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ASSOCIATE AIRCRAFT SITE HAZARD ASSESSMENT FOR IDENTIFIED SOIL CONTAMINATION

1.0 PURPOSE

To determine the hazard associated with the localized sub-slab contamination found at the Associate Aircraft Site (AAS) in Fairfield, Ohio under a portion of the former AAS building (see figure 1). This assessment leads to the conclusion that the potential dose from the residual soil contamination is well below the current or likely use guideline, as proposed in 10 CFR 834.

2.0 INITIAL DERIVATION OF CLEANUP GUIDELINES

The Environmental Assessment Division of Argonne National Laboratory published *Derivation of Guidelines for Uranium Residual Radioactive Material in Soil at the Former Associate Aircraft Tool and Manufacturing Company Site, Fairfield, Ohio* in January 1995 (Reference 1). This work was sponsored and approved by the U.S. DOE, Office of Environmental Restoration.

The Associate Aircraft site has been identified for remedial action under the U.S. DOE's Formerly Utilized Sites Remedial Action Program (FUSRAP). Uranium guidelines were derived on the basis of the requirement that following remedial action, the 50-year committed effective dose equivalent to a hypothetical individual living or working in the immediate vicinity of the site should not exceed (1) 30 mrem/yr for the current-use and likely future-use scenarios or (2) 100 mrem/yr for less likely future-use scenarios (Yu et al. 1993).

The DOE residual radioactive material guideline computer code, RESRAD (version 5.41), which implements the methodology described in the DOE manual for establishing residual radioactive material guidelines, was used in the evaluation.

Three scenarios were considered in which it was assumed that the site would be used without radiological restrictions for a period of 1,000 years following remedial action. The three scenarios varied with regard to the type of site use, time spent at the site by the exposed individual, and sources of food consumed. The evaluation indicated that the EPA dose limit of 30 mrem/yr would not be exceeded for uranium (including U-234, U-235, and U-238) within 1,000 years provided that the soil concentration of total uranium at the site did not exceed 970 pCi/g for scenario 1 (industrial worker: current use scenario) or 280 pCi/g for scenario 2 (resident: municipal water supply, a likely future-use scenario). The DOE dose limit of 100 mrem/yr (DOE Order 5400.5) would not be exceeded at the site if the uranium concentration of the soil did not exceed 790 pCi/g for scenario 3 (subsistence farmer: on-site well water, a plausible but unlikely future-use scenario).

The uranium guidelines derived in the analysis applied to the total activity concentration of uranium isotopes (i.e., U-238, U-234, and U-235 present in their natural activity concentration of 1:1:0.046). In setting the actual uranium guidelines to be used at the Associate Aircraft site, DOE applied the as-low-as-reasonably-achievable (ALARA) policy to the decision-making process. After these considerations the actual uranium guideline used for residual radioactivity in soil was 35 pCi/g (1/8th of the most conservative derived guideline).

