April 9, 2004

Mr. Howard A. Pulsifer
Vice President, General Counsel & Secretary
AAR Corporation
One AAR Place
1100 N. Wood Dale Rd.
Wood Dale, IL 60191

SUBJECT: RESULTS OF OAK RIDGE INSTITUTE FOR SCIENCE AND EDUCATION CONFIRMATORY SURVEY OF PORTIONS OF THE AAR MANUFACTURING, INC. SITE IN LIVONIA, MICHIGAN, JANUARY 2004

Dear Mr. Pulsifer:

From August 4-7, 2003, a survey team from the Oak Ridge Institute for Science and Education (ORISE) conducted an independent radiological survey at the AAR Manufacturing, Inc. (AAR) site, under contract to the U.S. Nuclear Regulatory Commission (NRC). In January 2004, we received the ORISE report on the survey, "Confirmatory Survey of Portions of the AAR Manufacturing, Inc. Site in Livonia, Michigan." On January 28, 2004, we provided a copy of the report to you, your consultants, and representatives from Michigan Department of Environmental Quality for review and comment. On April 1, 2004, NRC and AAR held a conference call to discuss the results of the ORISE survey and NRC and AAR's review of the report.

As discussed in the conference call, you have only performed a cursory review of the ORISE report and have not analyzed the report in detail. We discussed the results of our review of the ORISE report, further analyses we completed on the localized elevated concentrations for which we calculated allowable limits [areal size-specific derived concentration guideline levels ($DCGL_{EMC}$s)], and our comparison of the data from the ORISE survey and your past characterization surveys to the $DCGL_{EMC}$s. We are providing these results as attachments to this letter, as promised in our conference call.

Attachment 1 provides a summary of our calculations of the $DCGL_{EMC}$s. Also, the CD enclosed with this letter contains the electronic files of the input data used in RESRAD to calculate these concentrations. Attachment 2 to this letter provides a discussion of the comparison of the ORISE survey results and results of AAR's past characterization surveys to the $DCGL_{EMC}$s. For completeness, Attachment 2 also includes discussion of the ORISE results and our review of the gamma scans, exposure rate measurements, and surface soil sampling.

To ensure that progress towards closure of the AAR site continues, please review the ORISE report and the results of our review and further analyses, and evaluate your options for addressing the areas of your site that exceed the $DCGL_{EMC}$s. We will be in contact a few weeks from the date of this letter to make arrangements for further discussions on these issues.

Please contact Kristina Banovac of my staff, at (301) 415-5114 or klb@nrc.gov, if you have any questions regarding this letter.

Sincerely,

/RA/

Daniel M. Gillen, Deputy Director
Decommissioning Directorate
Division of Waste Management
and Environmental Protection
Office of Nuclear Material Safety
and Safeguards

Attachment 1: Localized Elevated Concentrations
Attachment 2: Comparison of the Results of ORISE Survey and AAR Survey to the $DGCL_{EMC}$s for the Eastern and Western Parcels

Enclosure: CD containing electronic input files for RESRAD

Docket No. 040-00235
License No. STB-0362 (terminated)

cc: B. Koh
R. Skowronek
M. Wetterhahn (w/out enclosure)

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## Localized Elevated Concentrations

Two different types of dose assessments are usually required for a site. One is the site-wide average dose estimate. The other is the localized elevated area calculation, which investigates how much greater than the average source term a relatively smaller area can be. The averaging that occurs to create the site-wide dose estimate can mask areas that could cause much greater doses if an individual were to use a smaller area with concentrations greater than the average. For the AAR Manufacturing, Inc. (AAR) site, a number of scenarios were analyzed to determine the effect of the elevated concentrations of total thorium. These scenarios included initial scoping scenarios, which initiated the development of a request for additional information (NRC, February 13, 2003), and more developed scenarios after receipt of AAR's response to the request for additional information (AAR, April 15, 2003).

Because of the site characteristics, the staff initially evaluated creating areal site-specific derived concentration guideline levels (DCGLs), also known as $DCGL_{EMC}$s, for areas of 25 square meters ($m^2$) and 100 $m^2$. Based on this initial evaluation, the staff determined that using a 100 $m^2$ area is more representative of the effects of redistribution due to construction activities that would need to occur at the site for it to be used. Therefore, 25 $m^2$ $DCGL_{EMC}$s were not developed.

