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Mining, Inc.

June 18, 2001

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Mr. Mel Leach, Chief
Fuel Cycle Licensing Branch, FCSS
c/o Document Control Desk
U. S. Nuclear Regulatory Commission
Washington, D.C. 20555

RE: Missing Attachments for the June 15, 2001 Submittal

Dear Mr. Leach:

The replacement appendix pages were accidentally omitted from the June 15, 2001 submittal, concerning additional information for the December 2000 Decommissioning Plan. These appendixes are listed below and are attached for replacement in the plan.

1. Appendix A, Tables A-1 and A-2

2. Appendix B

3. Appendix C

4. Appendix E, Procedure D-5

Please contact me if you should have any questions regarding these replacement appendix pages.

Sincerely,

John Vaselin by PH

John Vaselin
Radiation Safety Officer

Enclosures (2 copies)

cc: E. Brummett - NRC, Washington DC
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NMSS01 Public

TABLE A-1 IRIGARAY PROJECT SPILLS

See the Irigaray Project - General Location and Spill Map for spill locations sites.

Number	Date	Location	Spill Solution	Volume (Gallons)	Spill Solution U308 (mg/l)	Spill Solution Ra226 (pCI/l)	Soil Sample (pCi/g) Uranium as U	Soil Sample (pCi/g) Ra226
1	12/11/1980	South side of plant	Yellowcake slurry	< 55				
2	09/03/87	Unit 5 trunkline	Wellfield	4,200	1.0			
3	12/17/87	Unit 7 trunkline	Wellfield	12,000	0.3			
4	04/20/88	Main wellfield building	Wellfield	1,500	1.2			
5	05/28/88	Unit 6 - 9 trunkline	Wellfield	2,000	1.1			
6	08/06/88	Unit 6 - 9 trunkline	Wellfield	11,000	1.2			
7	08/21/88	Unit 6 - 9 trunkline	Wellfield	6,000	1.5			
8	01/03/89	GI-142	Wellfield	1,000				
9	01/03/89	GI-142	Wellfield	1,000				
1	01/04/89	HI-82	Wellfield	5,000				
11	01/06/89	HI-13	Wellfield	2,500				
12	01/09/89	LP-66	Wellfield	1,500				
13	01/18/89	JI-127	Wellfield	1,000				
14	01/21/89	BI-40	Wellfield	4,000				
15	01/22/89	GI-30	Wellfield	1,600				
16	01/22/89	FI-42	Wellfield	1,000				
17	01/22/89	GI-132	Wellfield	1,500				
18	01/30/89	GP-36	Wellfield	1,000				
19	01/31/89	GI-84	Wellfield	2,500				
20	01/31/89	DI-20	Wellfield	3,000				
21	02/07/89	DI-101	Wellfield	3,000				
22	02/07/89	LP-28	Wellfield	3,000				
23	02/09/89	GP-58	Wellfield	1,500				
24	02/10/89	HI-97	Wellfield	1,000				
25	02/10/89	DI-31	Wellfield	1,400				
26	02/12/89	AI-37	Wellfield	1,000				
27	02/15/89	HI-34	Wellfield	1,000				

28	02/23/89	GP-57	Wellfield	1,500				
29	02/23/89	GI-27	Wellfield	1,120				
30	02/23/89	HI-102	Wellfield	1,000				
31	02/26/89	HP-85	Wellfield	2,000				
32	03/04/89	LP-25	Wellfield	1,000				
33	03/10/89	EI-90	Wellfield	2,000				
34	03/12/89	GI-18	Wellfield	1,000				
35	03/13/89	HP-67	Wellfield	2,000				
36	03/13/89	FI-108	Wellfield	3,000				
37	03/13/89	GI-149	Wellfield	2,500				
38	03/20/89	GP-5	Wellfield	1,250				
39	04/09/89	AI-30	Wellfield	1,000				
40	04/17/89	Unit 8/9 building	Wellfield	2,000				
41	04/25/89	Unit 1 injection	Wellfield	1,000				
42	04/30/89	GI-137	Wellfield	1,000				
43	05/05/89	FI-117	Wellfield	1,500				
44	11/10/89	GP-61	Wellfield	1,000	<15			
45	12/11/89	Unit 7 trunkline	Wellfield	2,000	1.2			
46	12/23/89	Unit 6 Prod. well	Wellfield	1,500	20.0			
47	05/02/90	JP-50	Wellfield	1,000	14.5			
48	05/09/90	Unit 1-5 recovery line	Wellfield	2,000	16.3			
49	05/24/90	S. side of plant	Wellfield	7,000	21.6		1.56	1.8
50	05/31/90	FI-119	Wellfield	1,000	26.2			
51	06/01/90	DP-36	Wellfield	1,000	11.9			
52	06/01/90	CI-17	Wellfield	1,000	15.3			
53	06/04/90	EP-13	Wellfield	1,000	6.8			
54	06/05/90	EP-13	Wellfield	500	6.8			
55	06/29/90	EP-13	Wellfield	350	9.4			
56	05/02/90	JP-50	Wellfield	1,000	14.5			
57	07/08/90	EP-13	Wellfield	200	9.3			
58	08/26/90	Restoration building	Wellfield	3,000	15.9			
59	09/15/90	Restoration building	Process	500	5.3			2.6

60	09/16/90	AP-10	Wellfield	200	18.1			
61	10/04/90	South side of plant	Process	330	4780			
62	11/02/90	Pond D	Pond	1,000	7.1			0.3
63	11/03/91	HP-9	Wellfield	700	17.4			
64	11/10/91	EI-33	Wellfield	2,500	1.3			
65	11/20/91	Between pond A + B	Pond	2,000	15.0			
66	11/22/91	AP-8	Wellfield	3,000	<0.1			
67	12/22/91	DI-86	Wellfield	2,000			26.50	43.9
68	12/30/91	Unit 5	Wellfield	2,000	12.9			23.0
69	01/15/92	FI-97	Wellfield	5,000	8.3			1.6
70	01/18/92	EP-13	Wellfield	1,000			38.70	2.2
71	01/19/92	DI-11	Wellfield	2,000			138.00	12.0
72	01/22/92	BP-8	Wellfield	2,000	3.7		28.10	1.2
73	01/25/92	FP-13	Wellfield	6,000			147.00	20.1
74	01/25/92	HP-68	Wellfield	2,500			44.80	9.1
75	02/19/92	EI-90	Wellfield	2,000	0.2		2.60	1.3
76	02/19/92	T42-1	Wellfield	2,500	12.6		7.10	3.5
77	02/22/92	L20-1	Wellfield	1,000	16.1		0.06	17.2
78	06/30/92	DP-14	Wellfield	5,000	3.8		43.50	5.1
79	07/25/92	Restoration building	Pond	5,000	11.6		13.30	1.5
80	08/03/92	CI-20	Wellfield	3,000	3.5			
81	08/05/92	FP-35	Wellfield	5,000	7.4		0.60	0.9
82	09/03/92	DI-64	Wellfield	2,000	8.0			
83	12/23/92	FI-110	Wellfield	1,700	2.6			
84	04/12/93	Trunkline behind plant annex	Pond	5,000	10.0		4.80	1.0
85	05/03/93	Between plant and wellfield	Pond	6,000	16.7		6.00	1.3
86	05/16/93	GI-84	Wellfield	500	5.5			
87	06/15/93	GI-129	Wellfield	750	7.3			
88	07/03/93	FI-119B	Wellfield	1,000	8.2		9.80	7.8
89	07/07/93	LP-49	Wellfield	12,200	18.0		10.30	6.1
90	07/13/93	JI-44	Wellfield	3,000	18.0		94.50	254.0
91	08/05/93	UNIT 7	Wellfield	1,080	16.2			

