



June 1, 2005

Larry W. Camper, Chief  
Decommissioning Branch  
Division of Waste Management  
Office on Nuclear Materials Safety and Safeguards  
United States Nuclear Regulatory Commission  
Washington, DC 20555-0001

**RE: Revised Probabilistic Dose Analysis  
Former Brooks and Perkins Site, Livonia, Michigan**

Dear Mr. Camper:

#### **INTRODUCTION**

On behalf of AAR Corp., we are submitting for your review a revised radiation dose assessment and a proposed remedial action associated with the thorium contaminated soil at the subject site. Once AAR has your agreement that this revised assessment represents an acceptable basis for resolution of this matter, the agreement can be finalized, necessary approvals obtained, and the contemplated remedial activities undertaken.

#### **DISCUSSION**

As a result of licensed operations by Brooks and Perkins, the former owner of the property, the soil surrounding the AAR Corp. facility in Livonia, Michigan, is contaminated with thorium. In a letter dated November 13, 2002, Partners submitted a probabilistic assessment of the radiation dose from the thorium and requested release of the site in accordance with 10 CFR Part 20. After reviewing the submittal, the NRC requested additional information, which was provided by letter dated April 15, 2003. One of the requests dealt with the use of a geometric average of the site data as compared to use of an arithmetic average. Subsequent to our response, the NRC engaged Oak Ridge Institute for Science and Education (ORISE) to conduct a final confirmatory survey of the site.

The results of the ORISE survey, which confirmed the previous AAR survey, were forwarded to AAR on April 9, 2004. In its transmittal letter, the NRC provided a criterion to evaluate areas of locally elevated thorium concentrations for compliance with 10 CFR Part 20. The NRC also analyzed the AAR and ORISE survey data and concluded that two grids in the Eastern Parcel and one grid in the Western Parcel failed to meet the criterion. AAR was asked to evaluate the options for addressing these areas.

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A telephone conference with AAR, Partners and the NRC was held on May 17, 2004, to discuss the options for addressing the areas of locally elevated thorium concentration. In that call, the NRC stated that it could not accept the use of the geometric average for determining site wide thorium concentration and requested that AAR revise its dose assessment using the arithmetic average.

## CONCLUSION

AAR and Partners have evaluated the options for dealing with areas of elevated thorium concentration using arithmetic averaging and propose the following to resolve this matter:

- Removal to a depth of one meter and disposal of grids 118 and 210 in the Eastern Parcel,
- Removal to a depth of one meter and disposal of grid 249 in the Western Parcel.

The NRC identified grid 219 in the Western Parcel as exceeding the elevated concentration criterion. However, Partners determined that it is grid 249 that exceeds the criterion. Our analysis is presented on the accompanying spread sheet entitled *Grid Analysis*.

Attached are the results of the probabilistic dose analyses of the Eastern and Western Parcels. The analyses were performed using the arithmetic averages of the AAR and ORISE survey data after grids 118, 210 and 249 are removed from the site. The results demonstrate that with the removal of these grids, the radiological conditions of the Eastern Parcel comply with the dose limit of 10 CFR 20.1402 for unrestricted release, and the radiological conditions of the Western Parcel comply with the dose limitations of 10 CFR 20.1403 for restricted release. For your convenience, the RESRAD input and outputs, as well as the results of the statistical analyses, are being provided in digital form.

We would appreciate your prompt review of this matter. If you have any questions regarding the analyses, please contact our office at 410-252-7498.

Sincerely,  
Partners Environmental Consulting, Inc.

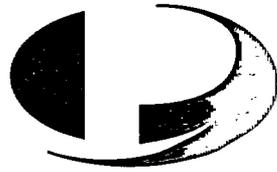


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Senior Engineer

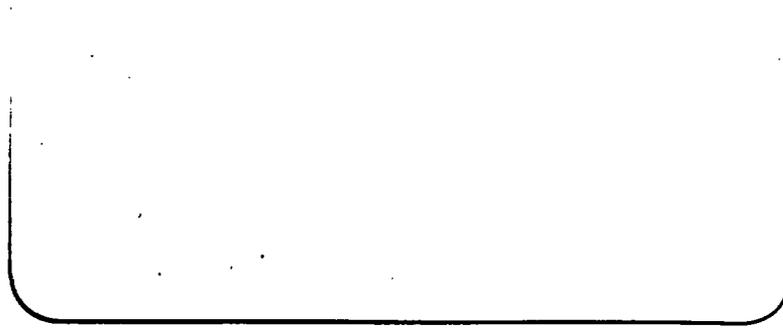


Dan B. Brown, CPG  
President

cc: Howard Pulsifer, with attachments  
Lisa Stetar, with attachments  
Mark Wetterhahn, with attachments



