Appendix D

Suggested Maximum Leachate Concentrations for Individual Constituents

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Table D-1. Suggested maximum leachate concentrations for organic constituents for liner compatibility.

Constituent[a]	Predicted Concentration in Leachate[b] (mg/L)	Compatible Concentration for HDPE (mg/L)	Compatible Concentration for GCL (mg/L)	Compatible Concentration for Clay (mg/L)	Suggested Maximum Leachate Concentration[c] (mg/L)
1,1,1-Trichloroethane	0.0609	-[d]	-[d]	20[e]	20
1,1,2,2-Tetrachloroethane	0.0002	—	—	—	—
1,1,2-Trichloroethane	0.0013	—	—	—	—
1,1-Dichloroethane	0.0105	—	—	—	—
1,1-Dichloroethene	0.0004	—	—	—	—
1,2,4-Trichlorobenzene	0.0113	—	—	—	—
1,2-Dichlorobenzene	0.0734	—	—	—	—
1,2-Dichloroethane	0.0001	—	—	—	—
1,2-Dichloroethene (total)	0.0003	—	—	—	—
1,3-Dichlorobenzene	0.0071	2,000[f]	—	—	2,000
1,4-Dichlorobenzene	5.1303	—	—	—	—
1,4-Dioxane	0.0000	—	—	—	—
2,4,5-Trichlorophenol	0.0441	—	—	—	—
2,4,6-Trichlorophenol	0.0427	—	—	—	—
2,4-Dichlorophenol	0.0371	—	—	—	—
2,4-Dimethylphenol	0.3041	—	—	—	—
2,4-Dinitrophenol	0.1705	—	—	—	—
2,4-Dinitrotoluene	0.0488	—	—	—	—
2,6-Dinitrotoluene	0.2903	—	—	—	—
2-Butanone	0.0063	200,000[f]	—	—	200,000
2-Chloronaphthalene	0.0108	2,000[g]	—	—	2,000
2-Chlorophenol	0.1867	2,000[g]	—	—	2,000
2-Hexanone	0.0001	—	—	—	—

Table D-1. (continued).

Constituent[a]	Predicted Concentration in Leachate[b] (mg/L)	Compatible Concentration for HDPE (mg/L)	Compatible Concentration for GCL (mg/L)	Compatible Concentration for Clay (mg/L)	Suggested Maximum Leachate Concentration[c] (mg/L)
2-Methylnaphthalene	1.7772	—	—	—	—
2-Methylphenol	0.2014	—	—	—	—
2-Nitroaniline	0.1728	—	—	—	—
2-Nitrophenol	0.0098	—	—	—	—
3,3'-Dichlorobenzidine	0.1896	—	—	—	—
3-Methyl Buta-l	0.0022	—	—	—	—
3-Nitroaniline	0.0165	—	—	—	—
4,6-Dinitro-2-methylphenol	0.0010	—	—	—	—
4-Bromophenyl-phenylether	0.0615	2,000[g]	—	—	2,000
4-Chloro-3-methylphenol	0.0810	—	—	—	—
4-Chloroaniline	0.0052	—	—	—	—
4-Chlorophenyl-phenylether	0.0288	—	—	—	—
4-Methyl-2-Pentanone	0.1131	—	—	—	—
4-Methylphenol	0.3766	—	—	—	—
4-Nitroaniline	0.1728	—	—	—	—
4-Nitrophenol	0.0029	—	—	—	—
Acenaphthene	0.0399	2,000[g]	—	—	2,000
Acenaphthylene	0.3366	2,000[g]	—	—	2,000
Acetone	6.2674	200,000[g]	—	—	100,000
Acetonitrile	0.0002	—	—	—	—
Acrolein	0.0001	200,000[g]	—	—	200,000
Acrylonitrile	0.0000	200,000[g]	—	—	200,000
Anthracene	0.0083	2,000[g]	—	—	2,000
Aramite	0.0000	—	—	—	—

Table D-1. (continued).

Constituent[a]	Predicted Concentration in Leachate[b] (mg/L)	Compatible Concentration for HDPE (mg/L)	Compatible Concentration for GCL (mg/L)	Compatible Concentration for Clay (mg/L)	Suggested Maximum Leachate Concentration[c] (mg/L)
Aroclor-1016	0.0000	—	—	—	—
Aroclor-1254	0.0002	—	—	—	—
Aroclor-1260	0.0087	—	—	—	—
Aroclor-1268	0.2891	—	—	—	—
Benzene	1.3491	2,000[g]	—	—	1,000
Benzidine	0.0000	200,000[g]	—	—	200,000
Benzo(a)anthracene	0.0001	2,000[g]	—	—	2,000
Benzo(a)pyrene	0.0000	2,000[g]	—	—	2,000
Benzo(b)fluoranthene	0.0000	2,000[g]	—	—	2,000
Benzo(g,h,i)perylene	0.0000	—	—	—	—
Benzo(k)fluoranthene	0.3024	—	—	—	—
Benzoic acid	0.1162	—	—	—	—
bis(2-Chloroethoxy)methane	0.0455	2,000[g]	—	—	2,000
bis(2-Chloroethyl)ether	0.0535	2,000[g]	—	—	2,000
bis(2-Chloroisopropyl)ether	0.0000	2,000[g]	—	—	2,000
bis(2-Ethylhexyl)phthalate	0.5714	2,000[g]	—	—	2,000
Butane,1,1,3,4-Tetrachloro-	0.0001	—	—	—	—
Butylbenzylphthalate	0.0080	200,000[g]	—	—	200,000
Carbazole	0.1856	—	—	—	—
Carbon Disulfide	0.0734	—	—	—	—
Chlorobenzene	0.0679	2,000[g]	—	—	2,000
Chloroethane	0.0000	—	—	—	—
Chloromethane	0.0000	2,000[g]	—	—	2,000
Chrysene	4.4199	2,000[g]	—	—	2,000

Table D-1. (continued).

Constituent[a]	Predicted Concentration in Leachate[b] (mg/L)	Compatible Concentration for HDPE (mg/L)	Compatible Concentration for GCL (mg/L)	Compatible Concentration for Clay (mg/L)	Suggested Maximum Leachate Concentration[c] (mg/L)
Decane, 3,4-Dimethyl	0.0004	—	—	—	—
Diacetone alcohol	0.0005	—	—	—	—
Dibenz(a,h)anthracene	0.0006	2,000[g]	—	—	2,000
Dibenzofuran	0.4156	—	—	—	—
Diethylphthalate	0.1897	100,000[g]	—	—	100,000
Dimethyl Disulfide	0.0127	—	—	—	—
Dimethylphthalate	0.0001	100,000[g]	—	—	100,000
Di-n-butylphthalate	0.0000	100,000[f]	—	—	100,000
Di-n-octylphthalate	0.4370	—	—	—	—
Eicosane	0.0472	—	—	—	—
Ethyl cyanide	0.0000	—	—	—	—
Ethylbenzene	0.0705	2,000[g]	—	—	2,000
Famphur	0.0000	—	—	—	—
Fluoranthene	0.0221	2,000[g]	—	—	2,000
Fluorene	3.0594	2,000[g]	—	—	2,000
Heptadecane, 2,6,10,15-Tetra	0.0000	—	—	—	—-
Hexachlorobenzene	0.0001	2,000[g]	—	—	2,000
Hexachlorobutadiene	0.0000	2,000[g]	—	—	2,000
Hexachlorocyclopentadiene	0.0025	2,000[g]	—	—	2,000
Hexachloroethane	0.0000	2,000[g]	—	—	2,000
Indeno(1,2,3-cd)pyrene	0.1585	2,000[g]	—	—	2,000
Isobutyl alcohol	0.0001	500,000[g]	—	—	500,000
Isophorone	0.1829	2,000[g]	—	—	2,000
Isopropyl Alcohol/2-propanol	0.0000	500,000[g]	—	—	500,000

Table D-1. (continued).

Constituent[a]	Predicted Concentration in Leachate[b] (mg/L)	Compatible Concentration for HDPE (mg/L)	Compatible Concentration for GCL (mg/L)	Compatible Concentration for Clay (mg/L)	Suggested Maximum Leachate Concentration[c] (mg/L)
Kepone	0.2511	—	—	—	—
Mesityl oxide	1.2939	—	—	—	—
Methyl Acetate	0.0057	—	—	—	—
Methylene Chloride	0.0165	2,000[g]	—	20[e]	20
Naphthalene	1.9193	2,000[g]	—	—	2,000
Nitrobenzene	0.0948	100,000[g]	—-	—	100,000
N-Nitroso-di-n-propylamine	0.0035	100,000[g]	—	—	100,000
N-Nitrosodiphenylamine	0.1896	100,000[g]	—	—	100,000
Octane,2,3,7-Trimethyl	0.0027	—	—	—	—
o-Toluenesulfonamide	0.0033	—	—	—	—
Pentachlorophenol	0.0046	100,000[g]	—	—	100,000
Phenanthrene	8.8500	2,000[g]	—	—	2,000
Phenol	0.1370	100,000[g]	—	—	100,000
Phenol,2,6-Bis(1,1-Dimethyl)	0.0674	—	—	—	—
p-Toluenesulfonamide	0.0000	—	—	—	—
Pyrene	3.2501	2,000[g]	—	—	2,000
RDX	0.0000	5,000[g]	—	—	5,000
Styrene	0.0000	2,000[g]	—	—	2,000
Tetrachloroethene	0.0235	5,000[g]	—-	20[h]	20
Toluene	16.3666	—	—	—	—
Tributylphosphate	1.2292	2,000[g]	—-	1,100[e]	1,100
Trichloroethene	1.1526	—	—	—	—
Trinitrotoluene	0.0000	—	—	—	—
Undecane,4,6-Dimethyl-	0.0003	5,000[g]	—	—	5,000

Table D-1. (continued).