Limiting scenarios were created for both the Eastern Parcel (unrestricted release; residential land use) and the Western Parcel (restricted release; industrial land use with restrictions in place, and residential land use assuming restrictions fail), using RESRAD 6.21. For the industrial scenario, the staff considered alternate uses such as a building being on, or next to, an elevated area, construction activities, a slag pile being created by construction activities, and use as a parking lot. For residential use, the staff evaluated a gardening/backyard scenario, as most other scenarios were similar to the industrial scenarios (e.g., occupancy in a building or construction of a building). The residential use scenario is limiting for both the Eastern and Western Parcels of the site.

### Industrial Scenario (Western Parcel - restrictions in place)

For the analysis where the restrictions are in place on the Western Parcel, which limits the use to non-residential, the most limiting small area scenario was the use of the area as a parking lot. The staff assumed that the lot would be paved with asphalt, which would provide some shielding from gamma radiation. To calculate the shielding factor, the staff used 5 cm (2 inches) of low-density concrete, approximately 2 $g/cm^3$ in density, to simulate the asphalt shielding in the Microshield v. 5.2 computer code. This analysis showed that a shielding factor of 0.4 would be an appropriate upper bound. The only pathway of concern is direct gamma and therefore, the only other parameter of importance is the time of exposure. The staff assumed that an individual spent approximately 1 hour per work day on or near the parking lot (e.g., work breaks, going to and from their vehicle, etc.). Based on these parameters, the staff calculated a $DCGL_{EMC}$ for this scenario [equivalent to 0.25 mSv/y (25 mrem/y), for a 100 $m^2$ area] of 13 Bq/g (360 pCi/g) for combined Th-232 and Th-228, and 116 Bq/g (3125 pCi/g) for Th-230.

**Residential Scenario (Western Parcel - restrictions fail; Eastern Parcel)**

For the analysis where the restrictions fail on the Western Parcel, the most limiting scenario assumed that the elevated area was used as a backyard with a garden. The staff eliminated all pathways and exposure modes except for outdoor exposure, inhalation, plant uptake, and inadvertent soil ingestion. The primary exposure pathways for the scenario are external exposure and plant uptake. The scenario assumed that the garden provides the average member of the critical group with the mean consumption rates of homegrown foods for leafy vegetables (21 kg/y), other vegetables (45 kg/y), fruits (53 kg/y), and grain (14 kg/y) as reported in NUREG/CR-5512, Vol. 3, Table 6.21. The default exposure time for outdoor use and gardening is 960 hours and 71 hours (NUREG/CR-5512, Vol. 3, Table 6.11), respectively. Since the area is only 100 $m^2$ versus the entire site, it would be inappropriate to use the entire outdoor time for the exposure calculation. The staff used a total outdoor exposure time (including both gardening and other uses) of 300 hours, or approximately 10 hours per week between mid-March and mid-October. The breathing volume was correspondingly changed to reflect the lower exposure time.

As the residential scenario is appropriate for assessing both doses from the unrestricted release of the Eastern Parcel [using the 0.25 mSv/y (25 mrem/y) dose constraint] and from the restricted release of the Western Parcel [assuming restrictions fail and using the 1 mSv/y (100 mrem/y) dose limit], there are two sets of soil $DCGL_{EMC}$s. For the Western Parcel and the consideration of the dose if restrictions fail, the 100 $m^2$ area $DCGL_{EMC}$ is 12 Bq/g (325 pCi/g) for combined Th-228 and Th-232, and 65.5 Bq/g (1770 pCi/g) for Th-230. For the Eastern Parcel and unrestricted release, the 100 $m^2$ area $DCGL_{EMC}$ is 3 Bq/g (80 pCi/g) for combined Th-228 and Th-232, and 16.4 Bq/g (440 pCi/g) for Th-230. These elevated concentrations would apply to the arithmetic average of 4 contiguous soil samples (each sample representing 25 $m^2$, and the average of 4 samples representing 100 $m^2$).

**Comparison of the Results of ORISE Survey and AAR Survey to the $DGCL_{EMC}$s for the Eastern and Western Parcels**

As discussed in Attachment 1, the limiting $DCGL_{EMC}$s calculated by the staff are:

- For the restricted release of the Western Parcel, considering restrictions fail and using the 1 mSv/y (100 mrem/y) dose limit, the 100 square meter ($m^2$) area $DCGL_{EMC}$ is 12 Bq/g (325 pCi/g) for combined Th-228 and Th-232, and 65.5 Bq/g (1770 pCi/g) for Th-230.