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**UPDATE TO THE  
PROBABILISTIC DOSE ASSESSMENT**

**Former Brooks and Perkins Site  
Livonia, Michigan**

**June 1, 2005**

**PREPARED FOR:** Mr. Larry W. Camper  
Decommissioning Branch  
Division of Waste Management  
Office of Nuclear Material Safety and Safeguards  
United States Nuclear Regulatory Commission  
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This report has been prepared by Partners Environmental Consulting, Inc. (Partners) for the benefit of our Client in accordance with the approved scope of work. Partners assumes no liability for the unauthorized use of information, conclusions or recommendations included in this report by a third party.

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**APPENDICES**

Provided on attached CD

## 1.0 INTRODUCTION

This report is an update to the probabilistic dose assessments that were previously submitted to the NRC for the AAR site in Livonia, Michigan (Partners Environmental, 2002 and 2003). The site, which is currently owned by AAR Manufacturing, Inc., is the former Brooks and Perkins Site. The Brooks and Perkins Corporation was licensed by the NRC to process thorium alloys. The license was terminated in May 1971, and the property was acquired by AAR Manufacturing Group, Inc. in 1981. Elevated levels of residual thorium levels were later discovered on the site.

The probabilistic dose assessments previously submitted for the AAR site were performed to demonstrate compliance with the dose limits specified for release of the property under 10 CFR 20, Subpart E, *Radiological Criteria for License Termination*. Specifically, the Western Area parcel was evaluated for restricted release under 10 CFR 20.1403, *Radiological Criteria for License Termination Under Restricted Conditions*. The Eastern Area parcel was evaluated for unrestricted release under 10 CFR 20.1402, *Radiological Criteria for Unrestricted Use*. In the previous dose assessments, the geometric mean was used as the representative exposure concentration. However, based on subsequent discussions with the NRC, the decision was made to use the arithmetic mean for determining compliance with the applicable dose limits.

In this report, the arithmetic means are presented for the Western Area and Eastern Area parcels. The arithmetic means were calculated using data from the AAR site characterization study (Koh 1996) and data from the Oak Ridge Institute for Science and Education (ORISE) confirmatory survey that was performed in 2003 (Weaver 2004).

The doses associated with the arithmetic mean soil concentration were evaluated using dose-source-ratios derived from the results of the previous probabilistic dose assessments which were performed using the RESRAD code. The dose source ratios were calculated by dividing the mean peak dose by the total thorium concentration value that was used as an input to the RESRAD code. NRC NUREG-1751 states that "the 'peak of the mean' dose distribution should be used for demonstrating compliance with 10 CFR 20, Subpart E (p. 5-6)."

Based on these dose evaluations, it was concluded that no further dose assessments were required for the Eastern Parcel. However, for the Western Area parcel revised probabilistic dose assessments were performed. These revised assessments are submitted as part of this report.

## 2.0 EASTERN AREA

Two grids within the Eastern Area, Grids 118 and 210, have been determined to exceed the NRC calculated 100-square meter DCGL for the site and, therefore, will be excavated (see letter, with attachments, regarding "Results of Oak Ridge Institute for Science and Education Confirmatory Survey..." from Daniel M. Gillen of the NRC to Howard Pulsifer, Docket No. 040-00235). Therefore, data for samples collected within these grids are not included in the calculation of the arithmetic averages for the Eastern parcel.