Constituent[a]	Predicted Concentration in Leachate[b] (mg/L)	Compatible Concentration for HDPE (mg/L)	Compatible Concentration for GCL (mg/L)	Compatible Concentration for Clay (mg/L)	Suggested Maximum Leachate Concentration[c] (mg/L)
Xylene (ortho)	0.0071	—	—	—	—
Xylene (total)	6.2805	—	—	—	—

Notes
a. Constituent reported in the "INEEL CERCLA Disposal Facility Design Inventory (EDF-ER-264).
b. Predicted leachate concentration in the first year of the ICDF landfill operation (EDF-ER-274).
c. The suggested maximum concentration selected for the ICDF liner system is based on the lowest of the concentrations listed for HDPE, GCL, and clay materials and are applicable for the leachate in the landfill and the waste liquids in the evaporation ponds.
d. "–" indicates that a specific test value was not available, compatibility issues are not anticipated.
e. The TCE solubility limit in water is 1,100 mg/l. A minimum of 2 pore volumes of permeant liquid was passed through the clay sample or until the concentration of total organic carbon in the influent and effluent were the same (Bowders and Daniel 1988). No significant change in permeability was observed.
f. From "Evaluation of Liner/Leachate Chemical Compatibility for the Environmental Restoration Disposal Facility," BHI-00359.
g. From manufacturer specifications.
h. 20 mg/l is the typical concentration of leachate found in muncipal landfills. No change in clay permeability was observed at this concentration (Kim, Tuncer, and Park 1999).

Table D-2. Suggested maximum leachate concentrations for inorganic constituent for liner compatibility.

Constituent[a]	Predicted Concentration in Leachate[b] (mg/L)	Compatible Concentration for HDPE (mg/l)	Compatible Concentration for GCL (mg/l)	Compatible Concentration for Clay (mg/l)	Suggested Maximum Leachate Concentration[c] (mg/l)
Aluminum	28.3029				
Antimony	0.1165				
Arsenic	1.8470	500,000[d]	—	-[e]	500,000
Barium	3.5848				
Beryllium	0.0011				
Boron	36.4728	500,000[d]	—	-[e]	500,000
Cadmium	0.5917	500,000[d]	—	-[e]	500,000
Calcium	4035.0217	500,000[d]	—	-[e]	500,000
Chloride	31.1061				
Chromium	1.3691				
Cobalt	0.5999	500,000[d]	—	-[e]	500,000
Copper	1.4906	500,000[d]	—	-[e]	500,000
Cyanide	4.0932	500,000[d]	—	-[e]	500,000
Dysprosium	0.2472				
Fluoride	64.4341				
Iron	46.5528				
Lead	0.5753				
Magnesium	883.9838	500,000[d]	—	-[e]	500,000
Manganese	4.1300				
Mercury	49.6286				
Molybdenum	1.0117	500,000[d]	—	-[e]	500,000
Nickel	0.1964				
Nitrate	65.4429				
Nitrate/Nitrite-N	3.6979				
Nitrite	0.1414				
Phosphorus	19.2492	500,000[d]	—	-[e]	500,000
Potassium	74.8819	500,000[d]	—	-[e]	500,000
Selenium	0.2084	500,000[d]	—	-[e]	500,000
Silver	0.1092				
Sodium	2.7716				
Strontium	1.5094	500,000[d]	—	-[e]	500,000
Sulfate	342.1180				

Table D-2. (continued).

Constituent[a]	Predicted Concentration in Leachate[b] (mg/L)	Compatible Concentration for HDPE (mg/l)	Compatible Concentration for GCL (mg/l)	Compatible Concentration for Clay (mg/l)	Suggested Maximum Leachate Concentration[c] (mg/l)
Sulfide	12641.8391				
Terbium	2.3867				
Thallium	0.0037				
Vanadium	3.5063	500,000[d]	—	-[e]	500,000
Ytterbium	0.8124				
Zinc	12.9486	500,000[4]	—	-[e]	500,000
Zirconium	0.1151				
Total Inorganic	18367.1936				

a. Constituent reported in the "INEEL CERCLA Disposal Facility Design Inventory (EDF-ER-264).
b. Predicted leachate concentration in the first year of the ICDF landfill operation (EDF-ER-274).
c. The suggested maximum concentration selected for the ICDF liner system is based on the lowest of the concentrations listed for HDPE, GCL, and clay materials and are applicable for the leachate in the landfill and the waste liquids in the evaporation ponds.
d. From manufacturer specifications
e. From manufacturer specifications

Table D-3. Suggested maximum leachate concentrations for radionuclide constituents for liner compatibility in the ICDF Landfill.

Constituent[a]	Predicted Activity Concentration in Leachate[b] (pCi/L)	Suggested Maximum Activity Concentration[c] (pCi/L)
Ac225	1.1E-07	2.2E+07
Ac227	4.5E-05	1.6E+09
Ac228	3.4E-10	9.4E+07
Ag106	0.0E+00	2.0E+08
Ag108	4.1E-08	—
Ag108m	8.9E+00	7.8E+07
Ag109m	5.5E-11	1.5E+09
Ag110	5.7E-10	1.1E+08
Ag110m	6.2E-08	4.6E+07
Ag111	0.0E+00	—
Am241	7.0E+01	2.3E+07
Am242	1.3E-04	6.7E+08
Am242m	1.3E-04	1.9E+09
Am243	9.8E-04	2.4E+07
Am245	0.0E+00	—
Am246	4.1E-25	1.0E+08
At217	8.5E-04	1.8E+07
Ba136m	0.0E+00	—
Ba137m	4.6E+05	1.9E+08
Ba140	0.0E+00	—
Be10	4.6E-06	6.3E+08
Bi210	1.1E-05	3.3E+08
Bi211	1.8E-04	1.9E+07
Bi212	5.5E-03	4.5E+07
Bi213	0.0E+00	—
Bi214	5.6E-05	5.9E+07
Bk249	5.4E-22	3.9E+09
Bk250	1.9E-26	1.1E+08
C14	9.1E-03	2.6E+09
Cd109	8.1E-10	6.5E+09
Cd113m	2.7E+02	6.9E+08
Cd115m	7.0E-52	2.0E+08
Ce141	3.6E-71	5.2E+08
Ce142	0.0E+00	—
Ce144	3.6E-03	1.1E+09
Cf249	8.1E-16	2.1E+07

Table D-3. (continued).

Constituent[a]	Predicted Activity Concentration in Leachate[b] (pCi/L)	Suggested Maximum Activity Concentration[c] (pCi/L)
Cf250	4.1E-16	2.1E+07
Cf251	1.9E-18	2.2E+07
Cf252	4.4E-20	1.2E+10
Cm241	3.2E-81	7.5E+08
Cm242	1.3E-17	2.1E+07
Cm243	8.9E-07	2.1E+07
Cm244	4.5E-04	2.2E+07
Cm245	2.0E-08	2.3E+07
Cm246	4.5E-10	2.4E+07
Cm247	1.6E-16	2.4E+07
Cm248	4.9E-17	2.7E+07
Cm250	1.4E-25	9.8E+07
Co57	3.7E-01	8.9E+08
Co58	5.8E-15	1.3E+08
Co60	1.9E+04	4.9E+07
Cr51	7.7E-53	3.5E+09
Cs132	0.0E+00	—
Cs134	2.2E+01	7.4E+07
Cs135	7.2E-02	2.3E+09
Cs136	0.0E+00	—
Cs137	4.9E+04	7.5E+08
Er169	0.0E+00	—
Eu150	5.1E-08	4.4E+08
Eu152	2.8E+03	1.0E+08
Eu154	2.4E+03	8.4E+07
Eu155	5.2E+02	1.0E+09
Eu156	0.0E+00	—
Fe59	2.0E-34	9.8E+07
Fr221	1.0E-07	2.0E+07
Fr223	5.6E-07	2.9E+08
Gd152	1.1E-13	5.9E+07
Gd153	8.4E-11	8.4E+08
H3	8.3E+05	2.2E+10
Hf181	1.7E-36	1.7E+08
Ho166m	1.1E-05	7.3E+07
I129	2.2E+04	1.6E+09
I131	0.0E+00	—

Table D-3. (continued).

Constituent[a]	Predicted Activity Concentration in Leachate[b] (pCi/L)	Suggested Maximum Activity Concentration[c] (pCi/L)
In114	4.8E-54	1.6E+08
In114m	5.1E-54	5.3E+08
In115	1.5E-11	8.4E+08
In115m	0.0E+00	—
K40	1.3E+02	2.1E+08
Kr81[d]	8.8E-05	—
Kr85[d]	1.9E+07	—
La138	0.0E+00	—
La140	2.2E-105	4.5E+07
Mn54	3.9E-07	1.5E+08
Nb92	6.3E-18	8.5E+07
Nb93m	1.3E-01	4.2E+09
Nb94	8.8E-05	7.4E+07
Nb95	4.8E-32	1.6E+08
Nb95m	1.8E-34	5.2E+08
Nd144	1.4E-09	6.7E+07
Nd147	0.0E+00	—
Np235	8.4E-09	1.3E+10
Np236	8.6E-06	3.7E+08
Np237	8.0E+01	2.6E+07
Np238	2.7E-05	1.6E+08
Np239	4.1E-02	3.1E+08
Np240	3.5E-12	8.0E+07
Np240m	3.1E-09	1.3E+08
Pa231	1.3E-04	2.3E+07
Pa233	7.9E-02	3.1E+08
Pa234	5.0E-06	5.2E+07
Pa234m	3.1E-03	1.5E+08
Pb209	4.8E-07	6.5E+08
Pb210	1.1E-05	3.3E+09
Pb211	1.8E-04	2.5E+08
Pb212	5.5E-03	4.0E+08
Pb214	5.6E-05	2.4E+08
Pd107	1.1E-01	3.9E+09
Pm146	2.4E-02	1.5E+08
Pm147	1.6E+03	2.1E+09
Pm148	1.7E-58	9.8E+07

Table D-3. (continued).

