Storage and Disposal	Transportation [4]	Monitoring and Maintenance 5 (10 yrs)	Closure and Monitoring	Total
Worker - Population	7.00E-03	1.98E+02	2.00E+01	6.73E+02	N/A	N/A	N/A	N/A	8.91E+02
Worker - MEI [3]	2.50E+00	5.00E+00	5.00E+00	5.00E+00	N/A	N/A	N/A	N/A	5.00E+00
Noninvolved Worker - Population	0.00E+00	1.33E-03	0.00E+00	2.49E-01	N/A	2.74E-02	N/A	N/A	2.78E-01
Noninvolved Worker - MEI	0.00E+00	1.02E-04	0.00E+00	2.01E-04	N/A	N/A	N/A	N/A	2.01E-04
General Public - Population	0.00E+00	5.90E-02	0.00E+00	6.70E+01	N/A	8.15E-03	N/A	N/A	6.71E+01
General Public - MEI	0.00E+00	1.50E-06	0.00E+00	1.93E-03	N/A	N/A	N/A	N/A	1.93E-03

Notes:
[1] Continued Operations include Tank Farm and Evaporator 1
[2] MEI receptor dose is noted in rem
[3] Worker MEI is assumed to work for 30 years maximum
4. TRANSPORT HLW TO CANISTER STORAGE BUILDING, 107 TRIPS (428 CANISTERS) OVER 6 YRS; 10 Km each Round TRIP
TRANSPORT LAW TO EXISTING GROUT VAULTS, 610 TRIPS OVER 10 YRS; 4 Km each Round TRIP
5. HLW. and LAW ONSITE INTERIM STORAGE.

~~1440 boxes~~ 14,300 boxes.
Wash D. include HLW onsite transport.

Table D.4.9.16 Atmospheric Radiological Emissions for Total Alternative

Continued Operations				Retrieval Emissions		Separations and Treatment Emissions			
Tank Farm Emissions		Evaporator Emissions 1				Phase 1		Phase 2	
Contaminants	Ci/yr Released	Contaminants	Ci/yr Released	Contaminants	Ci/yr Released	Contaminants	Ci/yr Released	Contaminants	Ci/yr Released
Total Alpha[1]	2.88E-08	Total Alpha[1]	2.10E-05	Sr-90	5.50 ~~5.00~~E-04	Am-241	4.04E-04	Am-241	~~4.74~~ ~~3.08~~E-03 3.11
Total Beta[2]	7.91E-07	Total Beta[2]	1.20E-05	Cs-137	2.20 ~~2.00~~E-03	C-14	2.30E+02	C-14	~~2.36~~ ~~2.21~~E+02 2.55
Sr-90	1.81E-05			I-129	4.40 ~~4.00~~E-03	Cs-137	2.96E-01	Cs-137	~~[illegible]~~ 1.47 ~~1.49~~E+00
Cs-137	5.38E-05					Pu-239	4.42E-04	I-129	~~4.20~~ 2.0 ~~2.13~~E+00
I-129	4.60E-05					Sr-90	4.48E-01	Pu-239 240	~~[illegible]~~ 3 ~~6.70~~E-04
						Tc-99	3.07E-05	Ru-106	~~7.37~~ 1.12E-09 ~~4.80E-07~~
								Sm-151	~~[illegible]~~ 1.38 ~~1.45~~E-02
								Sr-90	~~2.15~~ 1.59 ~~1.40~~E+00
								Tc-99	~~1.29~~ ~~8.46E-04~~
								Zr-93	~~1.70~~ 2 ~~8.39E-03~~

1.06E-02

Notes:
[1]Total alpha is assumed to be Pu-239
[2]Total beta is assumed to be Sr-90

3. Annual Average Emissions based on 17 yrs of Waste treatment

37.43

2.20

17

2.42E-04

(12 YRS [50 YRS])

Table D.4.9.18 Summary of Anticipated Radiological Exposure for Total Alternative