- For the unrestricted release of the Eastern Parcel, using the 0.25 mSv/y (25 mrem/y) dose constraint, the 100 $m^2$ area $DCGL_{EMC}$ is 3 Bq/g (80 pCi/g) for combined Th-228 and Th-232, and 16.4 Bq/g (440 pCi/g) for Th-230.

These elevated concentrations would apply to the arithmetic average of 4 contiguous soil samples (each sample representing 25 $m^2$, and the average of 4 samples representing 100 $m^2$).

**ORISE Data**

The data from the Oak Ridge Institute for Science and Education (ORISE) January 2004 report, *Confirmatory Survey of Portions of the AAR Manufacturing, Inc. Site in Livonia, Michigan* (ORISE 2004), were evaluated against these $DCGL_{EMC}$s. Groups of four soil samples were averaged after subtracting background thorium concentrations. The sum of fractional contributions (concentration/DCGL) were added, and the 100 $m^2$ area failed if the sum of fractions was greater than 1.0. The ratio of Th-230:Th-232 was also calculated.

**ORISE Results**

Although there was some variability in the Th-230:Th-232 ratio in individual samples across the site, when averaging the data for a 100 $m^2$ area, the use of a Th-230:Th-232 of 2:1 is reasonable.

One 1-2 meter depth and four 0-1 meter depth 100 $m^2$ areas exceed the associated $DCGL_{EMC}$. The deep subsurface (1-2 meter depth) volume has a combined fraction of 1.17 and is at location 15S35W [grid area 210, as noted in the August 1999, "Site Characterization Report, Phase II, Former Brooks and Perkins, Inc. Site, AAR Manufacturing Group, Inc., Livonia, Michigan" (AAR 1999)]. The 0-1 meter volume at the same location has a combined fraction of 11.87 (i.e., the concentration is 11.87 times the allowable limit for unrestricted use). Additional results are shown in Table 1. Values greater than 1.0 are highlighted. Table 1 values are based on the ORISE data only.

It should be noted that the group of four samples taken at 65S100W (which is on the boundary of the Eastern and Western Parcels) was evaluated using the higher Western area $DCGL_{EMC}$. If this borderline area is evaluated against the smaller Eastern area $DCGL_{EMC}$, the combined fraction would be four times higher (greater than 3.0).

Table 1 Results of ORISE Survey

| AAR Site ORISE 2004 Data Summary Table | | | | | |
|---|---|---|---|---|---|
| Background Subtracted | | | | Ratio | |
| | | SumFrac | | Th230:Avg228or232 | |
| GridPoint | | 0 to 1m | 1 to 2m | 0 to 1m | 1 to 2m |
| 15S35W | East | 11.87 | 1.17 | 3.12 | 1.54 |
| 45S55W | East | 1.97 | 0.09 | 2.50 | 1.80 |
| 55S65W | East | 1.35 | 0.10 | 1.86 | 2.88 |
| 65S100W | West | 0.76 | NA | 0.88 | |
| 65S115W | West | 0.12 | 0.01 | 2.66 | 2.76 |
| 55S115W | West | 0.44 | 0.03 | 2.72 | 3.48 |
| 55S125W | West | 0.96 | NA | 3.26 | |
| 15S125W | West | 3.43 | 0.25 | 1.26 | 2.31 |
| 00S125W | West | 0.13 | NA | 3.35 | |
| 10S135W | West | 0.03 | NA | 2.23 | |
| 70S125E | East | 0.34 | 0.05 | 3.46 | 1.64 |
| 70S170E | East | 0.18 | 0.05 | 1.95 | 2.29 |
| 70S220E | East | 0.08 | NA | 1.88 | |
| 55S230E | East | 0.49 | NA | 2.82 | |
| 30S100E | East | ~0.5 | | | |

**AAR 1999 Survey Data**

Survey data from AAR 1999 were evaluated against the $DCGL_{EMC}$s. The survey data in AAR 1999 are presented as "total thorium," which in the context of that report is the sum of Th-228 and Th-232 concentrations, in pCi/g. Equilibrium between Th-232 and its daughter Th-228 is assumed, so the concentration of Th-228 is equal to that of Th-232. Soil samples were analyzed for Th-232, and the resulting concentrations were doubled to obtain "total thorium" concentrations. An additional assumption that the activity of Th-230 is twice that of Th-232 is made, but Th-230 activity is not included "total thorium."

Given the relationships between Th-232, Th-228, and Th-230, the $DCGL_{EMC}$s derived by the staff can be expressed as $DCGL_{EMC}$s on the sum of Th-232 and Th-228. The $DCGL_{EMC}$s on the sum of Th-232 and Th-228 are 10 Bq/g (275 pCi/g) for the Western Parcel and 2.5 Bq/g (68 pCi/g) for the Eastern Parcel.