As part of the initial probabilistic assessment, the Eastern parcel was subdivided into four areas of approximately 10,000 m<sup>2</sup> each (Areas A, B, C, and D), and these four areas were evaluated separately. Therefore, an arithmetic average of the total thorium concentrations was calculated for each of these sub-areas. The average values based on the AAR site characterization survey data for Areas A, B, C, and D are 8.4, 0.01, 2.8, and 4.0 pCi/g, respectively. When the ORISE data are included, the mean concentration for Area A of the Eastern parcel is 9.52 pCi/g. This mean was determined by calculating an average for each grid based on the AAR data. Additionally, an average was calculated for each grid sampled by ORISE using the ORISE data. A site-wide average was then calculated by averaging the grid averages. The AAR data average

was used for grids not sampled by ORISE and an average of the AAR grid average and ORISE grid average was used for those grids also sampled by ORISE (see AAR EAST Data 5-05.xls). It should be noted that these averages represent the 0 to 1 m layer of soil. For dose assessment purposes, these concentrations were conservatively assumed to exist down to 2 m. Sampling data from the AAR site characterization study and the ORISE confirmatory survey indicate that most of the contamination is present within the upper 1 meter of soil.

Based on the peak mean dose calculated for the resident farmer in the initial probabilistic dose assessment, the dose-source-ratio for the Eastern parcel is estimated to be 2.4 mrem/year per pCi/g (6.4 mrem/year divided by 2.68 pCi/g). Therefore, the estimated dose for Area A (the area of highest contamination) using the arithmetic average of 9.5 pCi/g is 23 mrem/year. Based on this evaluation, it is concluded that with the removal of grids 118 and 210 to meet the 100-square meter DCGL, the Eastern parcel of the AAR site meets the criteria for unrestricted use specified in 10 CFR 20.1402.

### 3.0 WESTERN AREA

The following is a discussion of the results of the revised probabilistic dose assessments that have been performed for the Western Area of the AAR site. Two primary modifications to the Western Area dose assessments are:

- the modeling of the 0 to 1m and 1 to 2 m soil layers separately (as opposed to assuming the concentrations measured in the top meter are present down to 2 m)
- the use of site-specific ingestion factors for homegrown fruit and vegetables based on regional data for the Midwest reported in the EPA Exposure Factors Handbook (EPA 1997).

The Western Area was evaluated for restricted release in accordance with 10 CFR 20.1403 using an industrial use scenario and a 25 mrem/year dose limit. Additionally, an assessment was performed to evaluate the potential dose associated with unrestricted use of the Western parcel in the event that the restrictions fail at some point in the future. For this assessment, the resident farmer scenario and a 100 mrem/year dose limit was used. Probabilistic assessments were performed to determine the peak of the mean dose distribution for each scenario from 0 to 1000 years.

#### 3.1 Soil Removal

One grid within the Western Area, Grid 249, was found to exceed the NRC calculated 100-square meter DCGL for the site and, therefore, will be removed (see letter, with attachments, regarding "Results of Oak Ridge Institute for Science and Education Confirmatory Survey..." from Daniel M. Gillen of the NRC to Howard Pulsifer, Docket No. 040-00235). Therefore, sampling data for the top 1 m of soil within this grid were excluded from the dose assessments.

#### 3.2 Industrial Scenario

The Western Area Industrial Scenario was modeled using the RESRAD code, version 6.21 (see RESRAD input files: WESTAARIND1.rad and WESTAARIND2.rad). A probabilistic assessment was performed using the RESRAD default distributions for all parameters except those listed in Table 1 and those for which the code does not provide default distributions. For parameters not included in Table 1 for which no default distribution is provided, the RESRAD default deterministic value was used. The pathways that were evaluated for the industrial scenario are external exposure, inhalation, and inadvertent soil ingestion.