	Radiological Dose (person-rem)[1,2]								
Receptor	Construction (~~12~~ yrs) ~~8~~ 16	Continued Operations[1] (~~20~~ yrs) ~~30~~ 31	Retrieval (~~22~~ yrs) 20 ~~8~~	Separations and Treatment 17 (~~26~~ yrs)	Storage and Disposal	Transportation[5] (18 yrs)	Monitoring and Maintenance ~~(100 yrs)~~	Post-Closure ~~and~~ Monitoring (~~100~~ yrs) 124/50	Total
Worker - Population	7.51E+00	3.94E+02	4.42E+03	3.34E+03	N/A	N/A	8.40E-01	1.34E+01	8.18E+03
Worker - MEI[3,4]	1.00E+01	1.45E+01	1.30E+01	1.50E+01	N/A	N/A	1.45E+01	1.50E+01	1.50E+01
Noninvolved Worker - Population	0.00E+00	1.58E-03	9.10E-03	1.32E+00	N/A	3.65E+03	0.00E+00	0.00E+00	3.65E+03
Noninvolved Worker - MEI	0.00E+00	7.93E-05	2.40E-03	6.30E-04	N/A	N/A	0.00E+00	0.00E+00	2.40E-03
General Public - Population	0.00E+00	8.00E-02	2.30E+00	3.94E+02	N/A	1.76E+02	0.00E+00	0.00E+00	5.72E+02
General Public - MEI	0.00E+00	2.19E-06	7.50E-05	6.00E-03	N/A	N/A	0.00E+00	0.00E+00	6.00E-03

Notes:
[1] Continued operations include Tank Farm and Evaporator 1
[2] MEI receptor dose is noted in rem
[3] Worker MEI is assumed to work for 30 years
[4] Total for the MEI represents the highest single exposure
MEI = Maximally-exposed individual

5 TRANSPORT HLW FROM CANISTER STORAGE BUILDING TO PHASE 2 STORAGE PAD, 107 TRIPS, 4 Km ROUND TRIP; TRANSPORT LAW FROM GROUT VAULT TO PHASE 2 LAW BURIAL VAULT AREA, 610 TRIPS, 4 Km ROUND TRIP.

(428 CANISTERS)

(1830 BOXES)

6. POTENTIAL FOR 50 YRS INTERIM STORAGE

the population-weighted Chi/Q value was 3.70E-04 sec/m³. For the general public population of 376,000 occupying an area outside the Hanford Site boundary within an 80 km (50 mi) radius centered on the 200 Areas, the population-weighted Chi/Q value was 1.70E-03 sec/m³.

D.4.12.1.3 Exposure

The radiological exposure for the alternative is presented in Table D.4.12.3. The table shows the exposure each receptor would receive.

Table D.4.12.3 Summary of Anticipated Radiological Exposure for Overpack and Ship Alternative

	Dose (person-rem) [1]		
Receptor	Overpack and Ship 18 (~~19~~ yr)	Transportation (1 yr)	Total
Worker - Population	2.80E+01	N/A	2.80E+01
Worker - MEI	9.50E+00	N/A	9.50E+00
Noninvolved Worker - Population	2.50E-04	4.39E+01	4.39E+01
Noninvolved Worker - MEI	3.60E-07	N/A	3.60E-07
General Public - Population	1.20E-03	2.13E+00	2.13E+00
General Public - MEI	2.50E-08	N/A	2.50E-08

Notes:
[1] MEI receptor dose are noted in rem

The worker population dose is dependent on the number of people in the population and the anticipated individual dose. The data were obtained from the Site maintenance and operations contractor and the TWRS EIS contractor (WHC 1995h and Jacobs 1996). The calculations for the worker exposures from storage and overpacking operations are as follows:

Storage/Overpacking = (1.48E+02 person-yr) · (2.00E-01 rem/person-yr) = 2.84E+01 person-rem

The MEI worker was assumed to receive a dose of 500 mrem (5.00E-01 rem) per year for the duration of the alternative (not exceeding 30 years).