Constituent[a]	Predicted Activity Concentration in Leachate[b] (pCi/L)	Suggested Maximum Activity Concentration[c] (pCi/L)
Pm148m	3.4E-57	5.9E+07
Po210	6.8E-06	2.4E+07
Po211	4.6E-09	1.7E+07
Po212	2.2E-03	1.5E+07
Po213	2.9E-07	1.5E+07
Po214	3.7E-05	1.7E+07
Po215	1.2E-04	1.7E+07
Po216	3.7E-03	1.9E+07
Po218	3.7E-05	2.1E+07
Pr143	0.0E+00	—
Pr144	7.4E-03	1.0E+08
Pr144m	1.1E-04	1.1E+10
Pu236	3.9E-05	2.2E+07
Pu237	8.6E-58	2.1E+09
Pu238	1.7E+03	2.3E+07
Pu239	4.8E+01	2.5E+07
Pu240	1.1E+01	2.5E+07
Pu241	4.6E+02	2.4E+10
Pu242	1.7E-03	2.6E+07
Pu243	4.6E-15	6.6E+08
Pu244	1.8E-10	2.8E+07
Pu246	9.9E-25	8.3E+08
Ra222	1.2E-115	2.0E+07
Ra223	2.0E-04	2.2E+07
Ra224	5.5E-03	2.2E+07
Ra225	5.1E-07	1.1E+09
Ra226	4.7E+00	2.7E+07
Ra228	1.5E-09	1.1E+10
Rb86	0.0E+00	—
Rb87	2.0E-04	1.6E+09
Rh102	5.7E-04	1.6E+09
Rh103m	5.4E-57	3.3E+09
Rh106	2.2E-01	7.9E+07
Rn218	2.1E-112	1.8E+07
Rn219	3.4E-01	1.9E+07
Rn220	9.2E+00	2.0E+07
Rn222	1.0E-01	2.3E+07

Table D-3. (continued).

Constituent[a]	Predicted Activity Concentration in Leachate[b] (pCi/L)	Suggested Maximum Activity Concentration[c] (pCi/L)
Ru103	3.6E-28	2.3E+08
Ru106	2.2E-01	3.2E+09
Sb124	4.1E-39	5.7E+07
Sb125	1.9E+02	2.4E+08
Sb126	4.1E-01	4.2E+07
Sb126m	2.9E+00	5.9E+07
Sc46	9.2E-20	6.0E+07
Se79	4.1E+01	2.4E+09
Sm146	1.8E-09	5.1E+07
Sm147	1.7E-05	5.7E+07
Sm148	4.2E-12	6.4E+07
Sm149[e]	2.1E-11	—
Sm151	1.4E+03	6.5E+09
Sn117m	0.0E+00	—
Sn119m	1.1E-06	6.5E+09
Sn121m	2.1E-01	1.5E+09
Sn123	6.5E-16	4.2E+10
Sn125	0.0E+00	—
Sn126	1.1E+00	2.4E+08
Sr89	5.0E-42	3.6E+08
Sr90	1.9E+06	2.2E+08
Tb160	1.3E-33	2.3E+08
Tb161	0.0E+00	—
Tc98	6.8E-04	9.5E+07
Tc99	2.2E+04	8.4E+07
Te123	3.6E-14	1.5E+09
Te123m	2.4E-22	7.5E+09
Te125m	1.8E+01	5.2E+08
Te127	7.5E-19	8.0E+08
Te127m	7.6E-19	5.6E+08
Te129	5.4E-70	1.4E+09
Te129m	8.6E-70	2.1E+08
Th226	2.2E-116	4.1E+08
Th227	1.8E-04	2.0E+07
Th228	3.3E-01	2.1E+07
Th229	5.1E-07	2.4E+07
Th230	1.7E+00	2.5E+07

Table D-3. (continued).

Constituent[a]	Predicted Activity Concentration in Leachate[b] (pCi/L)	Suggested Maximum Activity Concentration[c] (pCi/L)
Th231	1.6E+00	2.7E+07
Th232	1.6E+00	7.2E+08
Th234	1.7E-02	3.2E+07
Tl207	1.8E-04	1.9E+09
Tl208	2.0E-03	2.6E+08
Tl209	1.1E-08	3.2E+07
Tm170	2.7E-25	3.2E+07
Tm171	6.6E-12	3.8E+08
U230	0.0E+00	—
U232	8.8E-02	4.9E+09
U233	4.2E-03	2.4E+07
U234	9.9E+02	2.7E+07
U235	1.8E+01	2.7E+07
U236	3.3E+01	2.8E+07
U237	0.0E+00	—
U238	3.2E+02	2.8E+07
U240	4.2E-09	3.0E+07
Xe127	2.6E-68	8.0E+08
Xe129m	0.0E+00	—
Xe131m	4.5E-108	4.1E+08
Xe133	0.0E+00	—
Y90	1.3E+05	7.9E+08
Y91	2.4E-36	1.3E+08
Zn65	1.7E-07	2.1E+08
Zr93	1.4E+00	2.2E+08
Zr95	4.9E-25	6.6E+09

Notes:

Constituent reported in the "INEEL CERCLA Disposal Facility Design Inventory" (EDF-ER-264).
Predicted average leachate activity concentration during the 15 year operational period.
The suggested maximum activity concentration selected for the ICDF liner system is based on a total absorbed dose of 1,000,000 rads for the individual constituent and a 4 cm leachate depth.
The constituents are gaseous elements so not part of the leachate.
No energy emitted since stable isotope.

Table D-4. Suggested maximum leachate concentrations for radionuclide constituents for liner compatibility in the ICDF Evaporation Pond.

Constituent[a]	Predicted Activity Concentration in Leachate[b] (pCi/L)	Suggested Maximum Activity Concentration[c] (pCi/L)
Ac225	1.1E-07	2.4E+06
Ac227	4.5E-05	1.8E+08
Ac228	3.4E-10	1.0E+07
Ag106	0.0E+00	2.3E+07
Ag108	4.1E-08	—
Ag108m	8.9E+00	8.7E+06
Ag109m	5.5E-11	1.6E+08
Ag110	5.7E-10	1.2E+07
Ag110m	6.2E-08	5.1E+06
Ag111	0.0E+00	—
Am241	7.0E+01	2.6E+06
Am242	1.3E-04	7.4E+07
Am242m	1.3E-04	2.2E+08
Am243	9.8E-04	2.7E+06
Am245	0.0E+00	—
Am246	4.1E-25	1.1E+07
At217	8.5E-04	2.0E+06
Ba136m	0.0E+00	—
Ba137m	4.6E+05	2.1E+07
Ba140	0.0E+00	—
Be 10	4.6E-06	7.0E+07
Bi210	1.1E-05	3.7E+07
Bi211	1.8E-04	2.2E+06
Bi212	5.5E-03	5.0E+06
Bi213	0.0E+00	—
Bi214	5.6E-05	6.6E+06
Bk249	5.4E-22	4.3E+08
Bk250	1.9E-26	1.2E+07
C14	9.1E-03	2.9E+08
Cd109	8.1E-10	7.2E+08
Cd113m	2.7E+02	7.7E+07
Cd115m	7.0E-52	2.3E+07
Ce141	3.6E-71	5.8E+07
Ce142	0.0E+00	—
Ce144	3.6E-03	1.3E+08
Cf249	8.1E-16	2.3E+06

Table D-4. (continued).

Constituent[a]	Predicted Activity Concentration in Leachate[b] (pCi/L)	Suggested Maximum Activity Concentration[c] (pCi/L)
Cf250	4.1E-16	2.4E+06
Cf251	1.9E-18	2.4E+06
Cf252	4.4E-20	1.4E+09
Cm241	3.2E-81	8.3E+07
Cm242	1.3E-17	2.3E+06
Cm243	8.9E-07	2.3E+06
Cm244	4.5E-04	2.4E+06
Cm245	2.0E-08	2.6E+06
Cm246	4.5E-10	2.6E+06
Cm247	1.6E-16	2.7E+06
Cm248	4.9E-17	3.1E+06
Cm250	1.4E-25	1.1E+07
Co57	3.7E-01	9.9E+07
Co58	5.8E-15	1.5E+07
Co60	1.9E+04	5.5E+06
Cr51	7.7E-53	3.9E+08
Cs132	0.0E+00	—
Cs134	2.2E+01	8.3E+06
Cs135	7.2E-02	2.5E+08
Cs136	0.0E+00	—
Cs137	4.9E+04	8.3E+07
Er169	0.0E+00	—
Eu150	5.1E-08	4.9E+07
Eu152	2.8E+03	1.1E+07
Eu154	2.4E+03	9.3E+06
Eu155	5.2E+02	1.2E+08
Eu156	0.0E+00	—
Fe59	2.0E-34	1.1E+07
Fr221	1.0E-07	2.2E+06
Fr223	5.6E-07	3.3E+07
Gd152	1.1E-13	6.6E+06
Gd153	8.4E-11	9.3E+07
H3	8.3E+05	2.5E+09
Hf181	1.7E-36	1.9E+07
Ho166m	1.1E-05	8.2E+06
I129	2.2E+04	1.8E+08
I131	0.0E+00	-

Table D-4. (continued).