<b>Table 1. Site-Specific, Deterministic Parameter Values Used in Western Area Industrial Scenario Assessment</b>		
<b>Parameter</b>	<b>Value</b>	<b>Basis</b>
Inhalation Rate	12,264 m <sup>3</sup> /year	NUREG/CR-5512
Exposure Duration	25 years	NUREG/CR-5512 and RESRAD Default for Industrial Scenario
Indoor Time Fraction	0.17	NUREG/CR-5512 and RESRAD default for Industrial Scenario
Outdoor Time Fraction	0.06	NUREG/CR-5512 and RESRAD default for Industrial Scenario
Area of Contaminated Zone	6175 m <sup>2</sup>	Site specific
Depth of Contaminated Zone	1 m	Site specific
Cover Depth	1m	Site specific (used only for 1 to 2 m soil layer evaluation)
Precipitation Rate	1.8 m/year	Site specific value

### 3.3 Resident Farmer Scenario

The resident farmer scenario was modeled using RESRAD 6.21 (see RESRAD input files: AARWESTRES1.rad and AARWESTRES2.rad). A probabilistic assessment was performed using the RESRAD default distributions for all parameters except those listed in Table 2 and those for which the code does not provide default distributions. For parameters for which no default distribution is provided, the default deterministic value was used. The pathways that were evaluated for the resident farmer scenario are external exposure, inhalation, ingestion of produce, meat, milk, and fish, and inadvertent ingestion of soil. The drinking water pathway was not included because, as discussed in previous submittals, it is not considered plausible that near-surface wells (i.e., those that could be affected by the thorium contamination present at the AAR site) would serve as future sources of drinking water. In the past, shallow wells in this region have not provided a reliable source of drinking water. The site and surrounding areas are zoned for industrial use and, currently, drinking water is provided by local municipalities. A 1913, report by the State of Michigan describes the surface soil region as a layer of sand or sand and gravel ranging from a few feet to 30 feet deep underlain by an impervious clay layer that prevents infiltration of near surface groundwater. Precipitation will accumulate above the clay layer, but the levels will fluctuate with the seasons and after prolonged drought may essentially evaporate. Historically, shallow wells in this region were not sufficient to support a reliable, potable water supply (Sherzer 1913). The findings of the 1996 site characterization study support this description of the surface soil region for the AAR site (Koh 1996).

**Table 2. Site-Specific, Deterministic Parameter Values Used in Western Area Resident Farmer Scenario Assessment**

Parameter	Value	Basis
Inhalation Rate	12,264 m <sup>3</sup> /year	NUREG/CR-5512
Indoor Time Fraction	0.66	NUREG/CR-5512
Outdoor Time Fraction	0.12	NUREG/CR-5512
Ingestion of Fruit, Vegetables, and Grain	84.6 kg/year	EPA Exposure Factors Handbook <sup>a</sup>
Ingestion of Leafy Vegetables	7.4 kg/year	EPA Exposure Factors Handbook <sup>a</sup>
Ingestion of Meat and Poultry	65 kg/year	NUREG/CR-5512
Ingestion of Fish	21 kg/year	NUREG/CR-5512
Ingestion of Other Aquatic Food	0 kg/year	Assumed (RESRAD default for fish =5.4 kg/yr and other aquatic = 0.9 kg/yr)
Area of Contaminated Zone	6175 m <sup>2</sup>	Site specific
Depth of Contaminated Zone	1 m	Site specific
Cover Depth	1m	Site specific (used only for 1 to 2 m soil layer evaluation)
Precipitation Rate	1.8 m/year	Site specific value

<sup>a</sup> Mean values calculated from data for Midwest region in Table 13-33, Seasonally Adjusted Consumer Only Homegrown Intake from EPA Exposure Factors Handbook 1997 (see also Produce Ingestion.xls).