The noninvolved workers and general public exposures from inhalation of the atmospheric emissions (source term) were converted to a radiological dose in rem using the GENII computer code and applying the appropriate Chi/Q.

D.4.12.1.4 Risk

Latent cancer fatalities are calculated as the product of the estimated dose times the dose-to-risk conversion factor (Section D.2.2.4). The dose-to-risk conversion factors used were 4.00E-04 LCFs per person-rem for workers and noninvolved workers and 5.00E-04 LCFs per person-rem for the general public.

D.4.13.1.3 Exposure

The radiological exposure for the alternative is presented in Table D.4.13.3. The table shows the exposure each receptor would receive.

Table D.4.13.3 Summary of Anticipated Radiological Exposure for Vitrify with Tank Waste Alternative

Receptor	Dose (person-rem) [1]		
	Storage/Overpack (~~25~~ 28-yr)	Transportation (18 yr/5)	Total
Worker - Population	2.80E+01	N/A	2.80E+01
Worker - MEI	9.50E+00	N/A	9.50E+00
Noninvolved Worker - Population	2.50E-04	1.98E+01	1.98E+01
Noninvolved Worker - MEI	3.60E-07	N/A	3.60E-07
General Public - Population	1.20E-03	9.62E-01	9.63E-01
General Public -MEI	2.50E-08	N/A	2.50E-08

Notes:
[1] MEI receptor dose is noted in rem

The worker population dose is dependent on the number of people in the population and the anticipated individual dose. The data were obtained from the Site maintenance and operations contractor and the TWRS EIS contractor (WHC 1995h and Jacobs 1996). The calculations for the worker exposures from storage and overpacking operations are as follows:

Storage/Overpack = (1.40E+02 person-yr) · (2.00E-01 rem/person-yr) = 2.8E+01 person-rem

The MEI worker was assumed to receive a dose of 500 mrem (5.00E-01 rem) per year for a duration of the alternative (not exceeding 30 years).

The noninvolved workers and general public exposures from inhalation of the atmospheric emissions (source term) were converted to a radiological dose in rem using the GENII computer code and applying the appropriate Chi/Q.

D.4.13.1.4 Risk

Latent cancer fatalities are calculated as the product of the estimated dose times the dose-to-risk conversion factor (Section D.2.2.4). The dose-to-risk conversion factors used were 4.00E-04 LCFs per person-rem for workers and noninvolved workers and 5.00E-04 LCFs per person-rem for the general public.

The sum of the radiological dose from construction, continued operations, treatment, and closure, for each receptor shown in the combined dose column in Table D.4.13.4, was multiplied by the appropriate dose-to-risk conversion factor to produce the LCF risk.

JACOBS ENGINEERING GROUP INC.

DATE _____ SUBJECT _____ SHEET NO. _____

BY _____ CHKD. _____ JOB NO. _____

Combo 1 = 18yrs treatment = Ex Sw Int. Sep.

Radiological Operating Emissions should be

= to the recovery fraction (table attached) X the

Intermediate Sep Emission . X 18yrs/18yrs.

Combo 2 Same Methodology

Phased Implementation Phase 1 from DStein Calc.

FORM 91-005-1 (4/81)