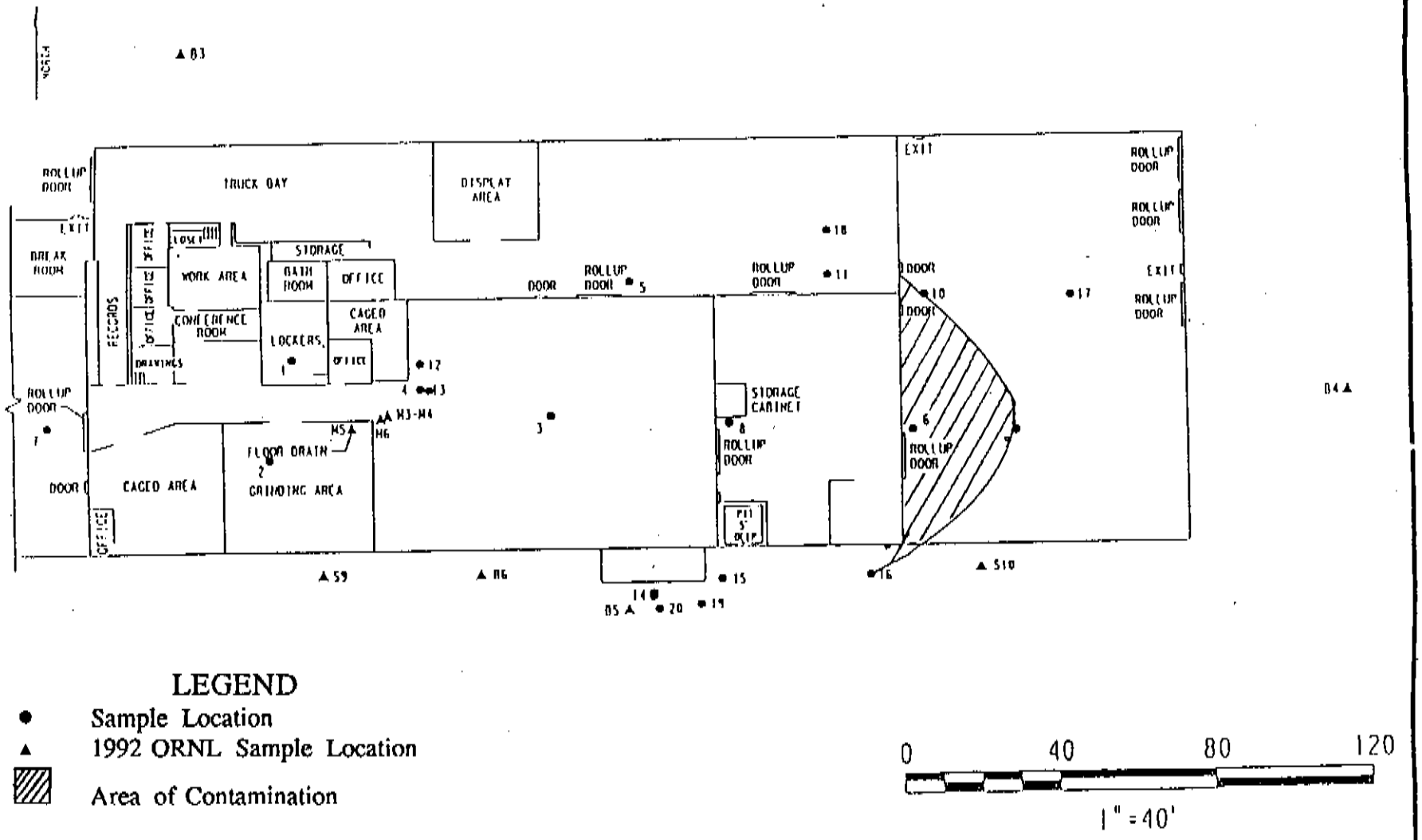

Figure 1
Former Associate Aircraft Site

3.0 HAZARD DETERMINATION FOR RESIDUAL SOIL CONTAMINATION AT AAS

In December 1994 and February 1995, 111 samples were collected from 15 locations inside the former AAS building, and 34 samples were collected from 13 locations outside the building. These locations were selected to further delineate boundaries (both vertical and horizontal) of contamination identified in the ORNL report. Figure 1 shows interior and exterior sampling locations.

Based on the results obtained, uranium-238 concentrations above the site specific criteria (35pCi/g) were found at locations 1, 4 and 6. Uranium-238 concentrations from the sampling locations in these areas are presented in Table 2. The radioactive contamination detected at locations 4 and 6 were delineated in a second phase of sampling by placement of sample locations 10, 9 and 16 for location 6, and additional sample locations 12 and 13 for location 4. Vertical and areal extent of contamination has thereby been established for these locations. The areas around location 1 and 4 were adjacent to a radioactively contaminated expansion joint and have since been remediated. Therefore this hazard assessment applies to the area in the proximity location 6.

The sample results of location 6 indicate radioactive contamination at a maximum concentration of 134 pCi/g. Table 1 summarizes the results of the sampling at location 6, 9, 10, and 16.