Constituent[a]	Predicted Activity Concentration in Leachate[b] (pCi/L)	Suggested Maximum Activity Concentration[c] (pCi/L)
In114	4.8E-54	1.8E+07
In114m	5.1E-54	5.9E+07
In115	1.5E-11	9.3E+07
In115m	0.0E+00	—
K40	1.3E+02	2.3E+07
Kr81[d]	8.8E-05	—
Kr85[d]	1.9E+07	—
La138	0.0E+00	—
La140	2.2E-105	5.0E+06
M54	3.9E-07	1.7E+07
Nb92	6.3E-18	9.4E+06
Nb93m	1.3E-01	4.7E+08
Nb94	8.8E-05	8.3E+06
Nb95	4.8E-32	1.8E+07
Nb95m	1.8E-34	5.8E+07
Nd144	1.4E-09	7.5E+06
Nd147	0.0E+00	—
Np235	8.4E-09	1.4E+09
Np236	8.6E-06	4.2E+07
Np237	8.0E+01	2.9E+06
Np238	2.7E-05	1.8E+07
Np239	4.1E-02	3.4E+07
Np240	3.5E-12	8.9E+06
Np240m	3.1E-09	1.5E+07
Pa231	1.3E-04	2.6E+06
Pa233	7.9E-02	3.5E+07
Pa234	5.0E-06	5.8E+06
Pa234m	3.1E-03	1.7E+07
Pb209	4.8E-07	7.2E+07
Pb210	1.1E-05	3.7E+08
Pb211	1.8E-04	2.8E+07
Pb212	5.5E-03	4.4E+07
Pb214	5.6E-05	2.6E+07
Pd107	1.1E-01	4.3E+08
Pm146	2.4E-02	1.7E+07
Pm147	1.6E+03	2.3E+08
Pm148	1.7E-58	1.1E+07

Table D-4. (continued).

Constituent[a]	Predicted Activity Concentration in Leachate[b] (pCi/L)	Suggested Maximum Activity Concentration[c] (pCi/L)
Pm148m	3.4E-57	6.6E+06
Po210	6.8E-06	2.7E+06
Po211	4.6E-09	1.9E+06
Po212	2.2E-03	1.6E+06
Po213	2.9E-07	1.7E+06
Po214	3.7E-05	1.8E+06
Po215	1.2E-04	1.9E+06
Po216	3.7E-03	2.1E+06
Po218	3.7E-05	2.4E+06
Pr143	0.0E+00	—
Pr144	7.4E-03	1.1E+07
Pr144m	1.1E-04	1.2E+09
Pu236	3.9E-05	2.5E+06
Pu237	8.6E-58	2.3E+08
Pu238	1.7E+03	2.6E+06
Pu239	4.8E+01	2.8E+06
Pu240	1.1E+01	2.8E+06
Pu241	4.6E+02	2.7E+09
Pu242	1.7E-03	2.9E+06
Pu243	4.6E-15	7.3E+07
Pu244	1.8E-10	3.1E+06
Pu246	9.9E-25	9.2E+07
Ra222	1.2E-115	2.2E+06
Ra223	2.0E-04	2.4E+06
Ra224	5.5E-03	2.5E+06
Ra225	5.1E-07	1.2E+08
Ra226	4.7E+00	3.0E+06
Ra228	1.5E-09	1.2E+09
Rb86	0.0E+00	—
Rb87	2.0E-04	1.8E+08
Rh102	5.7E-04	1.8E+08
Rh103m	5.4E-57	3.7E+08
Rh106	2.2E-01	8.8E+06
Rn218	2.1E-112	2.0E+06
Rn219	3.4E-01	2.1E+06
Rn220	9.2E+00	2.3E+06
Rn222	1.0E-01	2.6E+06

Table D-4. (continued).

Constituent[a]	Predicted Activity Concentration in Leachate[b] (pCi/L)	Suggested Maximum Activity Concentration[c] (pCi/L)
Ru103	3.6E-28	2.6E+07
Ru106	2.2E-01	3.6E+08
Sb124	4.1E-39	6.3E+06
Sb125	1.9E+02	2.7E+07
Sb126	4.1E-01	4.7E+06
Sb126m	2.9E+00	6.6E+06
Sc46	9.2E-20	6.7E+06
Se79	4.1E+01	2.7E+08
Sm146	1.8E-09	5.6E+06
Sm147	1.7E-05	6.3E+06
Sm148	4.2E-12	7.1E+06
Sm149[e]	2.1E-11	—
Sm151	1.4E+03	7.2E+08
Sn117m	0.0E+00	—
Sn119m	1.1E-06	7.2E+08
Sn121m	2.1E-01	1.6E+08
Sn123	6.5E-16	4.7E+09
Sn125	0.0E+00	—
Sn126	1.1E+00	2.7E+07
Sr89	5.0E-42	4.0E+07
Sr90	1.9E+06	2.4E+07
Tb160	1.3E-33	2.6E+07
Tb161	0.0E+00	—
Tc98	6.8E-04	1.1E+07
Tc99	2.2E+04	9.4E+06
Te123	3.6E-14	1.7E+08
Te123m	2.4E-22	8.3E+08
Te125m	1.8E+01	5.8E+07
Te127	7.5E-19	8.9E+07
Te127m	7.6E-19	6.2E+07
Te129	5.4E-70	1.6E+08
Te129m	8.6E-70	2.4E+07
Th226	2.2E-116	4.6E+07
Th227	1.8E-04	2.2E+06
Th228	3.3E-01	2.3E+06
Th229	5.1E-07	2.6E+06
Th230	1.7E+00	2.8E+06

Table D-4. (continued).

Constituent[a]	Predicted Activity Concentration in Leachate[b] (pCi/L)	Suggested Maximum Activity Concentration[c] (pCi/L)
Th231	1.6E+00	3.0E+06
Th232	1.6E+00	8.0E+07
Th234	1.7E-02	3.5E+06
Tl207	1.8E-04	2.1E+08
Tl208	2.0E-03	2.9E+07
Tl209	1.1E-08	3.6E+06
Tm170	2.7E-25	3.6E+06
Tm171	6.6E-12	4.2E+07
U230	0.0E+00	—
U232	8.8E-02	5.4E+08
U233	4.2E-03	2.7E+06
U234	9.9E+02	2.9E+06
U235	1.8E+01	3.0E+06
U236	3.3E+01	3.1E+06
U237	0.0E+00	—
U238	3.2E+02	3.2E+06
U240	4.2E-09	3.4E+06
Xe127	2.6E-68	8.9E+07
Xe129m	0.0E+00	—
Xe131m	4.5E-108	4.6E+07
Xe133	0.0E+00	—
Y90	1.3E+05	8.8E+07
Y91	2.4E-36	1.5E+07
Zn65	1.7E-07	2.3E+07
Zr93	1.4E+00	2.4E+07
Zr95	4.9E-25	7.3E+08

Notes:
a. Constituent reported in the "INEEL CERCLA Disposal Facility Design Inventory (EDF-ER-264).
b. Predicted average leachate activity concentration during the 15 year operational period.
c. The suggested maximum activity concentration selected for the ICDF liner system is based on a total absorbed dose of 1,000,000 rads for the individual constituent and a 36 cm liquid waste depth.
d. The constituents are gaseous elements so not part of the leachate.
e. Stable isotope

Appendix E

Suggested Maximum Leachate Concentrations for Individual Constituents in Evaporation Pond Liquid

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Table E-1. Suggested maximum leachate concentrations for organic constituents for liner compatibility in evaporation pond.

Constituent[a]	Predicted Concentration in Leachate[b] (mg/L)	Compatible Concentration for HDPE (mg/L)	Compatible Concentration for GCL (mg/L)	Compatible Concentration for Clay (mg/L)	Suggested Maximum Leachate Concentration[c] (mg/L)
1,1,1-Trichloroethane	0.0609	-[d]	-[d]	20[e]	20
1,1,2,2-Tetrachloroethane	0.0002	—	—	—	—
1,1,2-Trichloroethane	0.0013	—	—	—	—
1,1-Dichloroethane	0.0105	—	—	—	—
1,1-Dichloroethene	0.0004	—	—	—	—
1,2,4-Trichlorobenzene	0.0113	—	—	—	—
1,2-Dichlorobenzene	0.0734	—	—	—	—
1,2-Dichloroethane	0.0001	—	—	—	—
1,2-Dichloroethene (total)	0.0003	—	—	—	—
1,3-Dichlorobenzene	0.0071	2,000[f]	—	—	2,000
1,4-Dichlorobenzene	5.1303	—	—	—	—
1,4-Dioxane	0.0000	—	—	—	—
2,4,5-Trichlorophenol	0.0441	—	—	—	—
2,4,6-Trichlorophenol	0.0427	—	—	—	—
2,4-Dichlorophenol	0.0371	—	—	—	—
2,4-Dimethylphenol	0.3041	—	—	—	—
2,4-Dinitrophenol	0.1705	—	—	—	—
2,4-Dinitrotoluene	0.0488	—	—	—	—
2,6-Dinitrotoluene	0.2903	—	—	—	—
2-Butanone	0.0063	200,000[f]	—	—	200,000
2-Chloronaphthalene	0.0108	2,000[g]	—	—	2,000
2-Chlorophenol	0.1867	2,000[g]	—	—	2,000
2-Hexanone	0.0001	—	—	—	—
2-Methylnaphthalene	1.7772	—	—	—	—
2-Methylphenol	0.2014	—	—	—	—
2-Nitroaniline	0.1728	—	—	—	—
2-Nitrophenol	0.0098	—	—	—	—
3,3'-Dichlorobenzidine	0.1896	—	—	—	—
3-Methyl Buta-l	0.0022	—	—	—	—
3-Nitroaniline	0.0165	—	—	—	—
4,6-Dinitro-2-methylphenol	0.0010	—	—	—	—
4-Bromophenyl-phenylether	0.0615	2,000[g]	—	—	2,000
4-Chloro-3-methylphenol	0.0810	—	—	—	—
4-Chloroaniline	0.0052	—	—	—	—
4-Chlorophenyl-phenylether	0.0288	—	—	—	—
4-Methyl-2-Pentanone	0.1131	—	—	—	—

Table E-1. (continued).