Ex Situ /In Situ Combination 1 Alternative FEIS Case (7/5/96)								
	20 wt% waste oxide loading, 1.2 blending factor							
	Radionuclide Inventory			HLW glass		Sel Ret. Recovery		
						fraction		
				Ci/m^3				
	Am-241			7.22E+00		7.67E-01		
	Am-243			2.77E-03		9.20E-01		
	C-14			0.00E+00		9.00E-01		
	Cm-244			5.22E-03		9.40E-01		
	Cs-135			1.20E-02		8.50E-01		
	Cs-137			3.06E+03		8.80E-01		
	I-129			0.00E+00		9.00E-01		
	Ni-63			2.11E+01		8.00E-01		
	Np-237			5.79E-03		9.32E-01		
	Pu-238			4.11E-02		3.97E-01		
	Pu-239			1.53E+00		6.27E-01		
	Pu-240			3.83E-01		6.07E-01		
	Pu-241			4.15E+00		5.65E-01		
	Ra-226			0.00E+00		8.30E-01		
	Ru-106			1.32E-06		3.70E-01		
	Sm-151			4.47E+01		7.20E-01		
	Sn-126			3.44E-02		7.30E-01		
	Sr-90			3.69E+03		7.00E-01		
	Tc-99			5.34E-01		9.00E-01		
	Th-230			3.16E-09		8.20E-01		
	U-233			9.04E-07		8.00E-01		
	U-234			1.60E-05		8.10E-01		
	U-235			1.80E-03		9.10E-01		
	U-238			4.07E-02		9.00E-01		
	Zr-93			2.59E-01		6.70E-01		
	Total (m3)			9.99E+03				
Number of 1.17 m^3 canisters				8.54E+03				
Number of 1.17 m^3 can/HMPC				4				
Number of HMPCs				2134				
Number of trips to the repository				214				
Based on 10 HMPCs per train and rounded to nearest trip								
Note the combination alt. retrieval fraction is calculated from the % of SST and DST inventory								
recovered as follows: recovery fraction = (curies recovered from SSTs + Curies from DSTs)								
divided by (total curies in the SSTs+total curies in DSTs)								
Note: Curies from decay daughter products not included								

Combo 2

SST +DST total			Combo Low
Radionuclide			% Recovered for Ex Situ Processing
Ac-225	4.4E-06		33%
Ac-227	0.010816		57%
Ac-228	0		0%
Am-241	76187.93		73%
Am-242	35.1641		56%
Am-242m	35.33228		56%
Am-243	19.59712		61%
At-217	4.4E-06		33%
Ba-135m	0		0%
Ba-137m	40362246		75%
Bi-210	1.55E-08		33%
Bi-211	0.010816		57%
Bi-212	0		0%
Bi-213	4.4E-06		33%
Bi-214	6.12E-08		30%
C-14	4253.385		80%
Cm-242	29.16645		56%
Cm-244	92.49279		69%
Cm-245	0.00694		68%
Cs-135	72.73039		51%
Cs-137	31887379		83%
Eu-154	75040.88		99%
Fr-221	4.4E-06		33%
Fr-223	0.000149		57%
I-129	30.87092		81%
Nb-93m	541.2141		17%
Ni-59	0		0%
Ni-63	74990.81		28%
Np-237	83.29269		79%
Np-238	0.168182		56%
Np-239	19.59712		61%
Pa-231	0.019377		56%
Pa-233	38.24489		64%
Pa-234	0.384643		51%
Pa-234m	240.4019		51%
Pb-209	4.4E-06		33%
Pb-210	1.55E-08		33%
Pb-211	0.010816		57%
Pb-212	0		0%
Pb-214	6.12E-08		30%
Pd-107	49.22507		65%
Po-210	1.55E-08		33%
Po-211	2.95E-05		57%
Po-212	0		0%
Po-213	4.31E-06		33%
Po-214	6.12E-08		30%
Po-215	0.010816		57%
Po-216	0		0%
Po-218	6.12E-08		30%
Pu-236	0		0%
Pu-238	323.3833		13%
Pu-239	7647.107		29%
Pu-240	1904.529		28%
Pu-241	18933.88		21%
Pu-242	0.000174		56%
Ra-223	0.010816		57%
Ra-224	0		0%
Ra-225	4.4E-06		33%
Ra-226	6.12E-08		30%
Ra-228	0		0%
Rh-106	0.05246		9%
Rn-219	0.010816		57%
Rn-220	0		0%
Rn-222	6.12E-08		30%
Ru-106	0.05246		9%
Sb-126	19.23266		22%
Sb-126m	137.3762		22%
Se-79	512.1212		64%
Sm-151	138914		21%
Sn-126	137.3762		22%
Sr-90	21015666		36%
Tc-99	27392.43		85%
Th-227	0.010666		57%
Th-228	0		0%
Th-229	4.4E-06		33%
Th-230	8.26E-06		27%
Th-231	10.07772		50%
Th-232	0		0%
Th-233	0		0%
Th-234	240.4019		51%
Tl-207	0.010786		57%
Tl-208	0		0%
Tl-209	9.51E-08		33%
U-232	0		0%
U-233	0.004521		48%
U-234	0.0486		25%
U-235	10.07772		50%
U-236	0.000315		14%
U-237	0.144499		14%
U-238	240.4019		51%
Y-90	21401117		35%
Zr-93	419.4471		11%