Table 1 - Sampling Results

Borehole	Depth (ft)	Field Counts (cpm)*	U-238 (pCi/g)**
6	0 - 1	40	< 2.3
	1 - 2	40	< 2.4
	3 - 4	1400	134
	4 - 5	60	5.8
	5 - 6	50	< 5.0
	6 - 7	50	< 1.9
	7 - 8	50	< 2.5
9	0 - 1	45	< 1.7
	1 - 2	45	< 1.3
	2 - 3	50	< 1.5
	3 - 4	50	< 1.3
	4 - 5	50	< 2.6
	5 - 6	45	< 3.8
	6 - 7	45	< 2.9
	7 - 8	45	< 1.9
	8 - 9	45	< 2.7
	9 - 10	50	< 4.4
	10 - 11	50	< 1.7
	11 - 12	45	< 2.2
10	0 - 1	42	.44
	1 - 2	42	< 1.4
	3 - 4	44	< 2.0
	4 - 5	55	.63
	5 - 6	52	1.8
	6 - 7	52	.40
	7 - 8	70	.47
	8 - 9	70	< 1.5
	9 - 11	54	< 1.4
16	0 - 1	58	.84
	1 - 2	41	.60
	2 - 3	55	< 1.3
	3 - 4	50	< 1.2

* Measured with HP 210 or HP 260 field radiation detection instrument

** Measured with Gamma Spectroscopy radiation detection instrument

3.1 CALCULATIONS

Using the derived maximum dose/source ratios (see Attachment A), calculations were performed for all three scenarios. Based on the calculations, utilizing RESRAD, it has been determined that this material represents a minimal hazard.The results of the calculations are shown in Table 2 below.

Table 2
Maximum Annual Dose From Residual Radioactive Contamination at the Former Associate Aircraft Site

Scenario #	Dose/Source Ratio x Soil Activity Conc= (mrem/yr)/(pCi/g) (pCi/g)				Dose (mrem/yr)
1[a]	3.1×10^{-2}	x	134	=	4.154
2[b]	1.1×10^{-1}	x	134	=	14.74
3[c]	1.3×10^{-1}	x	134	=	17.42

a-Industrial worker: no consumption of water or foods obtained on the site.
b-Resident: water used for drinking, household purposes, and irrigation was assumed to be from uncontaminated municipal sources.
c-Subsistence farmer-water used for drinking, household purposes, livestock watering, and irrigation was assumed to be from an on-site well.

3.2 SUMMARY OF RESULTS

Scenario 1 - The results of the RESRAD calculations determined that in scenario 1 an industrial worker would receive an annual exposure of 4.154 mrem/yr due to the residual contamination on the site.

Scenario 2 - The results of the RESRAD calculations determined that in scenario 2 a resident would receive an annual exposure of 14.74 mrem/yr due to the residual contamination on the site.

Scenario 3 - The results of the RESRAD calculations determined that in scenario 3 a subsistence farmer would receive an annual exposure of 17.42 mrem/yr due to the residual contamination on the site.

All of the calculated values are below the 30 mrem/yr for current or likely land use, as proposed in 10 CFR 834. Furthermore, the calculations only allowed for a shielding factor of 30% for the attenuation of external gamma radiation in scenario 1, in reality the shielding provided would provide much greater than 30% shielding. In scenarios 2 and 3, it is likely that large amounts of the contaminated soil would be removed in preparing the site for residential or farming use. The initial dose/source ratios were determined on a large homogeneously contaminated area. For a small, isolated area of contamination, such as the area in question (see figure 1), the annual dose would be even less due to the smaller amount of contact possible (Yu et al. 1993). Therefore, the calculated annual doses are very conservative.

4.0 CONCLUSION

The calculations performed for this assessment lead to the conclusion that the potential dose from residual radioactive contamination for in all three scenarios is well below the 30 mrem/yr current or likely land use guideline, as proposed in 10 CFR 834. All scenarios use conservative assumptions and address all credible pathways. Furthermore, scenario 1 is most likely at this site, consideration of scenarios 2 and 3 provide additional evidence of the minimal hazard.