92	09/12/93	HP-49	Wellfield	8,000	26.3		5.40	1.2
93	11/17/93	LI-68	Wellfield	1,500	0.5			
94	11/22/93	KP-53	Wellfield	1,000	1.8			
95	01/05/94	HI-82	Wellfield	1,250	1.8			
96	01/08/94	JI-38	Wellfield	1,000	1.6			
97	01/15/94	JI-22	Wellfield	2,250	15.1			
98	02/08/94	HI-137	Wellfield	2,000	9.7			
99	02/23/94	JI-80	Wellfield	1,100	7.9			
100	04/29/94	JI-27	Wellfield	1,200	12.7			
101	07/29/94	R.O. feed from pond RA	Pond	3,000	17.8			
102	08/01/94	South side of plant	Yellowcake	509				
103	08/15/94	Plant Annex	Process	1,000	159.4		196.00	5.9
104	10/13/94	Linde Building	Wellfield	6,000	1.5		2.40	1.1
105	11/16/94	JP-60	Wellfield	4,500	10.0			
106	11/30/94	Unit 7 Trunkline	Wellfield	1,000	1.1			
107	12/06/94	Unit 7, Trunkline 16	Wellfield	6,250	1.2			
108	12/10/94	Unit 8 Trunkline 8	Wellfield	5,000	0.2		2.30	2.1
109	12/10/94	JP-64	Wellfield	1,200	12.9		10.60	2.5
110	12/12/94	Unit 7Trunkline 3	Wellfield	5,000	7.0		2.90	2.3
111	12/15/94	KI-100B	Wellfield	2,500	12.0			
112	01/02/95	LP-41B	Wellfield	1,000	7.5			
113	01/11/95	LI-16	Wellfield	1,000	8.7			
114	01/16/95	Unit 9 Mod.	Wellfield	9,000	1.6			
115	01/17/95	JI-83	Wellfield	200	7.3			
116	01/17/95	JP-44	Wellfield	500	7.3			
117	01/17/95	JI-104	Wellfield	1,000	1.6			
118	01/18/95	KI-113B	Wellfield	1,000	8.7			
119	01/24/95	Unit 7, Recovery line #8	Wellfield	1,000	8.1			
120	02/01/95	Unit 6, Trunkline #8	Wellfield	1,000	2.6			
121	05/17/95	Unit 6 Trunkline	Wellfield	1,000	4.3			
122	07/07/95	Pond B	Process	9,000	17.8			
123	07/27/95	Plant Annex	Process	1,000	26.7		1315.00	4.6

124	08/01/95	Pond B	Process	1,500	8579.0		550.00	5.3
125	08/18/95	KI-96	Wellfield	5,000	8.4			
126	02/09/96	Unit 5 trunkline	Wellfield	3,000	8.8			
127	05/20/96	Unit 7 trunkline	Wellfield	500	10.6			
128	06/06/96	Pond D	Process	3,000	21.8	1730		1.9 - 12.4
129	08/01/96	Pond D	Pond	500	10.1			
130	08/09/96	Pond D	Process	1,000	15.6			
131	12/06/96	Pond RA	Pond	1,000	146.0		13.20	<1.3
132	12/06/96	R.O. Plant feed line.	Wellfield	2,000	<0.2			
133	12/06/96	T3	Wellfield	800	8.4			
134	12/09/96	Rec. Riser	Wellfield	2,000	6.9		8.30	3.5
135	04/22/97	Pond RB	Process	59,400	237.7		38.40	1.4
136	05/21/97	GP-23	Wellfield	1,000	2.0			
137	06/21/97	GI-112	Wellfield	2,000	5.0			
138	06/24/97	Pump House	Wellfield	1,500	<0.4			
139	07/12/97	GI-129	Wellfield	5,000	0.7		3.50	2.0
140	09/13/97	GI-112	Wellfield	2,000	4.5			
141	09/16/97	RA Trans. Line	Pond	2,240	78.5		18.20	3.8
142	10/20/97	GP-11	Wellfield	1,000	<0.4			
143	10/26/97	GI-96B	Wellfield	430	6.2		10.50	6.0
144	10/26/97	GI-141	Wellfield	1,000	3.4		14.70	10.5
145	11/05/97	GI-84	Wellfield	50	6.1		2.15	1.2
146	11/05/97	GI-22	Wellfield	50	5.4		2.71	1.4
147	11/17/97	HP-75	Wellfield	1,000	4.4		19.00	48.7
148	12/26/97	GP-56	Wellfield	2,000	3.2			
149	01/06/98	GI-17	Wellfield	150	5.1			
150	01/06/98	GI-14	Wellfield	300	5.0		0.21	2.7
151	02/18/98	HP-87	Wellfield	3,000	3.2		0.073	1.4
152	04/04/98	GP-30	Wellfield	150	5.6			
153	09/07/98	GP-14	Wellfield	2,000	2.3			
154	09/09/98	GP-44	Wellfield	3,000	2.2			
155	09/10/98	5I7 ponds	Pond	150	159.8			

156	09/16/98	GI-51	Wellfield	4,000	2.2			
157	09/17/98	GI-106	Wellfield	1,700	2.0			
158	09/18/98	LI-123	Wellfield	1,200	2.9			
159	09/19/98	GP-23	Wellfield	2,000	3.0			
160	09/25/98	FP-29	Wellfield	3,000	2.5			
161	12/25/98	LI-59	Wellfield	700	10.5			
162	12/25/98	LP-25	Wellfield	700	8.8			
163	02/12/99	LP-26	Wellfield	1,000	3.6			
164	03/17/99	Unit 7 trunkline	Wellfield	3,000	4.2			2.1
165	04/03/99	Unit 9 Trunkline	Wellfield	13,000	<0.4		6.27	10.3
166	04/08/99	LP-22	Wellfield	1,000	3.8		6.05	1.0
167	04/15/99	KI-34	Wellfield	200	6.2		7.85	4.3
168	04/15/99	LI-84	Wellfield	1,000	,0.4		7.85	4.6
169	06/14/99	LI-73	Wellfield	1,000	6.7		8.84	2.7
170	08/15/99	KI-88	Wellfield	5,000	2.6		7.11	3.7
171	10/29/99	Pond RB	Pond	200	89.2		16.30	1.2
172	02/08/00	JI-80	Wellfield	1,500	6.9		8.07	21.4
173	03/25/00	Ki-156	Wellfield	500	5.0		17.80	40.2
174	04/19/00	KI-62	Wellfield	3,000	7.2			
175	07/19/00	Unit 6 Trunkline	Wellfield	450	6.9			

TABLE A-2 CHRISTENSEN RANCH PROJECT SPILLS

See the Christensen Ranch Project - General Location and Spill Map for spill locations sites.