Personnel Changes for Appendix D

	Const.	T-op	E-op	Ret.	S&T	M&M	C&M	Total
NA								-
Time (Yr)		100	100					
# of worker		500	64					564
LTM								
Time (Yr)	10	100	100	10				
# of worker	72	500	8	182				762
ISFC		12	12		9			
Time (Yr)	2	~~19~~	~~18~~		~~8~~		100	
# of worker	69	637	34		125		8	873
ISV		16	16		1			
Time (Yr)	17 ~~18~~	~~19~~	~~18~~		~~0.8~~		100	
# of worker	337 ~~318~~	558	34		662		7	1579
ESIS		25	25	11	18	50		
Time (Yr)	19	~~29~~	~~29~~	~~28~~	~~20~~	~~100~~	100	
# of worker	42	655	22	961	745	10	10	2436
ESNS		23	23	17	14	50		
Time (Yr)	19 ~~8~~	~~24~~	~~24~~	~~18~~	~~18~~	~~54~~	100	
# of worker	2 ~~160~~	454	27	1167	126	10	8	1952
ESES		16	16	10	19	50		
Time (Yr)	18 ~~20~~	~~30~~	~~30~~	~~28~~	~~28~~	~~16~~	100	
# of worker	44 ~~40~~	413	21	961	815	4	11	2265
ESISCt		16	16	10	18	50		
Time (Yr)	1 ~~20~~	~~29~~	~~29~~	~~28~~	~~20~~	~~100~~	100	
# of worker	2 ~~127~~ 51	655	22	574	500	8 ~~1~~	9	1888
ESISEZ								
Time (Yr)	18	25	25	20	18	50	100	
# Workers	27	460	22	284	597	8	9	
Ph I								
Time (Yr)	4	15	15	10	10	—	—	
# workers	—	750	22	10	365	—	—	
~~Ph II~~ Phase 2	~~20~~ ~~16~~	16	16	20	17	50	100	
Time (yr)	(44)	624	22	(960)	(1164)	10	10	
No. Workers	50			935	990			

Total = Ph1+Ph2

Real Workers.

+ Alex 7/9

Revised 7/12

Modified Phased Implementation

Ph 1 Continued Ops = 14,129 × .8 Real/Total = 11,300 staff yrs

Phase 2+1

Continued Ops = 14129 + 10078 = 24207

24207 × .8 Real/Total = 19,370

Ex Sito/In Sito Comb. Const. = 40% 1st Sap + 60% Ext

$$= \frac{.6 \times 42 \times 19\text{yrs} + .6 \times 69 \times 2}{18}$$

= 3.1

Construction hours Retained by Change in duration.

Pg. 1/6.
6 Pages Plus
Appended Material

TWRS EIS
CALCULATION COVER SHEET

DISCIPLINE & TITLE Engineering / HLW Repository Fee Cost Allocation and Estimate to Support FEIS

ORIGINATOR Colin Henderson DATE 7/26/96

REVISION NO. 0

OBJECTIVE Determine HLW disposal Fees for Placement of HLW in the Potential Geologic Repository

METHODOLOGY As Noted

ASSUMPTIONS As Noted.