Constituent[a]	Predicted Concentration in Leachate[b] (mg/L)	Compatible Concentration for HDPE (mg/L)	Compatible Concentration for GCL (mg/L)	Compatible Concentration for Clay (mg/L)	Suggested Maximum Leachate Concentration[c] (mg/L)
4-Methylphenol	0.3766	—	—	—	—
4-Nitroaniline	0.1728	—	—	—	—
4-Nitrophenol	0.0029	—	—	—	—
Acenaphthene	0.0399	2,000[g]	—	—	2,000
Acenaphthylene	0.3366	2,000[g]	—	—	2,000
Acetone	6.2674	200,000[g]	—	—	100,000
Acetonitrile	0.0002	-	—	—	-
Acrolein	0.0001	200,000[g]	—	—	200,000
Acrylonitrile	0.0000	200,000[g]	—	—	200,000
Anthracene	0.0083	2,000[g]	—	—	2,000
Aramite	0.0000	—	—	—	—
Aroclor-1016	0.0000	—	—	—	—
Aroclor-1254	0.0002	—	—	—	—
Aroclor-1260	0.0087	—	—	—	—
Aroclor-1268	0.2891	—	—	—	—
Benzene	1.3491	2,000[g]	—	—	1,000
Benzidine	0.0000	200,000[g]	—	—	200,000
Benzo(a)anthracene	0.0001	2,000[g]	—	—	2,000
Benzo(a)pyrene	0.0000	2,000[g]	—	—	2,000
Benzo(b)fluoranthene	0.0000	2,000[g]	—	—	2,000
Benzo(g,h,i)perylene	0.0000	—	—	—	—
Benzo(k)fluoranthene	0.3024	—	—	—	—
Benzoic acid	0.1162	—	—	—	—
bis(2-Chloroethoxy)methane	0.0455	2,000[g]	—	—	2,000
bis(2-Chloroethyl)ether	0.0535	2,000[g]	—	—	2,000
bis(2-Chloroisopropyl)ether	0.0000	2,000[g]	—	—	2,000
bis(2-Ethylhexyl)phthalate	0.5714	2,000[g]	—	—	2,000
Butane,1,1,3,4-Tetrachloro-	0.0001	—	—	—	—
Butylbenzylphthalate	0.0080	200,000[g]	—	—	200,000
Carbazole	0.1856	—	—	—	—
Carbon Disulfide	0.0734	—	—	—	—
Chlorobenzene	0.0679	2,000[g]	—	—	2,000
Chloroethane	0.0000	—	—	—	—
Chloromethane	0.0000	2,000[g]	—	—	2,000
Chrysene	4.4199	2,000[g]	—	—	2,000
Decane, 3,4-Dimethyl	0.0004	—	—	—	—
Diacetone alcohol	0.0005	—	—	—	—

Table E-1. (continued).

Constituent[a]	Predicted Concentration in Leachate[b] (mg/L)	Compatible Concentration for HDPE (mg/L)	Compatible Concentration for GCL (mg/L)	Compatible Concentration for Clay (mg/L)	Suggested Maximum Leachate Concentration[c] (mg/L)
Dibenz(a,h)anthracene	0.0006	2,000[g]	—	—	2,000
Dibenzofuran	0.4156	—	—	—	—
Diethylphthalate	0.1897	100,000[g]	—	—	100,000
Dimethyl Disulfide	0.0127	—	—	—	—
Dimethylphthalate	0.0001	100,000[g]	—	—	100,000
Di-n-butylphthalate	0.0000	100,000[f]	—	—	100,000
Di-n-octylphthalate	0.4370	—	—	—	—
Eicosane	0.0472	—	—	—	—
Ethyl cyanide	0.0000	—	—	—	—
Ethylbenzene	0.0705	2,000[g]	—	—	2,000
Famphur	0.0000	—	—	—	—
Fluoranthene	0.0221	2,000[g]	—	—	2,000
Fluorene	3.0594	2,000[g]	—	—	2,000
Heptadecane, 2,6,10,15-Tetra	0.0000	—	—	—	—
Hexachlorobenzene	0.0001	2,000[g]	—	—	2,000
Hexachlorobutadiene	0.0000	2,000[g]	—	—	2,000
Hexachlorocyclopentadiene	0.0025	2,000[g]	—	—	2,000
Hexachloroethane	0.0000	2,000[g]	—	—	2,000
Indeno(1,2,3-cd)pyrene	0.1585	2,000[g]	—	—	2,000
Isobutyl alcohol	0.0001	500,000[g]	—	—	500,000
Isophorone	0.1829	2,000[g]	—	—	2,000
Isopropyl Alcohol/2-propanol	0.0000	500,000[g]	—	—	500,000
Kepone	0.2511	—	—	—	—
Mesityl oxide	1.2939	—	—	—	—
Methyl Acetate	0.0057	—	—	—	—
Methylene Chloride	0.0165	2,000[g]	—	20[e]	20
Naphthalene	1.9193	2,000[g]	—	—	2,000
Nitrobenzene	0.0948	100,000[g]	—	—	100,000
N-Nitroso-di-n-propylamine	0.0035	100,000[g]	—	—	100,000
N-Nitrosodiphenylamine	0.1896	100,000[g]	—	—	100,000
Octane,2,3,7-Trimethyl	0.0027	—	—	—	—
o-Toluenesulfonamide	0.0033	—	—	—	—
Pentachlorophenol	0.0046	100,000[g]	—	—	100,000
Phenanthrene	8.8500	2,000[g]	—	—	2,000
Phenol	0.1370	100,000[g]	—	—	100,000

Table E-1. (continued).

Constituent[a]	Predicted Concentration in Leachate[b] (mg/L)	Compatible Concentration for HDPE (mg/L)	Compatible Concentration for GCL (mg/L)	Compatible Concentration for Clay (mg/L)	Suggested Maximum Leachate Concentration[c] (mg/L)
Phenol,2,6-Bis(1,1-Dimethyl)	0.0674	—	—	—	—
p-Toluenesulfonamide	0.0000	—	—	—	—
Pyrene	3.2501	2,000[g]	—	—	2,000
RDX	0.0000	5,000[g]	—	—	5,000
Styrene	0.0000	2,000[g]	—	—	2,000
Tetrachloroethene	0.0235	5,000[g]	—	20[h]	20
Toluene	16.3666	—	—	—	—
Tributylphosphate	1.2292	2,000[g]	—	1,100[e]	1,100
Trichloroethene	1.1526	—	—	—	—
Trinitrotoluene	0.0000	—	—	—	—
Undecane,4,6-Dimethyl-	0.0003	5,000[g]	—	—	5,000
Xylene (ortho)	0.0071	—	—	—	—
Xylene (total)	6.2805	—	—	—	—

Notes

a. Constituent reported in the "INEEL CERCLA Disposal Facility Design Inventory (EDF-ER-264)
b. Predicted leachate concentration in the first year of the ICDF landfill operation (EDF-ER-274).
c. The suggested maximum concentration selected for the ICDF liner system is based on the lowest of the concentrations listed for HDPE, GCL, and clay materials and are applicable for the leachate in the landfill and the waste liquids in the evaporation ponds.
d. "–" indicates that a specific test value was not available, compatibility issues are not anticipated.
e. The TCE solubility limit in water is 1,100 mg/l. A minimum of 2 pore volumes of permeant liquid was passed through the clay sample or
f. From "Evaluation of Liner/Leachate Chemical Compatibility for the Environmental Restoration Disposal Facility" (USACE, 1995, *Evaluation*
g. From manufacturer specifications.
h. 20 mg/l is the typical concentration of leachate found in muncipal landfills. No change in clay permeability was observed at this concentration
i. Maximum allowable concentration reduced by 50 percent since liner may reflect some attack at a pure concentration based on manufactures maximum concentration data (see Appendix B).

Table E-2. Suggested maximum leachate concentrations for inorganic constituent for liner compatibility.

Constituent[a]	Predicted Concentration in Leachate[b] (mg/L)	Compatible Concentration For HDPE (mg/l)	Compatible Concentration For GCL (mg/l)	Compatible Concentration For Clay (mg/l)	Suggested Maximum Leachate Concentration[c] (mg/l)
Aluminum	28.3029				
Antimony	0.1165				
Arsenic	1.8470	500,000[d]	—	-[e]	500,000
Barium	3.5848				
Beryllium	0.0011				
Boron	36.4728	500,000[d]	—	-[e]	500,000
Cadmium	0.5917	500,000[d]	—	-[e]	500,000
Calcium	4035.0217	500,000[d]	—	-[e]	500,000
Chloride	31.1061				
Chromium	1.3691				
Cobalt	0.5999	500,000[d]	—	-[e]	500,000
Copper	1.4906	500,000[d]	—	-[e]	500,000
Cyanide	4.0932	500,000[d]	—	-[e]	500,000
Dysprosium	0.2472				
Fluoride	64.4341				
Iron	46.5528				
Lead	0.5753				
Magnesium	883.9838	500,000[d]	—	-[e]	500,000
Manganese	4.1300				
Mercury	0.0944				
Molybdenum	1.0117	500,000[d]	—	-[e]	500,000
Nickel	0.1964				
Nitrate	65.4429				
Nitrate/Nitrite-N	3.6979				
Nitrite	0.1414				
Phosphorus	19.2492	500,000[d]	—	-[e]	500,000
Potassium	74.8819	500,000[d]	—	-[e]	500,000
Selenium	0.2084	500,000[d]	—	-[e]	500,000
Silver	0.1092				
Sodium	2.7716				
Strontium	1.5094	500,000[d]	—	-[e]	500,000
Sulfate	342.1180				
Sulfide	12641.8391				

Table E-2. (continued).