					Spill Solution (mg/l)		Soil Sample (pCi/g)	
Number	Date	Location	Spill Solution	Volume (Gallons)	Uranium as U308	Ra226	Uranium as U	Ra226
1	04/14/89	Access road between sites. Not shown on spill maps.	Yellowcake Slurry	< 55				
2	06/27/89	Mod. 3-4	Wellfield	2,500				
3	08/04/89	Mod. 3-3	Wellfield	1,500				
4	08/29/89	3C19-1	Wellfield	1,000				
5	03/06/90	R.O. Brine discharge	Process	2,126	2.5			
6	04/23/90	CR-1 pond	Pond	1,000				
7	05/03/91	MU3 Extension	Wellfield	4,500	0.2			
8	09/08/92	Mod. 3-4	Wellfield	1,000				
9	09/29/92	200' north of plant	Wellfield	14,000	1.0		1.90	2.7
10	03/05/93	Mod. 2-1	Wellfield	5,400	0.1			
11	03/24/93	Unit 2 trunkline (MW87)	Wellfield	10,000	1.3		1.09	2.2
12	04/04/93	Mod. 2-2	Wellfield	7,500	0.9		5.40	1.2
13	05/09/93	Mod 2-1	Wellfield	5,400	0.9		2.00	1.3
14	05/15/93	Unit 2-3 trunkline	Wellfield	30,000	1.9		1.50	1.2
15	07/18/93	2AH27-1	Wellfield	1,000	1.2			2.1
16	10/23/93	Mod 3-1	Wellfield	2,000	2.1			
17	01/02/94	2W47-1	Wellfield	1,500	1.3			
18	01/20/94	2AF23-2	Wellfield	7,500	2.1			6.0
19	06/22/94	Unit 4 pump station	Wellfield	1,000	0.5			
20	07/14/94	Mod. 4-2	Wellfield	2,500	235.0		36.10	3.4
21	07/20/94	Pond backwash line	Pond	3,400	21.7			
22	12/04/94	4M34-1	Wellfield	40,000	0.8			
23	04/07/95	Mod. 3-1	Wellfield	400	21.5			
24	04/11/95	Mod. 4-3	Wellfield	12,000	0.5	339.7	0.4 - 1.7	0.9 - 2.3
25	06/26/95	5AK62-2	Wellfield	5,000	50.0		22.00	2.2
26	06/27/95	5AM72-3	Wellfield	500	58.0		14.10	24.0
27	07/07/95	Mod 3-3 Manhole	Wellfield	2,000	2.1			
28	01/01/96	Mod. 5-1 Building	Wellfield	4,000	1.0			

TABLE A-2 CHRISTENSEN RANCH PROJECT SPILLS

See the Christensen Ranch Project - General Location and Spill Map for spill locations sites.

					Spill Solution (mg/l)		Soil Sample (pCi/g)	
29	01/10/96	Unit 4 pump station	Wellfield	1,000	1.0			
30	01/15/96	5AU57-1	Wellfield	20,000	1.4		2.70	<0.6
31	01/14/96	5BE47-2	Wellfield	7,200	0.5			
32	02/11/96	5AU51-1	Wellfield	1,000	0.5			
33	02/16/96	5AV57-1	Wellfield	1,000	1.0			
34	02/29/96	Mod. 3-1 Building	Wellfield	1,000	36.7		9.40	<0.6
35	03/04/96	5AM69-1	Wellfield	1,000	1.1			
36	03/10/96	5BC53-2	Wellfield	6,350	0.8			
37	03/14/96	5TW-02	Wellfield	1,000	2.0			
38	03/17/96	5AU47-1	Wellfield	6,000	N/A			
39	05/08/96	5BI43-1	Wellfield	1,500	N/A			
40	05/22/96	5BK43-1	Wellfield	1,000	0.7			
41	06/07/98	5BJ61-1	Wellfield	1,000	1.0		2.50	3.1
42	06/18/96	5BK51-2	Wellfield	1,500	30.5		11.7-23.4	2.8 -6.3
43	07/28/96	Unit 4 Pump Station	Wellfield	2,000	N/A		0.90	2.3
44	09/01/96	5BH45-1	Wellfield	2,000	2.2		1.90	2.5
45	11/07/96	Mod. 3-3 Manhole	Wellfield	4,600	1.4			
46	12/02/96	5AU57-1	Wellfield	14,600	1.0			
47	01/10/97	Mod. 6-1, Inj. Trunkline	Wellfield	1,900	1.1		4.20	20.1
48	01/27/97	5BK48-2	Wellfield	2,300	30.4		5.40	1.7
49	01/29/97	6 Pump Station Manhole	Wellfield	9,000	0.7		1.20	1.2
50	02/28/97	5BG65-1	Wellfield	6,012	0.2		3.10	3.2
51	05/17/97	Mod.3-2, Manhole	Wellfield	60,000	0.7			8.0
52	05/17/97	5BH64-1	Wellfield	300	13.1		7.90	<1.8
53	07/24/97	Mod. 6-2	Wellfield	700	30.0		3.58	2.0
54	08/19/97	Mod. 6-3	Wellfield	3,280	2.0		0.69	0.7
55	11/19/97	6AO49-2	Wellfield	<400	40.2			
56	01/13/98	6AM47-3	Wellfield	1,000	1.5			
57	05/11/98	6AC38-1	Wellfield	4,125	0.8		1.12	1.1
58	05/14/98	5AV55-1	Wellfield	107,826	1.1	<0.2	1.83	7.4

TABLE A-2 CHRISTENSEN RANCH PROJECT SPILLS

See the Christensen Ranch Project - General Location and Spill Map for spill locations sites.

					Spill Solution (mg/l)		Soil Sample (pCi/g)	
59	07/08/98	5AV55-1	Wellfield	28,213	2.0		1.73	4.5
60	8/31/98	6AL48-2	Wellfield	3,000	1.7			
61	09/18/98	6AO59-1	Wellfield	1,000	0.8			
62	12/14/98	5AM80-1	Wellfield	4,500	20.1			
63	03/26/99	Mod. 3-1 Building	Wellfield	23,520	1.2		3.12	3.8
64	03/29/99	3HI17-1	Wellfield	60,918	<0.4		2.12	46.5
65	04/12/99	6V27-1	Wellfield	32,400	0.9		3.22	2.9
66	05/03/99	5BK82-1	Wellfield	2,650	1.6		28.80	48.8
67	05/07/99	5BD47-1	Wellfield	14,910	1.8		2.28	1.5
68	05/12/99	3L29-1	Wellfield	1,000	<0.4		5.98	32.7
69	07/13/99	5BN162-2	Wellfield	3,780	19.3		8.79	2.9
70	10/04/99	6AI69-3	Wellfield	400	72.2		17.30	2.1
71	05/01/00	DDW#1	Process	2,000	0.6		2.22	1.5

Appendix B

Dose Assessment-Surface Contamination

B.0 Introduction

RESRAD-Build 3.0 (ANL, 1994; NRC, 2000) was used to evaluate the dose to industrial workers occupying the buildings formerly used for extracting uranium at the ISL sites. The use for these buildings, if left at the site, is most likely to be storage and maintenance of ranching or farm equipment. Another possible use of the plant buildings would be as a service center for the local oil and gas industry. Because of the possibility for contamination beneath the floor in the yellowcake storage and handling section of the plant annex at Irigaray, this portion of the building will be demolished and the materials decontaminated to unrestricted release levels or handled as byproduct waste.

The most restrictive exposure scenario related to these two buildings is for workers, probably mechanics, hired to service equipment brought to the site. The current offices, or portions of the offices, associated with the plant buildings are uncontaminated and assumed to remain to serve as administrative and support facilities for the workers. Therefore the workers would normally take breaks and eat lunch in the currently uncontaminated office facilities.

The surface contamination should reflect those of the constituents in the process water at the plants, namely uranium, radium-226, and lead-210. The approach used was to calculate the radiological dose to industrial workers, assuming that the surface contamination was made up exclusively of one constituent. As will be seen, the worst-case model assumed all of the contamination to be uranium. The total gross surface contamination limit was then based on the presence of uranium that would result in a maximum dose to the workers of 25 mrem/y. By choosing this approach, the gross contamination limit eliminates the need to determine the radionuclide mix within the structures. The dose criterion is based on 10 CFR Part 20, §20.1402

B.1 Current Contamination

Low levels of surface contamination are known to exist generally throughout the plant with the older Irigaray plant more highly contaminated than the Christensen Ranch plant. Measured total gross alpha levels up to 8,000 dpm/100 cm^2 have been measured recently in the processing areas of the plant. Since the yellowcake handling and storage section of the Irigaray plant annex will be demolished, no preliminary characterization data exists for this section. Preliminary characterization data show that individual removable fractions of contamination are limited to approximately 16 percent of the total. This is not surprising since the floor surfaces are physically clean and spills have been addressed by acid cleaning where necessary to control the spread of contamination. Once the process equipment is removed from the buildings, a thorough cleaning of the contaminated building surface areas will be done, rendering the surface cleanliness and contamination levels comparable to and possibly below current levels.