**AAR 1999 Results**

Only one area exceeds the $DCGL_{EMC}$s for the AAR 1999 measurements. This is the 0-1 meter area at location 5S125W (AAR 1999 grid area 249). This area is contiguous with 15S125W (AAR 1999 grid area 219), which was high for the ORISE survey.

**Combined Data for Areas Exceeding the $DCGL_{EMC}$s**

The best characterization of a 100 cubic meter ($m^3$) volume is obtained with as many samples as possible. For those areas exceeding the $DCGL_{EMC}$s based on the ORISE data, the corresponding AAR 1999 results were also considered (after subtracting the background as

determined in ORISE 2004). It should be noted that the locations of features on the AAR and ORISE grids may not coincide exactly. Spatial uncertainties on the order of one to two meters may exist for a given feature, so some judgement is required during the combined analysis.

For the AAR data, the ratio of Th-230 to either Th-232 or Th-228 was assumed to be the same as that measured by ORISE for the samples in the same 100 $m^3$ volume, rather than a fixed multiple. The AAR data was then averaged with the ORISE data and the fraction of the applicable $DCGL_{EMC}$s calculated. The fractions were summed. If the fraction is less than or equal to 1.0, the volume is less than the $DCGL_{EMC}$.

**Results of Combined Data**

Table 2 presents the combined results for those locations that originally exceeded the $DCGL_{EMC}$s using only the ORISE results. Combined results give concentrations that are approximately half of those based on ORISE data alone. The 15S35W 1-2 meter depth and 55S65W 0-1 depth no longer exceed the $DCGL_{EMC}$s. Three 0-1 meter depth, 100 $m^2$ areas remain, although the 45S55W location exceeds the $DCGL_{EMC}$ by only 5%.

Table 2 Combined Data Results

| AAR Site<br>ORISE 2004 + AAR 1999 Data<br>Background Subtracted | | | |
|---|---|---|---|
| | | SumFrac | |
| GridPoint | | 0 to 1m | 1 to 2m |
| 15S35W | East | 6.12 | 0.60 |
| 45S55W | East | 1.05 | NA |
| 55S65W | East | 0.72 | NA |
| 15S125W | West | 1.90 | NA |

In addition, the 65S100W 0-1 meter depth area has a combined fraction of approximately 1.6 when the combined data are used and the Eastern $DCGL_{EMC}$ is applied.

**Discussion and Conclusions**

Based on the AAR 1999 and ORISE 2004 surveys, three 100 $m^2$ areas at the AAR site exceed the $DCGL_{EMC}$s. These are 15S35W, 45S55W, and the northern part of 15S125W/southern part of 5S125W. In addition, if the Eastern $DCGL_{EMC}$ is applied to the 0-1 meter depth at 65S100W (on the boundary of the Eastern and Western Parcels), that area would exceed the $DCGL_{EMC}$.

The gamma scan in the vicinity of 15S35W was not elevated above background (ORISE 2004, Figure 4). No surface soil samples were obtained in this area.

The gamma scan in the vicinity of 45S55W was slightly elevated. No surface soil samples were obtained in this area.

When the combined data are applied, the combined fraction for 55S65W is less than 1.0. The gamma scan in this vicinity is elevated; borehole data shows higher concentrations in the 0-1

meter depth than in the 1-2 meter depth. No surface soil samples were taken, but the gamma scan indicates that the radioactive material present is close to the surface.

The gamma scan in the vicinity of 15S125W was elevated. No surface soil samples were obtained in this area.

The gamma scan in the vicinity of 65S100W shows elevated count rates extending into the Eastern area. Elevated count rates also fan to the north, west, and southwest. While these locations did not exceed the $DCGL_{EMC}$, near-surface soil samples, gamma scan count rates, and exposure rate measurements indicate elevated thorium levels that may require further survey, analysis, modeling, and/or remediation to meet ALARA considerations.

Figures 3 and 4 of ORISE 2004 show some spots of elevated count rates. The highest count rate is associated with 65S100W as noted previously. A smaller area with a lower maximum count rate is associated with 55S65W, also noted previously. Other areas with elevated gamma scan count rates are shown in Figures 3 and 4. While the borehole data indicates volume-averaged subsurface soils with thorium concentrations less than the $DCGL_{EMC}$s, further evaluation and/or modeling of these hot spots may be necessary to meet ALARA considerations.