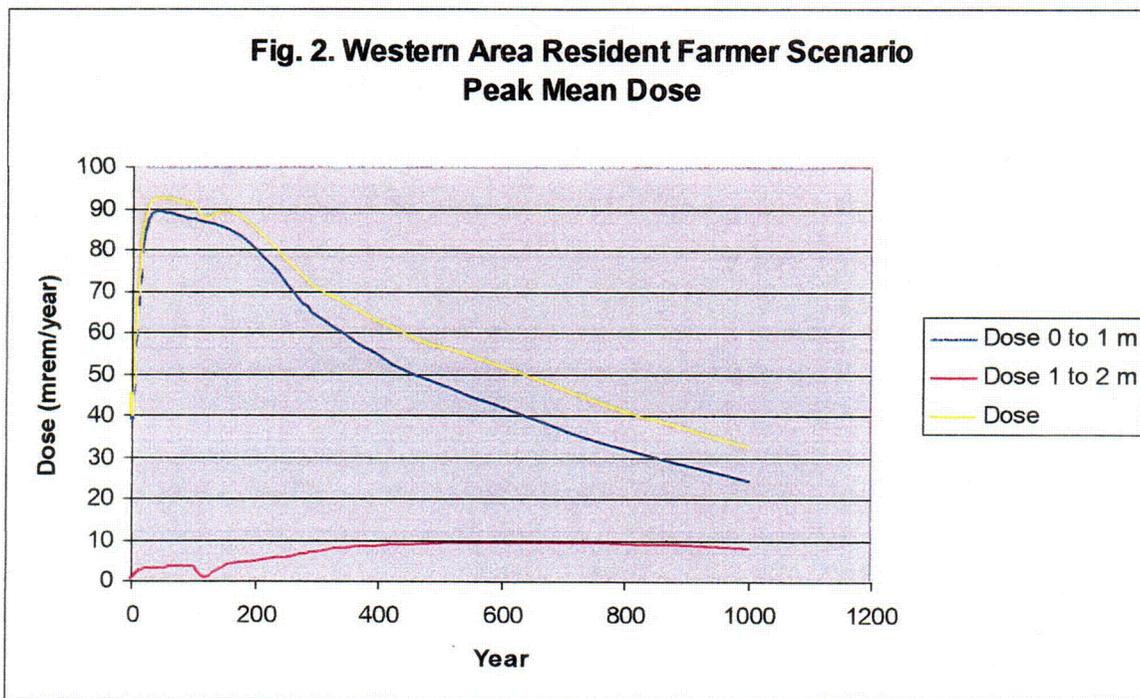
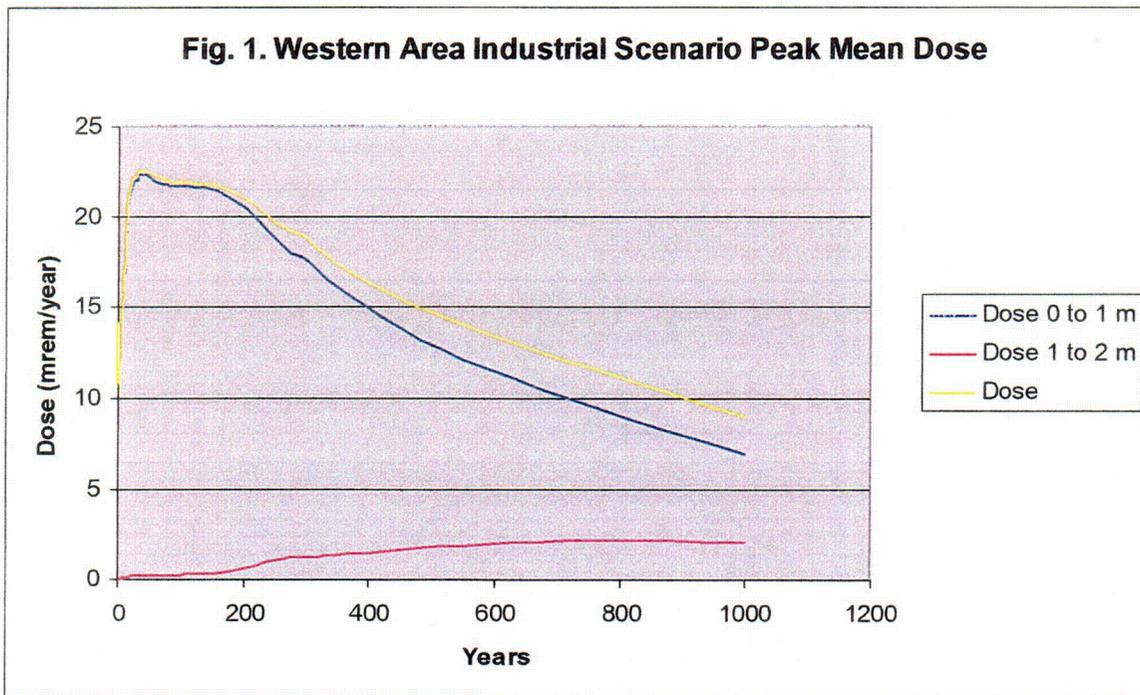
### 3.4 Sample Data Analysis