B.2 Parameter Justification

The exposure pathways considered in the industrial occupancy scenario are external exposure due to the source, inhalation of airborne radioactive material, and inadvertent ingestion of radioactive material. The parameter analysis is based on guidance provided in NUREG-5512 Volumes 1 and 3 (NRC, 1992, NRC, 1999) and NUREG 2000. The selected parameter values, along with default parameter values, are provided in Table B-1. The bases for selecting parameter values are discussed below.

The default condition assumes that the maximum dose is received during the first year of occupancy by assuming the removable fraction is linearly removed within 365 days. We believe that this is reasonable but conservative for this situation since the levels of removable contamination will decrease over time in some areas. A build-up of dirt, grease, oil, paint, or other coverings may also occur which will reduce airborne concentration levels. The occupancy time was assumed to be 250 days per year, 8 hours per day over the 365-day exposure period. The fraction of the exposure period that a worker spends indoors is then 250*8/365*24 = 0.228. The workers were assumed to spend two-thirds of their work day in the contaminated area, assuming that they will take breaks, work outside a portion of the time, and perhaps have administrative duties in the uncontaminated office facility. The default breathing rate of 18 m^3/day was used since it is representative of active workers.

The room size of 10-m x 10-m by 10-m was used in the model and represents the size of a typical equipment service room in a high-bay building. The calculated dose, however, is not highly sensitive to the room size. An exchange rate of slightly less than 1 change per hour is normal for homes in the U.S. Reported studies of homes show maximum air exchange rates for homes average slightly less than one per hour and are typically less than 3 air exchanges per hour. (NRC, 2000). Since the buildings are not built to have low air exchange rates, and it is probable that the large door would remain open during occupancy in reasonably warm weather, an air exchange rate of 2 air exchanges per hour was used in the model.

The model provides for a plane source or volume source. The source selected for the model was assumed to be a uniformly contaminated floor of size equal to the room size. It is unlikely that the contaminated area is larger than the floor area. Should this not be the case, the characterization surveys will reveal it and the calculated average limits will be reduced by an appropriate area factor. The results will show that the airborne activity is the predominant dose pathway to the occupants. It is probable that the resuspended particulate will arise from the contaminated floor rather than the walls or ceiling. For these reasons, it is believed that considering only the floor to be contaminated is a reasonable approach for modeling the dose using RESRAD-Build.

Preliminary site characterization data for the process plants at the Christensen Ranch and the Irigaray Projects indicate removable fractions of less than 16 percent and 5 percent, respectively. The contamination levels are generally less at Christensen because no uranium extraction from the resin occurred at that plant. Since an extensive survey and cleaning effort will occur prior to the release of the sites, we believe that 10 percent is representative of these buildings.

Table B-1 Parameter for the Industrial Use Scenario

RESRAD Building Parameter	Default Value	Selected Value
External dose rate factor from surfaces (mrem/h per dpm/100 cm^2	FG Report No. 12	FG Report No. 12
Inhalation CEDE factor (mrem/pCi inhaled)	FG Report No. 11	FG Report No. 11
Ingestion CEDE factor (mrem/pCi ingested)	FG Report No. 11	FG Report No. 11
Exposure period (days)	365	365
Fraction of time that exposure occurs during the exposure period (called indoor fraction in RESRAD-Build)		.228
Time fraction of receptor		0.67
Deposition velocity (m/s)	0.01	0.01
Resuspension rate (1/s)	5.0E-07	5.0E-07
Volumetric breathing rate (m^3/day)	18	18
Effective transfer rate for ingestion of removable contamination from surfaces to hands, from hands to mouth (m^2/h)	1.0E-04	1.0E-04
Fraction of Removable Contamination	20%	10%
Size of Room (m x m x m)	6x6x2.5	10x10x10
Loose Fraction Removal Time (days)	365	365
Air Exchange Rate (1/h)	0.8	2
Source Geometry (m x m x m)		10x10x10
Radon Release Fraction	0.1	0.3
Fraction of time at work subject to exposure		.67
Direct Ingestion Rate	0	0

The radon release fraction is based on the emanating fraction for radon in mill tailings, which typically ranges from 0.2-0.3. Since the contamination layer is very thin, we believe that most of the radon will be released and therefore have assigned a value of 0.3 rather than the default value of 0.1.

B.3 Results

RESRAD-Build was run for a room having a floor surface area of 100 m^2 and a ceiling height of 10 m. The floor was assumed to be contaminated at 1,000 dpm/100 cm^2 (4.5E5 pCi/m^2) for various alpha-emitting radionuclides. For uranium, the natural abundance ratio was assumed where the total activity for uranium was divided into 48.9 percent each for U-238 and U-234 and 2.2 percent for U-235. The results of the calculations are included in the RESRAD-Build reports included at the end of this section. The total effective dose equivalent (TEDE) for exposure to surfaces contaminated with natural uranium at 1,000 dpm/100 cm^2 was calculated to be 16 mrem/year for the first year. Exposure to surfaces contaminated by pure Pb-210 at 1,000 dpm/100 cm^2 was calculated to be 1.1 mrem/y. RESRAD-Build predicts a dose of 0.5 mrem/y from exposure to surfaces contaminated with Ra-226 at 1,000 dpm/100 cm^2. Since all of the removable contamination was assumed to become airborne during the first year, the TEDE for subsequent years is very low in comparison to the first year.

The reason that the TEDE results were calculated for the three different cases, pure uranium, pure Ra-226, and pure Pb-210 is that the variation of the radionuclide mix within the plants may be high and it is not practical to characterize the radionuclide mix. From the results above, a gross alpha limit of 1,000 dpm/100 cm^2 would limit the annual TEDE to the workers within the building to 25 mrem, regardless of the radionuclide mix.

B.4 Conservatism and ALARA

RESRAD-Build uses conservative dose conversation factors taken from Federal Guidance Report No. 11 (EPA, 1998). There is no user option for changing these factors. For uranium, the chemical form for inhalation is assumed by RESRAD to be very insoluble (Class Y) rather than the more soluble form (Class W) or the highly soluble (Class D) chemical form. Since the solution mining process removes soluble uranium from the ore body, the residual uranium remaining from process liquids is expected to be soluble. This was confirmed in a COGEMA-funded study (RSE, 1995) where samples from various areas were placed in a synthetic lung fluid and the solubility measured. In all samples, the Class D chemical form was prevalent. The sample taken from the dryer stack where materials had been exposed to elevated temperatures predictably resulted in the least solubility with 65 percent Class D, 15 percent Class W, and 5 percent Class Y. The inhalation dose conversation factor for Class W material is only 6 percent of that for Class Y material. Therefore, the calculated inhalation dose for uranium is probably overestimated by a factor of 17. Since the calculated dose for uranium was attributable to insoluble uranium, the actual dose may be less than 1 mrem/y. This would make the actual dose per unit concentration nearly equal.

As can be seen from the above discussion, COGEMA believes that the calculated 25 mrem/y dose that corresponds to gross surface contamination of 1,000 dpm/100 cm^2 is based on very conservative assumptions.

B.5 References

ANL, 1994. RESRAD-Build: A Computer Model for Analyzing the Radiological Doses Resulting from the Remediation and Occupancy of Buildings Contaminated with Radioactive Material. ANL/EAD/LD-3. Environmental Assessment Division, Argonne National Laboratory, 9700 South Cass Avenue, Argonne, Illinois 60439.

EPA, 1988. Limiting Values of Radionuclide Intake and Air Concentration and Dose Conversion Factors for Inhalation, Submersion, and Ingestion. Federal Guidance Report No. 11. 1988. Office of Radiation Programs, U.S. Environmental Protection Agency, Washington, D.C. 20460

NRC, 1992. Residual Radioactive Contamination from Decommissioning. NUREG/CR-5512 Vol. 1. 1992. U. S. Nuclear Regulatory Commission, Washington, D.C. 20555.