Results of these calculations show that supplemental limits are warranted for the area of location 6. Leaving the residual contamination in place does not pose a potential present or future exposure risk, and the cost (≈ $260,000) and time involved in remediation and restoration of this area is high relative to the long-term benefits that would result.

5.0 REFERENCES

1. Yu, C., et al., 1995, *Derivation of Guidelines for Uranium Residual Radioactive Material in Soil at the Former Associate Aircraft Tool and Manufacturing Company Site, Fairfield, Ohio*, ANL/EAD/LD-2, Argonne National Laboratory, Argonne, Ill., Jan.

2. Yu, C., et al., 1993, *Manual for Implementing Residual Radioactive Material Guidelines Using RESRAD, Version 5.0*, ANL/EAD/LD-2, Argonne National Laboratory, Argonne, Ill., Sept.

3. Spieker, A.M., 1965, *Hydrogeologic Aspects of an Analog Model Study of the Fairfield-New Baltimore Area, Ohio,* Doctoral Thesis, Stanford University, Stanford, Calif.

4. Orlandini, K.A., 1994, personal communication from Orlandini (Environmental Research Division) to C. Yu (Environmental Assessment Division), Argonne National Laboratory, Argonne, Ill., Dec. 19.

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ATTACHMENT A

DERIVATION OF TOTAL DOSE/SOURCE CONCENTRATION RATIOS FROM

Derivation of Guidelines for Uranium Residual Radioactive Material in Soil at the Former Associate Aircraft Tool and Manufacturing Company Site, Fairfield, Ohio

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1.0 Scenario Definitions

Three potential exposure scenarios were considered for the assessment of residual radioactivity guidelines for the soil. For each scenario, it was assumed that at some time within 1,000 years, the site would be released for use without radiological restrictions following remedial action. Potential radiation doses from nine exposure pathways were considered. The pathways are listed in Table A-1.

Table A-1

Summary of Exposure Pathways for Scenarios 1,2, and 3 at the Former Associate Aircraft Site

Pathway	Scenario 1[a]	Scenario 2[b]	Scenario 3[c]
External Exposure	Yes	Yes	Yes
Inhalation	Yes	Yes	Yes
Radon	Yes	Yes	Yes
Ingestion/plants	No	Yes	Yes
Ingestion/meat	No	No	Yes
Ingestion/milk	No	No	Yes
Ingestion/fish	No	No	Yes
Ingestion/soil	Yes	Yes	Yes
Ingestion/water	No	No	Yes

a-Industrial worker: no consumption of water or foods obtained on the site.
b-Resident: water used for drinking, household purposes, and irrigation was assumed to be from uncontaminated municipal sources.
c-Subsistence farmer-water used for drinking, household purposes, livestock watering, and irrigation was assumed to be from an on-site well.

The RESRAD computer code (YU et al. 1993) was used to calculate the potential radiation doses for the hypothetical future industrial worker (scenario 1) and the resident and subsistence farmer (scenarios 2 and 3 respectively) on the basis of the following assumptions:

- During one year, the industrial worker spends 2,000 hours (23%) indoors at the site, 250 hours (3%) outdoors at the site, and 6,510 hours (74%) away from the site. During one year, the resident and subsistence farmer spend 4,380 hours (50%) indoors, 2,190 hours (25%) outdoors, and 2,190 hours (25%) away form the site (Yu et al. 1993).

- The walls, floor, and foundation of the building reduce external exposure by 30%; the indoor dust level is 40% of the outdoor dust level.

- The airborne dust loading is 0.1 mg/m ^{3}.