Constituent[a]	Predicted Concentration in Leachate[b] (mg/L)	Compatible Concentration For HDPE (mg/l)	Compatible Concentration For GCL (mg/l)	Compatible Concentration For Clay (mg/l)	Suggested Maximum Leachate Concentration[c] (mg/l)
Terbium	2.3867				
Thallium	0.0037				
Vanadium	3.5063	500,000[d]	—	-[e]	500,000
Ytterbium	0.8124				
Zinc	12.9486	500,000[4]	—	-[e]	500,000
Zirconium	0.1151				
Total Inorganic Concentration	18317.5650				

Constituent reported in the "INEEL CERCLA Disposal Facility Design Inventory (EDF-ER-264).
Predicted leachate concentration in the first year of the ICDF landfill operation (EDF-ER-274).
The suggested maximum concentration selected for the ICDF liner system is based on the lowest of the concentrations listed for HDPE, GCL, and clay materials and are applicable for the leachate in the landfill and the waste liquids in the evaporation ponds.
From manufacturer specifications
From manufacturer specifications

Table E-3. Suggested maximum leachate concentrations for radionuclide constituents for liner compatibility in the ICDF Evaporation Pond.

Constituent[a]	Predicted Activity Concentration in Leachate[b] (pCi/L)	Suggested Maximum Activity Concentration[c] (pCi/L)
Ac225	1.1E-07	2.4E+06
Ac227	4.5E-05	1.8E+08
Ac228	3.4E-10	1.0E+07
Ag106	0.0E+00	2.3E+07
Ag108	4.1E-08	—
Ag108m	8.9E+00	8.7E+06
Ag109m	5.5E-11	1.6E+08
Ag110	5.7E-10	1.2E+07
Ag110m	6.2E-08	5.1E+06
Ag111	0.0E+00	—
Am241	7.0E+01	2.6E+06
Am242	1.3E-04	7.4E+07
Am242m	1.3E-04	2.2E+08
Am243	9.8E-04	2.7E+06
Am245	0.0E+00	—
Am246	4.1E-25	1.1E+07
At217	8.5E-04	2.0E+06
Ba136m	0.0E+00	—
Ba137m	4.6E+05	2.1E+07
Ba140	0.0E+00	—
Be 10	4.6E-06	7.0E+07
Bi210	1.1E-05	3.7E+07
Bi211	1.8E-04	2.2E+06
Bi212	5.5E-03	5.0E+06
Bi213	0.0E+00	—
Bi214	5.6E-05	6.6E+06
Bk249	5.4E-22	4.3E+08
Bk250	1.9E-26	1.2E+07
C14	9.1E-03	2.9E+08
Cd109	8.1E-10	7.2E+08
Cd113m	2.7E+02	7.7E+07
Cd115m	7.0E-52	2.3E+07
Ce141	3.6E-71	5.8E+07
Ce142	0.0E+00	—
Ce144	3.6E-03	1.3E+08
Cf249	8.1E-16	2.3E+06
Cf250	4.1E-16	2.4E+06
Cf251	1.9E-18	2.4E+06
Cf252	4.4E-20	1.4E+09

Table E-3. (continued).

Constituent[a]	Predicted Activity Concentration in Leachate[b] (pCi/L)	Suggested Maximum Activity Concentration[c] (pCi/L)
Cm241	3.2E-81	8.3E+07
Cm242	1.3E-17	2.3E+06
Cm243	8.9E-07	2.3E+06
Cm244	4.5E-04	2.4E+06
Cm245	2.0E-08	2.6E+06
Cm246	4.5E-10	2.6E+06
Cm247	1.6E-16	2.7E+06
Cm248	4.9E-17	3.1E+06
Cm250	1.4E-25	1.1E+07
Co57	3.7E-01	9.9E+07
Co58	5.8E-15	1.5E+07
Co60	1.9E+04	5.5E+06
Cr51	7.7E-53	3.9E+08
Cs132	0.0E+00	—
Cs134	2.2E+01	8.3E+06
Cs135	7.2E-02	2.5E+08
Cs136	0.0E+00	—
Cs137	4.9E+04	8.3E+07
Er169	0.0E+00	—
Eu150	5.1E-08	4.9E+07
Eu152	2.8E+03	1.1E+07
Eu154	2.4E+03	9.3E+06
Eu155	5.2E+02	1.2E+08
Eu156	0.0E+00	—
Fe59	2.0E-34	1.1E+07
Fr221	1.0E-07	2.2E+06
Fr223	5.6E-07	3.3E+07
Gd152	1.1E-13	6.6E+06
Gd153	8.4E-11	9.3E+07
H3	8.3E+05	2.5E+09
Hf181	1.7E-36	1.9E+07
Ho166m	1.1E-05	8.2E+06
I129	2.2E+04	1.8E+08
I131	0.0E+00	—
In114	4.8E-54	1.8E+07
In114m	5.1E-54	5.9E+07
In115	1.5E-11	9.3E+07
In115m	0.0E+00	—
K40	1.3E+02	2.3E+07
Kr81[d]	8.8E-05	—
Kr85[d]	1.9E+07	-

Table E-3. (continued).

Constituent[a]	Predicted Activity Concentration in Leachate[b] (pCi/L)	Suggested Maximum Activity Concentration[c] (pCi/L)
La138	0.0E+00	—
La140	2.2E-105	5.0E+06
Mn-54	3.9E-07	1.7E+07
Nb92	6.3E-18	9.4E+06
Nb93m	1.3E-01	4.7E+08
Nb94	8.8E-05	8.3E+06
Nb95	4.8E-32	1.8E+07
Nb95m	1.8E-34	5.8E+07
Nd144	1.4E-09	7.5E+06
Nd147	0.0E+00	—
Np235	8.4E-09	1.4E+09
Np236	8.6E-06	4.2E+07
Np237	8.0E+01	2.9E+06
Np238	2.7E-05	1.8E+07
Np239	4.1E-02	3.4E+07
Np240	3.5E-12	8.9E+06
Np240m	3.1E-09	1.5E+07
Pa231	1.3E-04	2.6E+06
Pa233	7.9E-02	3.5E+07
Pa234	5.0E-06	5.8E+06
Pa234m	3.1E-03	1.7E+07
Pb209	4.8E-07	7.2E+07
Pb210	1.1E-05	3.7E+08
Pb211	1.8E-04	2.8E+07
Pb212	5.5E-03	4.4E+07
Pb214	5.6E-05	2.6E+07
Pd107	1.1E-01	4.3E+08
Pm146	2.4E-02	1.7E+07
Pm147	1.6E+03	2.3E+08
Pm148	1.7E-58	1.1E+07
Pm148m	3.4E-57	6.6E+06
Po210	6.8E-06	2.7E+06
Po211	4.6E-09	1.9E+06
Po212	2.2E-03	1.6E+06
Po213	2.9E-07	1.7E+06
Po214	3.7E-05	1.8E+06
Po215	1.2E-04	1.9E+06
Po216	3.7E-03	2.1E+06
Po218	3.7E-05	2.4E+06
Pr143	0.0E+00	—
Pr144	7.4E-03	1.1E+07

Table E-3. (continued).

Constituent[a]	Predicted Activity Concentration in Leachate[b] (pCi/L)	Suggested Maximum Activity Concentration[c] (pCi/L)
Pr144m	1.1E-04	1.2E+09
Pu236	3.9E-05	2.5E+06
Pu237	8.6E-58	2.3E+08
Pu238	1.7E+03	2.6E+06
Pu239	4.8E+01	2.8E+06
Pu240	1.1E+01	2.8E+06
Pu241	4.6E+02	2.7E+09
Pu242	1.7E-03	2.9E+06
Pu243	4.6E-15	7.3E+07
Pu244	1.8E-10	3.1E+06
Pu246	9.9E-25	9.2E+07
Ra222	1.2E-115	2.2E+06
Ra223	2.0E-04	2.4E+06
Ra224	5.5E-03	2.5E+06
Ra225	5.1E-07	1.2E+08
Ra226	4.7E+00	3.0E+06
Ra228	1.5E-09	1.2E+09
Rb86	0.0E+00	—
Rb87	2.0E-04	1.8E+08
Rh102	5.7E-04	1.8E+08
Rh103m	5.4E-57	3.7E+08
Rh106	2.2E-01	8.8E+06
Rn218	2.1E-112	2.0E+06
Rn219	3.4E-01	2.1E+06
Rn220	9.2E+00	2.3E+06
Rn222	1.0E-01	2.6E+06
Ru103	3.6E-28	2.6E+07
Ru106	2.2E-01	3.6E+08
Sb124	4.1E-39	6.3E+06
Sb125	1.9E+02	2.7E+07
Sb126	4.1E-01	4.7E+06
Sb126m	2.9E+00	6.6E+06
Sc46	9.2E-20	6.7E+06
Se79	4.1E+01	2.7E+08
Sm146	1.8E-09	5.6E+06
Sm147	1.7E-05	6.3E+06
Sm148	4.2E-12	7.1E+06
Sm149[e]	2.1E-11	—
Sm151	1.4E+03	7.2E+08
Sn117m	0.0E+00	—
Sn119m	1.1E-06	7.2E+08

Table E-3. (continued).