NRC, 1999. Residual Radioactive Contamination from Decommissioning. Parameter Analysis. Draft Report for Comment. October 1999. U. S. Nuclear Regulatory Commission, Washington, DC 20555-0001.

NRC, 2000. Development of Probabilistic RESRAD 6.0 and RESRAD-Build 3.0 Computer Codes. November 2000. Prepared by Argonne National Laboratory for U. S. Nuclear Regulatory Commission, Washington, DC 20555-0001.

RSE, 1995. Letter report by Radiation Safety Engineering, Inc of uranium solubility study. July 21, 1995. Radiation Safety Engineering, Inc., 3245 N. Washington St., Chandler, AZ 85225-1121.

Title : Dose from Uranium
Input File : C:\WINBLD\RA-226

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Number of Sources : 1
Number of Receptors: 1
Total Time : 3.650000E+02 days
Fraction Inside : 2.280000E-01

ÍÍÍÍÍÍÍÍÍ Receptor Information ÍÍÍÍÍÍÍÍÍ

Receptor	Room	x [m]	y [m]	z [m]	FracTime	Inhalation [m3/day]	Ingestion(Dust) [m2/hr]
1	1	5.000	5.000	1.000	0.670	1.80E+01	1.00E-04

ÍÍÍ Receptor-Source Shielding Relationship ÍÍÍ

Receptor	Source	Density [g/cm3]	Thickness [cm]	Material
1	1	2.40E+00	0.00E+00	Concrete

ÍÍÍÍÍÍÍÍ Building Information ÍÍÍÍÍÍÍÍ

Building Air Exchange Rate: 2.00E+00 1/hr

```
 Height[m]      Air Exchanges [m3/hr]
 Area [m2]
          *******************************
          *                *
          *                *
          *                <=Q01: 2.00E+03
 H1: 10.000   *      Room 1      *    Q10 : 2.00E+03
          * LAMBDA: 2.00E+00       *
Area 100.000  *                *
          *                *
          *******************************
```

Deposition velocity: 1.00E-02 [m/s]   Resuspension Rate: 5.00E-07 [1/s]

Title : Dose from Uranium
Input File : C:\WINBLD\RA-226

ÍÍÍÍÍÍÍ Source Information ÍÍÍÍÍÍÍ

Source: 1
Location:: Room : 1 x: 10.00 y: 10.00 z: 0.00[m]
Geometry:: Type: Area Area:1.00E+02 [m2] Direction: z
Pathway ::
Direct Ingestion Rate: 0.000E+00 [1/hr]
Fraction released to air: 1.000E+00
Removable fraction: 1.000E-01
Time to Remove: 3.650E+02 [day]

Radon Release Fraction: 3.000E-01

Contamination::

Nuclide	Concentration	Dose Conversion Factors				
		Ingestion	Inhalation	External (Surface)	External (Volume)	Submersion
	[pCi/m2]	[mrem/pCi]	[mrem/pCi]	[mrem/yr/ (pCi/m2)]	[mrem/yr/ (pCi/m3)]	[mrem/yr/ (pCi/m3)]
`38	1.080E+05	2.690E-04	1.180E-01	3.530E-06	9.510E-08	1.600E-04
‿235	4.840E+03	2.670E-04	1.230E-01	1.950E-05	4.740E-07	9.030E-04
U-234	1.080E+05	2.830E-04	1.320E-01	8.750E-08	2.520E-10	8.930E-07
PA-231	0.000E+00	1.060E-02	1.280E+00	4.760E-06	1.190E-07	2.010E-04
TH-230	0.000E+00	5.480E-04	3.260E-01	8.780E-08	7.570E-10	2.040E-06
AC-227	0.000E+00	1.480E-02	6.720E+00	4.530E-05	1.260E-06	2.160E-03
RA-226	0.000E+00	1.330E-03	8.600E-03	1.940E-04	7.000E-06	1.040E-02
PB-210	0.000E+00	7.270E-03	2.320E-02	4.140E-07	3.820E-09	1.430E-05

Title : Dose from Uranium
Input File : C:\WINBLD\RA-226 Evaluation Time: 0.000000 years

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ííí Assessment for Time: 1 ííí
ííí Time =0.00E+00 yr ííí
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ííííííí Source Information ííííííí

Source: 1
Location:: Room : 1 x: 10.00 y: 10.00 z: 0.00 [m]
Geometry:: Type: Area Area:1.00E+02 [m2] Direction: z
Pathway ::
Direct Ingestion Rate: 0.000E+00 [1/hr]
Fraction released to air: 1.000E+00
Removable fraction: 0.000E+00
Time to Remove: 3.650E+02 [day]

Contamination::

Nuclide	Concentration [pCi/m2]
U-238	1.080E+05
U-235	4.840E+03
U-234	1.080E+05
PA-231	0.000E+00
TH-230	0.000E+00
AC-227	0.000E+00
RA-226	0.000E+00
PB-210	0.000E+00

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Source Contributions to Receptor Doses
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[mrem]

	Source 1	Total
Receptor 1	1.6E+01	1.6E+01
Total	1.6E+01	1.6E+01

Title : Dose from Uranium
Input File : C:\WINBLD\RA-226 Evaluation Time: 0.000000 years

Pathway Detail of Doses
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[mrem]

Source: 1

Receptor	External	Deposition	Immersion	Inhalation	Radon	Ingestion
1	5.84E-03	2.54E-04	1.86E-06	1.55E+01	1.51E-23	9.11E-02
Total	5.84E-03	2.54E-04	1.86E-06	1.55E+01	1.51E-23	9.11E-02

Title : Dose from Uranium
Input File : C:\WINBLD\RA-226 Evaluation Time: 0.000000 years

Nuclide Detail of Doses
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[mrem]

Source: 1

Nuclide	Receptor 1	Total
U-238		
U-238	7.20E+00	7.20E+00
U-235		
U-235	3.37E-01	3.37E-01
U-234		
U-234	8.04E+00	8.04E+00

Title : Dose from Ra-226 and Pb-210
Input File : C:\RA-226

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Number of Sources : 1
Number of Receptors: 1
Total Time : 3.650000E+02 days
Fraction Inside : 2.280000E-01

ÍÍÍÍÍÍÍÍÍ Receptor Information ÍÍÍÍÍÍÍÍÍ

Receptor	Room	x [m]	y [m]	z [m]	FracTime	Inhalation [m3/day]	Ingestion(Dust) [m2/hr]
1	1	5.000	5.000	1.000	0.670	1.80E+01	1.00E-04

ÍÍÍ Receptor-Source Shielding Relationship ÍÍÍ

Receptor	Source	Density [g/cm3]	Thickness [cm]	Material
1	1	2.40E+00	0.00E+00	Concrete