(Continue on another sheet if necessary)

J Colin Henderson 7/26/96.
SIGNATURE/DATE

RDW 8-2-96
CHECKED/DATE

CALCULATION & RESULTS
ATTACHED

JACOBS\FORMS\CALCVR.SHT

JACOBS ENGINEERING GROUP INC.

DATE _____ SUBJECT _____ SHEET NO. _____

BY _____ CHKD. _____ JOB NO. _____

Methodology: Using the Attached Repository Disposal Fee Estimates for the Hanford Tank Waste Remediation System EIS (Letter Milner to Kinzer dated July 01, 1996)

the allocated defense share was apportioned between Hanford and other DOE sites based on the ratio of Waste Packages produced at Hanford to the total number of waste packages. This was done for the applicable scenarios that were evaluated by RW. The disposal fees for alternatives that were not evaluated by RW were calculated by interpolating between the data developed by RW.

Step 1. Apportion Repository fee for Scenario 2 (Intermediate Separations and Phased Implementation alternative)

Defense Share = 8.6 B.

Hanford Canisters = 12,200

Hanford Waste Packages = $\frac{12,200}{4} = 3,050$

Total Defense Waste Packages = $\frac{20386}{4} = 5097$

Hanford Share = $\frac{3050}{5097} \times 8.6B = \$5,100$ million \$94.

32
5017
4
20386

Step 2.

Similar procedure used to apportion the cost for each of the Scenarios analyzed by RW.

Step 3. A plot of disposal fee (Hanford) -vs- number of waste packages was developed. An equation for the line between Scenario 3 (min Volume) and Scenario 2 (Intermediate Sep) was developed. A similar line between Scenario 2 and Scenario 4 was developed. These Points were used to be Conservative in the extrapolation of the fee for other alternatives.

FORM 91-005-1 (4/81)

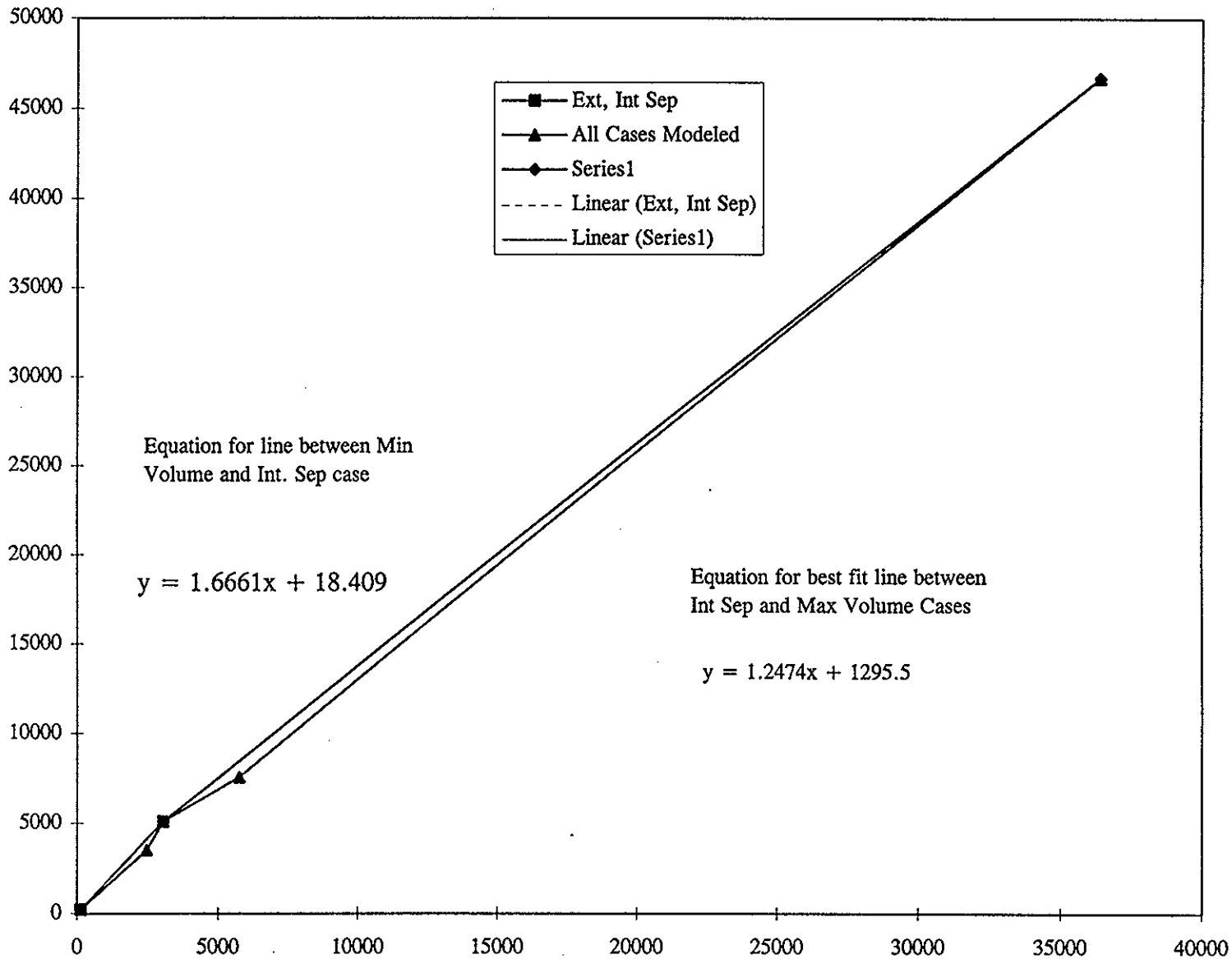
JACOBS ENGINEERING GROUP INC.