Constituent[a]	Predicted Activity Concentration in Leachate[b] (pCi/L)	Suggested Maximum Activity Concentration[c] (pCi/L)
Sn121m	2.1E-01	1.6E+08
Sn123	6.5E-16	4.7E+09
Sn125	0.0E+00	—
Sn126	1.1E+00	2.7E+07
Sr89	5.0E-42	4.0E+07
Sr90	1.9E+06	2.4E+07
Tb160	1.3E-33	2.6E+07
Tb161	0.0E+00	—
Tc 98	6.8E-04	1.1E+07
Tc 99	2.2E+04	9.4E+06
Te123	3.6E-14	1.7E+08
Te123m	2.4E-22	8.3E+08
Te125m	1.8E+01	5.8E+07
Te127	7.5E-19	8.9E+07
Te127m	7.6E-19	6.2E+07
Te129	5.4E-70	1.6E+08
Te129m	8.6E-70	2.4E+07
Th226	2.2E-116	4.6E+07
Th227	1.8E-04	2.2E+06
Th228	3.3E-01	2.3E+06
Th229	5.1E-07	2.6E+06
Th230	1.7E+00	2.8E+06
Th231	1.6E+00	3.0E+06
Th232	1.6E+00	8.0E+07
Th234	1.7E-02	3.5E+06
Tl207	1.8E-04	2.1E+08
Tl208	2.0E-03	2.9E+07
Tl209	1.1E-08	3.6E+06
Tm170	2.7E-25	3.6E+06
Tm171	6.6E-12	4.2E+07
U230	0.0E+00	—
U232	8.8E-02	5.4E+08
U233	4.2E-03	2.7E+06
U234	9.9E+02	2.9E+06
U235	1.8E+01	3.0E+06
U236	3.3E+01	3.1E+06
U237	0.0E+00	—
U238	3.2E+02	3.2E+06
U240	4.2E-09	3.4E+06
Xe127	2.6E-68	8.9E+07
Xe129m	0.0E+00	—

Table E-3. (continued).

Constituent[a]	Predicted Activity Concentration in Leachate[b] (pCi/L)	Suggested Maximum Activity Concentration[c] (pCi/L)
Xe131m	4.5E-108	4.6E+07
Xe133	0.0E+00	—
Y90	1.3E+05	8.8E+07
Y91	2.4E-36	1.5E+07
Zn65	1.7E-07	2.3E+07
Zr93	1.4E+00	2.4E+07
Zr95	4.9E-25	7.3E+08

Notes:

a. Constituent reported in the "INEEL CERCLA Disposal Facility Design Inventory" (EDF-ER-264).

b. Predicted average leachate activity concentration during the 15 year operational period.

c. The suggested maximum activity concentration selected for the ICDF liner system is based on a total absorbed dose of 1,000,000 rads for the individual constituent and a 36 cm liquid waste depth.

d. The constituents are gaseous elements so not part of the leachate.

e. Stable isotope

Appendix F

Analysis of Leachate Impact on the Liner Systems for the ICDF Landfill and Evaporation Pond

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TECHNICAL MEMORANDUM CH2MHILL

Analysis of Ni-59, Ni-63, and Fe-55 Leachate on the Liner Systems for the ICDF Landfill and Evaporation Ponds

PREPARED FOR: ICDF Implementation Project

PREPARED BY: CH2M HILL

DATE: November 17, 2003

The purpose of this technical memorandum is to evaluate the impact that the leachate will have on the ICDF liner systems based on the addition Ni-59, Ni-63, and Fe-55 to the waste inventory at the INEEL CERCLA Disposal Facility (ICDF).

Requirements

For the given soil concentrations, the estimated concentrations of the identified radionuclides in the leachate during the fifteen-year operations period and the effect on the liner system will be evaluated.

Background

The INEEL plans to dispose of remediation wastes at the INEEL CERCLA Disposal Facility (ICDF). Recent evaluations identified three radionuclides which had not been included in the original design inventory. As such, these radionuclides were not assigned WAC guideline concentrations or mass limits. These radionuclides are Nickel-59 (Ni-59), Nickel-63 (Ni-63), and Iron-55 (Fe-55).

Methodology

This evaluation involves calculating estimated leachate concentrations for each radionuclide listed above according to the methodologies presented in EDF-ER-274.

Calculation of Leachate Concentrations

Leachate and mass reduction estimates for these constituents were evaluated by adding the constituents to the spreadsheet used in EDF-ER-274, determining contaminant distribution coefficients (Kds) consistent with EDF-ER-274 methodology and performing leachate concentration and mass reduction calculations. The radionuclides are assigned the same Kd values as were originally assigned to the non-isotopic, total metal elemental forms (100 ml/g for Ni and 220 ml/g for Fe). Leachate concentrations and mass exiting the waste soil are calculated for each radionuclide over the simulation period of 15 years and are adjusted for radiological decay.

Calculation of Radiation Dose

The radiation dose from the three radionuclides was determined utilizing the methods described in EDF-ER-278. The average leachate concentration for the radionuclides evaluated in this memo were added to a radiation dosage spreadsheets as shown in EDF-ER-278, Appendix B. These spreadsheets calculate the maximum dosage that each constituent would contribute to the landfill and evaporation pond liners.

Results and Discussion

Leachate Concentrations

Table 1 shows the results of the leachate concentration calculations.

TABLE 1
Input Parameters and Peak Leachate Concentration for Ni-59, Ni-63, and Fe-55 at Measured Soil Concentrations.

Constituent	New Soil Concentration (pCi/kg)[1]	Kd surrogate bin[2]	Half-Life (yrs)[3]	Peak Leachate Concentration (pCi/L)	Peak Leachate Concentration (mg/L)
Ni-59	9.50E+06	7	7.60E+04	9.49E+04	1.17E-03
Ni-63	6.00E+07	7	1.00E+02	6.00E+05	1.30E-05
Fe-55	2.00E+09	7	2.70E+00	9.09E+06	4.13E-06

[1]Soil Concentration provided via e-mail originating from Jim Curnutt on 8/27/03.

[2]As reported in EDF-ER-275.

[3] "Table of Nuclides (c) 2000-2002 Nuclear Data Evaluation Lab. Korea Atomic Energy Research Institute http://www2.bnl.gov/ton/index.html".

Radiation Doses

Table 2 shows the results of the radiation dose calculations, based on the previously described spreadsheet model.

TABLE 2

Constituent	Landfill Dose (Rads/hr)	Evaporation Pond Dose (Rads/hr)
Ni-59	3.80E-05	3.42E-04
Ni-63	5.78E-04	5.21E-03
Fe-55	7.98E-04	7.18E-03
Total	1.41E-03	1.27E-02

Based on these results, the landfill and evaporation pond liners will be exposed to a maximum total quantity of radiation over a 15-year period of 185 rads (1.41E-03 rads/hr over 15 years), and 1,669 rads (1.27E-02 rads/hr over 15 years), respectively.

Liner Compatibility

As described in EDF-278, individual constituents in the ICDF landfill design inventory were evaluated to determine maximum allowable ICDF landfill waste concentrations, that if placed in the landfill would generate leachate compatible with the liner system. Many of the individual design inventory constituents have not been included in the composition of leachate used for published compatibility studies. However, the constituents used in the published studies are in similar chemical groups as the constituents in the ICDF design inventory and therefore, would react similarly with the liner materials. Moreover, the use of general chemical categories rather than individual constituents provide a worst-case scenario due to possible synergistic effects of mixed compounds.

Table 3 provides the recommended maximum concentration of chemical categories that, if present in the landfill leachate, may be incompatible with the polymeric or earthen material comprising the ICDF landfill and evaporation pond liner systems. These limits are based on review of the published liner compatibility studies and manufacturers' recommendations. The maximum allowable concentration for HDPE geomembrane, GCL, and SBL were compared to determine the highest acceptable value. The lowest of all three values was selected as the suggested maximum concentration.

TABLE 3

Chemical Category	Compatible Concentration for HDPE	Compatible Concentration for GCL and Clay	Suggested ICDF Maximum Concentration or Value	Design Inventory Concentration Dose or Value
Organics	500,000[a] mg/L	500,000[b] mg/L	500,000 mg/L	70 mg/L
Acids and Bases	750,000[a] mg/L	500,000[b] mg/L	500,000 mg/L	0[d] mg/L
Inorganics	500,000[a] mg/L	500,000[b] mg/L	500,000 mg/L	17,100 mg/L
Dissolved Salts	No Limit	35,000 mg/L	35,000 mg/L	8,000 mg/L[c]
Strong Oxidizers	1,000 mg/L	No limit	1,000 mg/L	0 [d] mg/L
Radionuclides	1,000,000[b] rads	No limit	1,000,000 rads	12,000 rads (15 yr) 800,000 rads (1000 yr)
pH	0.5 - 13.0[a]	0.5 - 13.0	0.5 - 13.0	8.0

a. Based on the manufacturers' maximum concentration of the list of constituents tested by the manufacturers. The manufacturers' recommendations are provided in Appendix C of EDF-ER-278.

b. Based on reported literature values.

c. Based on the maximum sodium concentration determined in the Geochemical Evaluation.

d. Strong acids, bases, or oxidizing compounds were not reported in the design inventory.

Conclusions

Comparing the information in Table 3 and the aforementioned concentration and radiation dose calculations show the following:

1. The total dose applied to the landfill and evaporation pond liners will only slightly increase the total radiation dose over the life of the facility, and will not approach the recommended limit of 1,000,000 rads. Therefore, the addition of the radionuclides to the waste inventory will not negatively affect the integrity of the liner systems.
2. EDF-ER-278 should be amended to include the results of this memo.

References

EDF-ER-274, 2002, "Leachate Contaminant Reduction Time Study", Rev 1., Environmental Restoration Program, Idaho National Engineering and Environmental Laboratory, 2002.

EDF-ER-278, 2002, "Liner/Leachate Compatibility Study", Rev 1., Environmental Restoration Program, Idaho National Engineering and Environmental Laboratory, 2002.

DOE-ID, 2003, *Waste Acceptance Criteria for ICDF Landfill*, DOE/ID-10865, Rev.3, U.S. Department of Energy Idaho Operations Office, Idaho Falls, Idaho, July 2003.

TECHNICAL MEMORANDUM CH2MHILL

Analysis of Leachate Impact on the Liner Systems for the ICDF Landfill and Evaporation Ponds

PREPARED FOR: ICDF Implementation Project

PREPARED BY: CH2M HILL

DATE: March 24, 2004

The purpose of this technical memorandum is to evaluate the impact that the leachate will have on the ICDF liner systems based on addition of several constituents to the waste inventory at the INEEL CERCLA Disposal Facility (ICDF). The analysis also accounts for increasing the soil concentration of several constituents that were included in the original design inventory.