Title : Dose from Ra-226 and Pb-210
Input File : C:\RA-226

íííííííí Building Information íííííííí

Building Air Exchange Rate: 2.00E+00 1/hr

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Height[m]       Air Exchanges [m3/hr]
Area [m2]
           ********************************
           *                *
           *                *
           *                <=Q01: 2.00E+03
H1:  10.000   *      Room  1      *    Q10 :  2.00E+03
           *  LAMBDA: 2.00E+00      *
Area 100.000   *                *
           *                *
           ********************************
```

Deposition velocity: 1.00E-02 [m/s]   Resuspension Rate: 5.00E-07 [1/s]

Title : Dose from Ra-226 and Pb-210
Input File : C:\RA-226

ÍÍÍÍÍÍÍÍ Source Information ÍÍÍÍÍÍÍÍ

Source: 1
Location:: Room : 1 x: 10.00 y: 10.00 z: 0.00[m]
Geometry:: Type: Area Area:1.00E+02 [m2] Direction: z
Pathway ::
Direct Ingestion Rate: 0.000E+00 [1/hr]
Fraction released to air: 1.000E+00
Removable fraction: 1.000E-01
Time to Remove: 3.650E+02 [day]

Radon Release Fraction: 3.000E-01

Contamination::

Nuclide	Concentration [pCi/m2]	Ingestion [mrem/pCi]	Inhalation [mrem/pCi]	External (Surface) [mrem/yr/ (pCi/m2)]	External (Volume) [mrem/yr/ (pCi/m3)]	Submersion [mrem/yr/ (pCi/m3)]
·226	4.500E+04	1.330E-03	8.600E-03	1.940E-04	7.000E-06	1.040E-02
-210	4.500E+04	7.270E-03	2.320E-02	4.140E-07	3.820E-09	1.430E-05

Title : Dose from Ra-226 and Pb-210
Input File : C:\RA-226 Evaluation Time: 0.000000 years

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ííí Assessment for Time: 1 ííí
ííí Time =0.00E+00 yr ííí
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íííííííí Source Information íííííííí

Source: 1
Location:: Room : 1 x: 10.00 y: 10.00 z: 0.00 [m]
Geometry:: Type: Area Area:1.00E+02 [m2] Direction: z
Pathway ::
Direct Ingestion Rate: 0.000E+00 [1/hr]
Fraction released to air: 1.000E+00
Removable fraction: 0.000E+00
Time to Remove: 3.650E+02 [day]

Contamination::

Nuclide	Concentration [pCi/m2]
RA-226	4.500E+04
PB-210	4.500E+04

Title : Dose from Ra-226 and Pb-210
Input File : C:\RA-226   Evaluation Time: 0.000000   years

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Source Contributions to Receptor Doses
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[mrem]

	Source 1	Total
Receptor 1	1.5E+00	1.5E+00
Total	1.5E+00	1.5E+00

Title : Dose from Ra-226 and Pb-210
Input File : C:\RA-226 Evaluation Time: 0.000000 years

Pathway Detail of Doses
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[mrem]

Source: 1

Receptor	External	Deposition	Immersion	Inhalation	Radon	Ingestion
1	1.10E-01	4.67E-03	4.00E-05	8.01E-01	2.60E-02	5.76E-01
Total	1.10E-01	4.67E-03	4.00E-05	8.01E-01	2.60E-02	5.76E-01

Title : Dose from Ra-226 and Pb-210
Input File : C:\RA-226   Evaluation Time: 0.000000   years

Nuclide Detail of Doses
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[mrem]

Source: 1

Nuclide	Receptor 1	Total
RA-226		
RA-226	4.47E-01	4.47E-01
PB-210		
PB-210	1.07E+00	1.07E+00

Appendix C

Building Contamination Survey and Sampling Plan

C.0 Introduction

The procedures for conducting gross alpha surface contamination surveys follow guidance prepared by the Multi-Agency Radiation Survey and Site Investigation Manual (MARSSIM) guidance (NUREG-1575). The instrumentation performance calculations assume that all contamination is natural uranium since the dose-based gross alpha contamination limits were based on uranium, which was shown to be the most restrictive constituent in the possible mixture of radionuclides. For freshly purified uranium, one alpha particle and approximately one beta particle will be emitted per uranium disintegration. Therefore the possibility of demonstrating compliance exists using gross alpha measurements or gross beta measurements, or a combination of the two. Gross alpha measurements suffer from the potential masking of the non-penetrating alpha particles from surface features, surface moisture, or other absorbing surface layers. However, the low background of the detectors provide for a very low minimum detectable concentration (MDC) under ideal conditions. The beta particles are much more penetrating but the high background of portable beta detectors results in a high MDC. Monitoring for beta particles is also influenced by gamma-rays.

The gross contamination limit for the structures was calculated to be 1,000 dpm/100 cm^2, averaged over 100 m^2. Since the exposure pathway was almost exclusively due to inhalation (See Appendix B), there is no maximum limit. However, it will be shown that as a part of ALARA, the scanning technique should identify all small areas above 50 percent of the limits and COGEMA will make a reasonable effort to further decontaminate them. In MARSSIM terminology, the limit is the derived concentration guideline level (DCGL).

Buildings to be decontaminated and transferred to the landowner for future use will be monitored according to the following plan. Using MARSSIM terminology, floors within the plant will be considered Class 1 while walls and ceiling will be classified as Class 2 and Class 3.

C.1 Equipment

The gross alpha scanning surveys will be conducted using a Ludlum Model 239-1F Floor Monitor (or equivalent). The floor monitor has a Ludlum Model 43-37 gas proportional detector with an active area of 582 cm^2. The detector is approximately 16-cm wide and 36-cm long. The alpha background for this detector is typically 5 cpm. Alpha-plus-beta measurements are made by increasing the voltage on the Ludlum 43-37 detector. When in the beta high voltage mode, the background is approximately 1800 cpm and the efficiency for uranium is estimated to be 0.4 cpm/dpm. The difference between the measurements made at the two different voltages is equal the beta count rate.

Static measurements (measurements at a single point) may be made using the floor monitor or by using a portable scaler and a ZnS alpha scintillometer or plastic scintillator for beta measurements. For alpha measurements, a Ludlum Model 2221 coupled to a Model 43-90 ZnS detector will be used (or equivalent). The active area of the Model 43-90 is 125 cm^2. The detector is 7.5 cm by 16.5 cm. The background for this detector is typically less than 1 cpm. For beta measurements, a Ludlum Model 44-116 (or equivalent) may be used which typically has a background count rate of 325 cpm, an area of 125 cm^2, and a beta efficiency of 0.2 cpm/dpm.

C.2 Minimum Detectable Concentration

Detector efficiency measurements were made for the Model 43-90 and Model 43-37 detectors using a depleted uranium NIST traceable source. While it is true that the efficiency will be slightly higher for a natural uranium source due to the higher average alpha energy, other factors such as dust on the floor will reduce the detector efficiency during actual surveys. The Model 43-90 has an alpha efficiency of 13 percent when the detector was in contact with the surface while only 5.5 percent when the detector was placed at 11 mm from the surface. The Model 43-37 had an alpha efficiency of approximately 9 percent at a height of 11 mm from the surface. The background count rates for the Model 43-90 and Model 43-37 were measured to be 1 cpm and 4 cpm, respectively.

The final verification measurements will be made using static one-minute counts or less providing an adequate minimum detectable concentration (MDC) can be achieved. Using the formula 6-7 from MARSSIM, the MDC for a one-minute count for the floor monitor (Model 43-37) is calculated to be 23 dpm/100 cm^2 for alpha measurents. The MDC for the Ludlum 43-90 alpha scintillator is calculated to be 107 dpm/100 cm^2. The counting times may be changed to obtain an approximate 100 dpm/100 cm^2 MDC, based on the background count rate in the facility. In any case, the counting time will be adjusted to meet the goal of having the MDC for static alpha measurements be less than 10 percent of the 1000 dpm/100 cm^2 limit.

Using existing data, we estimate that the MDC for a one-minute static measurement for beta contamination using a Model 43-37 is 167 dpm/100 cm^2 and 333 dpm/100 cm^2 using a Model 44-116 detector. For purified U-nat, we expect approximately one energetic beta particle and one alpha particle to be emitted per disintegration of U-nat. Therefore, the MDC for U-nat for alpha and beta measurements will be the same as calculated above. Naturally, the much lower MDC for alpha measurements will make alpha measurements the preferred method for demonstrating compliance with the surface contamination limit.

In order to take advantage of the low MDC for alpha measurements, surface beta contamination measurements will be made to assure that the alpha emission rate is not attenuated by moisture, surface coatings, or other surface features during the initial characterization and the decontamination phases. For the final status survey, a minimum of three static beta measurements will be made within each MARSSIM 100-m^2 Class 1 and Class 2 survey unit. The selection of the three locations will be made at random from the set of alpha contamination measurement locations.