DATE _____ SUBJECT _____ SHEET NO. 1

BY _____ CHKD. _____ JOB NO. _____

Based on the equations developed (see attached graph) the Hanford Repository fee was calculated for all remaining alternatives. Results shown on attached table.

FORM 91-005-1 (4/81)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35000
40000
Ext, Int Sep
All Cases Modeled
Series1
Linear (Ext, Int Sep)
Linear (Series1)
Equation for line between Min Volume and Int. Sep case
y = 1.6661x + 18.409
Equation for best fit line between Int Sep and Max Volume Cases
y = 1.2474x + 1295.5

	No. Waste Packages	Hanford Rep. Fee	Hanford Rep. Fee	Fee per WP	Fee per WP	Total Repository
		Millions 1994$	Millions 1995$	Millions 1994$	Millions 1995$	Millions 1994$
Low Volume	133	240	$250	1.836	1.880	32,600
Base Case	2465	3510	$3,630	1.424	1.473	33,100
Ex Situ Intermediate Sep/Phased Imp	3050	5,100	$5,280	1.688	1.731	34,500
Scenario 1	5750	7600	$7,870	1.322	1.369	35,100
Scenario 4	36400	46700	$48,330	1.283	1.328	66,200
Ex Situ No Separations Vitrification	29100	37580	$38,900	1.291	1.337	58,990
Ex Situ No Separations Calcination	10300	14140	$14,630	1.373	1.420	41,010
Ex Situ/In Situ Combination 1	2135	3580	$3,710	1.677	1.738	33,200
Ex Situ/In Situ Combination 2	1235	2080	$2,150	1.684	1.741	32,340
Ex Situ Extensive Separations	143	260	$270	1.818	1.888	490

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BY _____ CHKD. _____ JOB NO. _____

Appended Supporting Information.

1. Letter Milner to Kinzer, July 01, 1996. Repository Disposal Fee Estimate for the Hanford TWRS EIS.

2. Supporting Communications on disposal fee methodology.

FORM 91-005-1 (4/81)