The summation of $DSR_{ip}(t)$ for all pathways p is the $DSR_i(t)$ for the ith isotope; that is,

$$DSR_i(t) = \Sigma_p DSR_{ip}(t).$$

The total dose/source concentration ratio for total uranium can be calculated as

$$DSR(t) = \Sigma_i W_i DSR_i(t),$$

where W_i is the existing activity concentration fraction in soil at the site for uranium-234, uranium-235, and uranium-238.

For this analysis, W_i is assumed to represent the natural activity concentration ratios of 1/2.046, 1/2.046, and 0.046/2.046 for uranium-238, uranium-234, and uranium-235, respectively. The total dose/source concentration ratios for single radionuclides and total uranium are provided in Table A-2. These ratios were used to determine the allowable residual radioactivity for uranium in soil at the former Associate Aircraft site. These ratios will also be used to determine the level of hazard that will remain on-site at the given concentration of residual soil contamination.

Table A-2

Total Dose/Source Concentration Ratios for Uranium at the Former Associate Aircraft Site

	Maximum Dose/Source Concentration Ratio (mrem/yr)/(pCi/g)		
Radionuclide	**Scenario 1[a]**	**Scenario 2[b]**	**Scenario 3[c]**
Uranium-234	1.6×10^{-2}	5.9×10^{-2}	8.0×10^{-2}
Uranium-235	1.9×10^{-1}	6.1×10^{-1}	6.3×10^{-1}
Uranium-238	3.9×10^{-2}	1.3×10^{-1}	1.5×10^{-1}
Total uranium	3.1×10^{-2}	1.1×10^{-1}	1.3×10^{-1}

a-Industrial worker: no consumption of water or foods obtained on the site.
b-Resident: water used for drinking, household purposes, and irrigation was assumed to be from uncontaminated municipal sources.
c-Subsistence farmer-water used for drinking, household purposes, livestock watering, and irrigation was assumed to be from an on-site well.

Because the maximum dose occurs at time zero in all three scenarios, uncertainties in parameters that affect the leaching of radionuclides from the contaminated zone and their transport through unsaturated and saturated strata do not affect results. Breakthrough time (the time it takes the uranium to reach the water table) was estimated to occur in 600 years after remediation (Yu et al. 1995), however, the dose contribution from water-dependent pathways in scenario 3 is smaller than the contribution of the water-independent pathways at the time of peak dose. Changing the depth of the water table would only affect the breakthrough time, it would not significantly affect the magnitude of the dose contributed by water-dependent pathways.

The RESRAD default values were used in the calculations if no site-specific data were available. These default values are based on national average or reasonable maximum values.

United States Government

Department of Energy

memorandum

DATE: June 05, 1995

REPLY TO ATTN OF: EM-421 (W. A. Williams, 301-903-8149)

SUBJECT: Hazard Assessment for Radioactive Contamination at the Associate Aircraft Site, Fairfield, Ohio

TO: L. Price, OR

This memorandum is to provide comments and approval of the Associate Aircraft Site Hazard Assessment for Identified Soil Contamination.

The hazard assessment was prepared and supplemental limits were requested, based on a single soil sample with 134 picoCuries per gram of uranium. This sample was obtained from underneath the building slab in an area that was a loading dock for the facility during Atomic Energy Commission operations during the 1950s. The area is not readily accessible because of industrial equipment located over the soil contamination area. The estimated cost for removing the equipment and removing the contaminated soil is $260,000. The cost of removing the uranium exceeds any potential benefit.

At the request of my staff, some additional data was obtained concerning the extent of the residual uranium. This data was furnished by facsimile on May 31, 1995, and confirms the limited extent of the residual uranium.

We approve the Hazard Assessment and the use of supplemental limits for the inaccessible soil contamination at the site. Dose calculations, using the RESidual RADioactivity code, show the potential exposures to be well within the dose limits specified within the Department of Energy Order 5400.5, Chapter IV.

If you have any questions regarding this, please call me at 301-903-2531.

James W. Wagoner II
Director
Off-Site/Savannah River Program Division
Office of Eastern Area Programs
Office of Environmental Restoration

cc:
M. Murray, ORNL
J. Wood, BNI