Because of the better detector sensitivity, all scanning will be done using the Model 43-37 detector in the alpha high voltage range and possibly the Model 43-90 detector. The critical level, L_c, is defined as the net response level, in counts, at which the detector output can be considered above background. For this project, a 5 percent error rate has been assumed for both the Type 1 and Type 2 errors where Equations 6-6 are used to calculate the critical levels. For static one-minute counts, the floor monitor has an $L_c = 4$ counts; the Ludlum 43-90 has an $L_c = 2$ counts. Therefore, any area where the net counts (after subtracting background counts) exceed these levels are considered above background. Again, this may change as the background changes at the facility.

C.3 Scanning Surveys and Decontamination

C.3.1 Class 1 Areas

A scanning survey will be conducted on all floor surfaces using a floor monitor. With a low background count rate, normally the technician will consider stopping upon hearing a count to determine whether the count was from contamination or a spurious background count. In order to determine the maximum scanning speed for an instrument, Equation 6-12 in MARSSIM was used along with the detector parameters noted above. The result shows that in order to have a probability of at least 95 percent of observing at least one count while passing over an area the size of the detector contaminated at 1000 dpm/100 cm^2, the scanning speed has to be less than 45 cm/sec. This is a very fast scanning speed and shows that the instrumentation is very adequate for the task. Application of equation 6-13 shows that if one stops for a minimum of 0.25 seconds, there is a 90 percent probability that another count will be observed within that 0.25 seconds, providing the area is contaminated at the 1000 dpm/100 cm^2 level or higher. In fact, applying equation 6-14 shows that there is a 92 percent probability that 2 or more counts will be registered in 1 second while traversing an area contaminated at the limit of 1,000dpm/100 cm^2. Slowing the scanning speed to 23 cm/sec (9 inches/sec), if the technician stops when he/she hears 2 counts/second and investigates further, the calculations indicate that all areas greater than $0.1m^2$ contaminated at or above the limit will be investigated. In order to arrive at that number, since the detector is 16 cm wide and 36 cm long, and if the technician is scanning at a rate of 23 cm/s stops when he/she hears two counts per second, this will provide a 92 percent assurance that spots as small as 36 x 23 = 828 cm^2, or approximately 0.1 m^2, will be further evaluated.

In order to assure ALARA is implemented, the scanning speed will be adjusted to assure a high probability of detecting contamination at 500dpm/100 cm^2 over a relatively small area. The calculations show that if the floor monitor is pushed at a rate of 23 cm/s (9 inches/sec), there is a 96 percent chance of one or more counts while passing over a contaminated area with average contamination equal to 500 dpm/100 cm^2. The calculations also show that there is almost a 100 percent chance of two or more counts being registered in 2 seconds while passing over this area. Since the detector is 16 cm wide and 36 cm long, if the technician stops when he/she hears two counts within a period of 2 seconds, this will assure that spots as small as 36 x 23 x 2 = 1,656 cm^2, or approximately 0.2 m^2, will be further evaluated. The technician will stop and mark the area with chalk or otherwise delineate the area for further evaluation. Naturally, this criterion for further investigation is more conservative than the criterion for identifying contamination at the1,000 dpm/100 cm^2 limit (2 counts/second) and thus will be the ALARA-based action level.

Areas identified as exceeding the 500-dpm/100-cm^2 action level will be delineated and investigated further by static-point measurements. Further attempts at decontamination will be made to assure compliance with the ALARA goal of reducing the levels as low as reasonably achievable.

The dose assessment was based on a floor area of 100-m^2 with uniform contamination. The dose calculations show that the principal dose pathway is via inhalation of resuspended contaminated dust. The direct gamma exposure pathway was not significant and therefore no "hot spot" criteria are proposed for these buildings. However, the proposed scanning method should specifically identify most 0.2-m^2 areas having contamination above 50 percent of the criterion. The ALARA efforts at reducing the contamination levels in these special areas should result in an average contamination level that is considerably less than 50 percent of the criterion.

C.3.2 Class 2 Areas

The walls within 2 meters from the floor will be considered Class 2 areas. The area will be scanned using the detector taken from the floor monitor with possible use of the Model 43-90 in small or difficult to access areas.

Applying Equations 6-12 and 6-13 to the Model 43-90 detector shows that in order to have a 95 percent probability of detecting at least one count while passing over an area contaminated at the 1000 dpm/100 cm^2 level, a maximum scanning speed of 3 cm/sec should be used. If one stops for two seconds, there is a 90 percent probability of at least one other count if the contamination limit of 1000 dpm/100 cm^2 is exceeded.

Should areas of contamination be found in Class 2 areas that exceed 500 dpm/100 cm^2, the area will be reclassified as Class 1 and Class 1 verification procedures followed.

C.3.3 Class 3 Areas

The Class 3 areas consist of the ceilings and upper walls of the Plant Buildings. These walls and ceilings are very high, especially at Irigaray, and the consequences of exceeding the limit are very small since the contamination would more than likely remain undisturbed. In order to scan in these areas, an extensive effort would be required to protect the safety of the workers. Therefore biased static-point measurements will be made at a minimum of 30 locations within each building. One or more measurements will be made in all areas where process knowledge would indicate a potential for contamination. Potential sampling points include horizontal ledges, surfaces, and beams where dust may have collected as well as in and around HVAC and other ducts. An additional 30 random measurements will be made in each room of the building on wall and ceiling sections that are representative of the major portion of the Class 3 area. The Class 3 area within each room will be considered one survey unit.

Biased or random measurements results from Class 3 areas that exceed 25 percent of the limit of 1000 dpm/100 cm^2will indicate a need to reclassify at least a portion of the Class 3 area as Class 2. A complete scan will then be required according to Class 2 procedures.

C.4 Final Verification (Status) Survey

The MARSSIM guidance is, by necessity, based on the existing data and professional judgment. The method recognizes that small changes may be required as additional data are gathered. The preliminary site characterization data have been used along with actual measured detector parameters to prepare the following sections.

C.4.1 Class 1 Areas

In order to determine that the Class 1 areas meet the DCGL, the area will be divided into 100 m^2 survey units, using a grid system appropriate for each structure. The purpose of the Final Verification Survey is to demonstrate that each survey unit meets the cleanup criteria. In this case, the result of the dose modeling effort showed that a surface contamination limit of 1,000 dpm /100 cm^2, averaged over the entire 100-m^2 area, would not result in a TEDE of more than 25 mrem/y to the occupant.

The preliminary characterization survey showed that the background contamination levels are a very small fraction of the DCGL value of 1000 dpm/100 cm^2 and thus the background level may be ignored (assumed to be zero).

The null hypothesis, H_o, is that the survey unit exceeds the release criterion. Therefore it will be necessary to demonstrate that the null hypothesis can be rejected prior to release of the survey unit. A Type 1 decision error (α) would release the unit containing activity that exceeds the limit. A Type 2 decision error (β) is to incorrectly accept the null hypothesis, resulting in unnecessary work. For this project, we will accept 5 percent α and β decision errors.

The next task is to calculate the relative shift parameter as defined in MARSSIM by

$$(DCGL\text{-}LBGR)/\sigma$$

where DCGL is 1,000, the Lower Bound of the Gray Region (LBGR) is to be defined, and σ is the standard deviation of the measurements.

In Section 3.3, it was shown that the alpha scanning capability of the proposed instrumentation is very good and that hot spots at less than half of the criterion will be identified and investigated further. Where practical, these areas will be further cleaned to ALARA levels. Since all Class 1 surfaces will be scanned, this reduces the probability that a significant fraction of the survey unit will exceed the cleanup criterion. In addition, further cleaning will result in reducing the levels and thus result in reducing the standard deviation of the measurements in the final verification survey. It is reasonable to expect a standard deviation of 300dpm/100 cm^2 for the verification data for each survey unit.

Assuming a LBGR of 500, the relative shift parameter is 1.7. Using the equations in MARSSIM, the number of data points to demonstrate compliance is calculated to be 13. Increasing this by 20 percent, as recommended, brings the total measurements per grid block to 16.