Requirements

Determine the impact on the liner system for the estimated leachate concentrations of the identified constituents during the fifteen-year operations period.

Background

The INEEL plans to dispose of remediation wastes at the ICDF. Recent evaluations identified constituents which had not been included in the original design inventory or were included in the original design inventory but are included in this analysis because it has been found that the soil concentration of each constituent is significantly greater than that of the original design inventory. As such, these constituents were not assigned WAC guideline concentrations or mass limits, or these limits have been revised due to the increased soil concentration. The list of constituents can be found in Table 2.

Methodology

This evaluation compares estimated leachate concentrations of each constituent to known concentration limits for the liner system in accordance with EDF-ER-278, "Liner/Leachate Compatibility Study".

Results and Discussion

Liner Compatibility

As described in EDF-278, "Liner/Leachate Compatibility Study", individual constituents in the ICDF landfill design inventory were evaluated to determine maximum allowable ICDF landfill waste concentrations, that if placed in the landfill would generate leachate compatible with the liner system. Many of the individual design inventory constituents have not been included in the composition of leachate used for published compatibility studies. However, the constituents used in the published studies are in similar chemical groups as the constituents in the ICDF design inventory and therefore, would react similarly

with the liner materials. Moreover, the use of general chemical categories rather than individual constituents provide a worst-case scenario due to possible synergistic effects of mixed compounds.

Table 1 provides the recommended maximum concentration of chemical categories that, if present in the landfill leachate, may be incompatible with the polymeric or earthen material comprising the ICDF landfill and evaporation pond liner systems. These limits are based on review of the published liner compatibility studies and manufacturers' recommendations. The maximum allowable concentration for HDPE (high density polyethylene) geomembrane, GCL (geosynthetic clay liner), and SBL (sodium bentonite liner) were compared to determine the highest acceptable value. The lowest of all three values was selected as the suggested maximum concentration.

TABLE 1

Chemical Category	Compatible Concentration for HDPE	Compatible Concentration for GCL and SBL	Suggested ICDF Maximum Concentration or Value	New Design Inventory Concentration Dose or Value
Organics	500,000[a] mg/L	500,000[b] mg/L	500,000 mg/L	58,000 mg/L[e]
Acids and Bases	750,000[a] mg/L	500,000[b] mg/L	500,000 mg/L	0[d] mg/L
Inorganics	500,000[a] mg/L	500,000[b] mg/L	500,000 mg/L	280,000 mg/L[e]
Dissolved Salts	No Limit	35,000 mg/L	35,000 mg/L	8,000 mg/L[c]
Strong Oxidizers	1,000 mg/L	No limit	1,000 mg/L	0[d] mg/L
Radionuclides	1,000,000[b] rads	No limit	1,000,000 rads	13,400 rads (15 yr) 895,000 rads (1000 yr)
pH	0.5 - 13.0[a]	0.5 - 13.0	0.5 - 13.0	8.0

a. Based on the manufacturers' maximum concentration of the list of constituents tested by the manufacturers. The manufacturers' recommendations are provided in Appendix C of EDF-ER-278.

b. Based on reported literature values as discussed in EDF-ER-278.

c. Based on the maximum sodium concentration determined in the Geochemical Evaluation.

d. Strong acids, bases, or oxidizing compounds were not reported in the design inventory.

e. Total organic and inorganic concentrations increased significantly above the previous estimate. This is due to assuming that all soil placed in the ICDF landfill contains the organic and inorganic constituents at the design inventory concentrations. In actuality, only a fraction of the soil will contain these constituents at the design inventory concentrations.

The results of the liner compatibility analysis can be found in Table 2.

TABLE 2

Constituents	Average Leachate Concentration [C_{Liquid}][a] (mg/L or pCi/L)	Design Inventory Concentration in Soil [C_{Soil}][b] (mg/kg or pCi/kg)	Soil Concentration to Average Leachate Concentation Ratio [C_{Soil}/C_{Liquid}] (L/kg)	Maximum Concentration Allowed in Leachate For Compatibility [$C_{Leachate}$][c] (mg/L or pCi/L)	Maximum Allowable Concentration in Soil For Compatibility (mg/kg or pCi/kg)
INORGANICS					
Bromide	5.4E+01	3.6E+00	6.6E-02	5.0E+05	3.3E+04
Phosphate	8.6E+01	5.7E+00	6.6E-02	5.0E+05	3.3E+04
Silicon	2.4E+05	1.6E+04	6.6E-02	5.0E+05	3.3E+04
Tin	3.0E+01	3.0E+00	1.0E-01	5.0E+05	5.1E+04
ORGANICS					
1,2,3,4,6,7,8,9-OCDD	2.7E-04	6.9E-02	2.5E+02	5.0E+05	1.3E+08
1,2,3,4,6,7,8,9-OCDF	5.7E-05	1.4E-02	2.5E+02	5.0E+05	1.3E+08
1,2,3,4,6,7,8-HpCDD	1.8E-04	4.6E-02	2.5E+02	5.0E+05	1.3E+08
1,2,3,4,6,7,8-HpCDF	4.8E-04	1.2E-01	2.5E+02	5.0E+05	1.3E+08
1,2,3,4,7,8,9-HpCDF	2.3E-06	5.9E-04	2.5E+02	5.0E+05	1.3E+08
1,2,3,4,7,8-HxCDD	4.4E-07	1.1E-04	2.5E+02	5.0E+05	1.3E+08
1,2,3,4,7,8-HxCDF	7.8E-04	2.0E-01	2.5E+02	5.0E+05	1.3E+08
1,2,3,6,7,8-HxCDD	3.3E-06	8.4E-04	2.5E+02	5.0E+05	1.3E+08
1,2,3,6,7,8-HxCDF	4.0E-05	1.0E-02	2.5E+02	5.0E+05	1.3E+08
1,2,3,7,8,9-HxCDD	9.4E-06	2.4E-03	2.5E+02	5.0E+05	1.3E+08
1,2,3,7,8,9-HxCDF	8.8E-08	2.2E-05	2.5E+02	5.0E+05	1.3E+08
1,2,3,7,8-PeCDD	4.2E-07	1.1E-04	2.5E+02	5.0E+05	1.3E+08
1,2,3,7,8-PeCDF	3.7E-06	9.3E-04	2.5E+02	5.0E+05	1.3E+08
2,3,4,6,7,8-HxCDF	6.5E-05	1.6E-02	2.5E+02	5.0E+05	1.3E+08
2,3,4,7,8-PeCDF	2.5E-05	6.3E-03	2.5E+02	5.0E+05	1.3E+08
2,3,7,8-TCDD	1.6E-08	4.1E-06	2.5E+02	5.0E+05	1.3E+08
2,3,7,8-TCDF	2.2E-04	5.5E-02	2.5E+02	5.0E+05	1.3E+08
1,2-dichloroethane	3.5E+01	2.5E+01	7.1E-01	2.0E+03	1.4E+03
2-nitroaniline	2.1E+01	3.4E+00	1.6E-01	5.0E+05	8.2E+04
3-nitroaniline	2.1E+00	3.4E+00	1.6E+00	5.0E+05	8.2E+05
4-nitroaniline	2.1E+01	3.4E+00	1.6E-01	5.0E+05	8.2E+04
Aroclor-1262	3.7E-03	5.0E+00	1.3E+03	2.0E+03	2.6E+06

TABLE 2

Constituents	Average Leachate Concentration [C_{Liquid}][a] (mg/L or pCi/L)	Design Inventory Concentration in Soil [C_{Soil}][b] (mg/kg or pCi/kg)	Soil Concentration to Average Leachate Concentation Ratio [C_{Soil}/C_{Liquid}] (L/kg)	Maximum Concentration Allowed in Leachate For Compatibility [$C_{Leachate}$][c] (mg/L or pCi/L)	Maximum Allowable Concentration in Soil For Compatibility (mg/kg or pCi/kg)
Bromomethane	3.9E+01	4.0E+00	1.0E-01	5.0E+05	5.1E+04
Polyvinyl Chloride	2.7E+00	2.7E+03	1.0E+03	5.0E+05	5.0E+08
Styrene	5.8E+04	4.3E+04	7.3E-01	2.0E+03	1.5E+03
Vinyl Chloride	9.7E+01	1.2E+01	1.3E-01	2.0E+03	2.5E+02
RADIONUCLIDES					
U233	2.7E+04	1.6E+05	6.1E+00	2.7E+07	1.6E+08

a. As determined from EDF-ER-274, "Leachate Contaminant Reduction Time Study".

b. As provided by BBWI in CN-23 dated February 3, 2004.

c. Determined from manufacturers' literature as given in EDF-ER-278, "Liner/Leachate Compatibility Study", Appendix C (See Table 1).

Comparison of the maximum allowable concentration in soil for compatibility to the design inventory concentration in soil from Table 1 for each constituent leads to the following conclusion:

1. None of the constituents, with the exception of styrene, has a design inventory soil concentration that will produce a leachate concentration that exceeds the maximum allowed concentration for compatibility.

2. The concentration of styrene in the leachate is a conservative estimate that is based on all soil placed in the ICDF landfill containing styrene at the design inventory concentration. In actuality, only a fraction of the soil will contain styrene at this concentration.

Conclusions

This analysis was used to determine impacts to the liner compatibility. EDF-ER-278 should be amended to include the results of this memo.

References

EDF-ER-274, 2002, "Leachate Contaminant Reduction Time Study", Rev 1., Environmental Restoration Program, Idaho National Engineering and Environmental Laboratory, 2002.

EDF-ER-278, 2002, "Liner/Leachate Compatibility Study", Rev 1., Environmental Restoration Program, Idaho National Engineering and Environmental Laboratory, 2002.