For the Western Area, two soil layers were modeled, 0 to 1 m and 1 to 2 m. In the previous dose assessment, the concentrations measured in the 0 to 1 m layer were conservatively assumed to be present down to 2 m. Site-wide, arithmetic averages for total thorium (Th-228, Th-232, and Th-23) for these two soil layers were calculated using data from the AAR site characterization survey report (Koh 1996) and the ORISE confirmatory survey (Weaver 2004). As discussed above, data for Grid 249 were excluded for the calculations for the 0 to 1 m layer, but included for the 1 to 2 m layer. An average was calculated for each survey grid within the Western Area using the AAR data. Additionally, an average was calculated for each grid sampled by ORISE using the ORISE data. A site-wide average was then calculated by averaging the grid averages. The AAR data average was used for grids not sampled by ORISE and an average of the AAR grid average and ORISE grid average was used for those grids sampled by ORISE (see AAR West Data 5-05.xls). It should be noted that data were not collected for the 1 to 2 m layer for grids 360 through 375 so data collected for the 0 to 1 m layer were used in the calculations of 1 to 2 m averages for those grids. The use of the 0 to 1 m data to represent the concentrations in the 1 to 2 m soil layer is conservative as discussed above.

The Western Area site-wide arithmetic average for the 0 to 1 m soil layer is 58 pCi/g total thorium (29 pCi/g Th-230, 14.5 pCi/g Th-232, and 14.5 pCi/g Th-228). The average for the 1 to 2 m layer is 12.9 pCi/g (6.45 pCi/g Th-230, 3.2 pCi/g Th-232, and 3.2 pCi/g Th-228). For each scenario, first layer was modeled using a contaminated zone depth of 1 m and a cover depth of 0. The second layer was modeled using a contaminated zone of 1 m with a 1 m cover depth. The peak mean doses for the two soil layers were then summed to calculate the total peak mean dose for the scenario.

### 3.5 Results

Using the arithmetic average concentration of thorium in the Western Area soils assuming removal of the top 1 m of soil from Grid 249, peak mean doses of 23 and 92 mrem/year were obtained for the industrial and resident farmer scenarios, respectively, as shown in Figures 1 and 2 (see also West Total Dose.xls). Therefore, it is concluded that the Western Area of the AAR site meets the criteria for restricted release as specified in 10 CFR 20, Subpart E.



#### 4.0 REFERENCES

- EPA 1997. *Exposure Factors Handbook*. EPA/600/P-95/002Fa. U. S. Environmental Protection Agency, Office of Research and Development, National Center for Environmental Assessment, Washington, D.C. August.
- Koh 1996. *Site Characterization Report, Former Brooks and Perkins, Inc. Site. AAR Manufacturing Group, Inc., Livonia, Michigan*. Prepared for Submittal to the Nuclear Regulatory Commission. April 1996.
- Partners Environmental 2002. *Probabilistic Dose Assessment: Former Brooks and Perkins Site, Livonia Michigan*. Prepared for Submittal to the Decommissioning Branch, Division of Waste Management, Office of Nuclear Material Safety and Safeguards, U.S. Nuclear Regulatory Commission. November 13.
- Partners Environmental 2003. *Response to Request for Additional Information, Former Brooks and Perkins Site, Livonia, Michigan*. Prepared for Submittal to the Decommissioning Branch, Division of Waste Management, Office of Nuclear Material Safety and Safeguards, U.S. Nuclear Regulatory Commission. April 15.
- Sherzer 1913. *Geological Report on Wayne County*. Michigan Geological and Biological Survey Publication 12, Geological Series 9.
- Weaver 2004. *Confirmatory Survey of Portions of the AAR Manufacturing Site, Livonia, Michigan*. Environmental Survey and Site Assessment Program, Radiological Safety Assessment and Training, Oak Ridge Institute for Science and Education. Docket No. 040-00235, RFTA No. 03-014. January.