As a final precaution, static beta contamination measurements will be made at a minimum of three of the 16 measurement locations. The locations shall be selected at random. Discrepancies in measurements must be evaluated.

C.4.2 Class 2 Areas

As indicated in a previous section, the Class 2 areas will have been scanned and determined to have, with a high probability, no areas higher than 50 percent of the criterion. Additional static-point measurements taken during this time will have provided evidence that the average contamination in these Class 2 areas is at or near-background levels.

Following the same method as for Class 1 Areas and using survey units of 100-m^2size, the standard deviation of these measurements is expected to be around 100 or less because it is not expected to have many results above background levels. Assuming a LBER of 700 would still result in a relative shift of 3, where the signP is 1. Type 1 errors are not as significant in Class 2 areas since the potential for exposure is much less from the lower walls than for the floor. Therefore we have chosen $\alpha = 0.2$. We have limited Type 2 errors to 0.1 since this type of error would necessarily involve further unnecessary remediation or further sampling. Type 2 errors have been limited to $\beta = 0.1$.

Substituting the numbers in Equation 5-2 of MARSSIM, the number of sampling points required is 5. Increasing this by 20 percent, as recommended requires 6 samples from each survey unit.

As a final precaution, static beta contamination measurements will be made at a minimum of three of the six measurement locations. The locations shall be selected at random. Discrepancies in measurements must be evaluated.

C.4.3 Class 3 Area

The Class 3 Area will consist of the ceilings and upper walls where biased and random measurements have demonstrated that the area is free of hot-spot contamination in excess of 25 percent of the criteria, and that the average levels are near background levels. Since normal background levels are insignificantly low compared to the 1,000dpm/100 cm^2 criterion, no further verification sampling is proposed. The average value for the Class 3 units will be calculated by averaging the 30 random measurements taken per room.

C.5 Measurement and Grid Construction

A grid will be established across all Class 1 and Class 2 survey units according to guidance in MARSSIM. A grid will be established over each 100-m^2survey unit.

Sixteen static point measurements will be made using the Model 43-90 detector. Data will be collected for 1 minute using standard operating procedures. A drawing of the grid and sampling points will be prepared and documented.

C.6 Data Evaluation

With the assumption that the background can be ignored, the data are evaluated using the MARSSIM guidance. If all values within a survey unit are below the criterion, the survey unit passes. If individual values exceed the criterion, the Sign Test will be applied to the data and the result used to determine whether the unit passes or fails.

C.7 References

NUREG-1575. Multi-Agency Radiation Survey and Site Investigation Manual (MARSSIM). Published jointly by the U.S. Nuclear Regulatory Commission, U. S. Environmental Protection Agency, U. S. Department of Energy, and the U. S. Department of Defense. December, 1997.

Revised in its Entirety

1. Purpose

This procedure provides guidance on the cleanup and verification of areas where contaminated soil is removed from deep excavations. This procedure applies only to areas where excavations will be backfilled with clean soil. In such areas the cleanup criteria for a mixture of radionuclides is equivalent to that which would provide a dose equal to the Benchmark Dose from 15 pCi/g Ra-226 plus background. If backfill is not required, SOP D-3 should be used.

2. Responsibilities

The RSO or a contact specialist is responsible for assuring that this procedure is implemented. The survey team members and sampling technicians are responsible for following the procedure.

3. Procedure

3.1 Equipment

The following equipment should be available prior to starting work. All radiological monitoring equipment should be function checked using SOP D-4.

_____Hand-held instrumentation such as the Ludlum Model 2221/44-10 or equivalent for localized areas of deep excavation requiring a survey.

_____Lead shielding appropriate for the hand-held meter used.

_____Soil sample coring instrument

_____Shovel/trowel

_____3-mil one-gallon plastic bags or equivalent and marking pens

_____5-gallon pails

_____Measuring tape

_____Sketching Pad

3.2 Soil Cleanup, Monitoring, and Sampling for Verification

Deep excavations normally occur as a result of leaking pipes or sumps or other spills. Since each excavation will be unique in size, depth, and shape, monitoring during the removal of contaminated soil must rely more on professional judgment of the technician. In addition, field sketches must be made of the excavation and locations of verification samples noted on the sketch.

3.2.1 Excavation Control Monitoring

For areas where contamination may be found at considerable depth, ground control technicians using Ludlum Model 2221/Model 44-10 NaI detectors shall conduct radiological surveys and guide the excavation effort. This real-time monitoring information provides a high level of confidence that once removal is complete, the area will meet the cleanup criteria. When monitoring deep excavations, it may be difficult to determine the source of the elevated gamma radiation. In those cases, it may be necessary to place a lead collimator on the detector and survey the sidewalls and floor. Correlation studies for the shielded detectors and for deep excavations have not been performed. Thus cleanup to the action levels for surface soils, as given in the Decommissioning Plan, should be considered. The technician should keep in mind that a gamma detector will increase in count rate by up to 50 percent when placed in a trench or other deep excavation, even if no contamination is present. A gamma action level for a specific excavation may be determined by bringing soil to the surface for monitoring or, if a screening laboratory has been established, submitting samples for analysis.

3.2.2 Radiological Survey

The following steps should be taken to conduct a radiological survey within an excavated area.

1. Upon completion of the excavation where preliminary excavation control indicates the locale is clean and consistent with the meter action level, a final gamma survey will be performed in the excavated area. A hand-drawn sketch of the excavation should be made and the sampling and measurement locations noted on the sketch.

2. Readings from the floor and sidewalls of the excavation will be taken at a sufficient frequency to ensure a minimum of seven readings per 100 m^2 of excavation floor or 100 m^2 of excavation sidewall. The dimensions of the excavation will be taken into account to ensure sufficient reading frequency. For excavations of less than 100-m^2 area, one reading per 10 m^2 will be taken. Data will be recorded on the attached form, CMI-D-5.01. The average of the counts for each 100 m^2 (or less) will be calculated for comparison against the instrument action level (see above). If the average exceeds the action level, additional excavation may be considered, followed by another gamma survey of the area.

3.2.3 Soil Sampling

1. For linear excavations (trenches) take a single six-inch deep soil sample at approximately one-half the excavation width at 150-ft. intervals. Place a labeled survey stake or pin flag at the trench crest adjacent to the sample location. Sample the sidewalls per instructions in No. 2 below.

2. For excavations other than long trenches, take a minimum of one five-point composite sample from the excavation floor and sidewalls. If the total excavation area exceeds 100 m^2, take a five point composite for each 100-m^2 area. The sample points for the composite should be more or less evenly spaced to provide adequate representative coverage of the area. Specific dimensions cannot be provided here due to the likely variability in excavation shape.

3. Thoroughly mix each five-point composite sample in a plastic bucket prior to filling the sample bag. Alternatively, the entire composite volume may be delivered to the sample preparation area for mixing and bagging.

4. Appropriately label the location identification of each sample collected. Composite sample locations will be marked with a corresponding identifying stake or pin flag in case the site must be resurveyed, resampled, or subjected to further cleanup.

5. A hand sketch should be made with the sample locations noted. Each sampled area will be surveyed for location prior to any final backfill.

3.2.4 Sample Handling and Analysis

Soil samples will be handled, managed, and analyzed following the procedure in SOP D-3.

Deep Excavation Cleanup Data Form

Rate Meter Ser. No. ____________

Detector Ser. No. ______________

Action Level ____________ *cpm/microR/h (cross out one)*

Location	***cpm or μR/hr***	***Location***	***cpm or μR/hr***	***Technician***

Reviewed By: ________________________ *Date* ______________

Form CMI-D-5.01