SUB-1435
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DEPARTMENT OF THE ARMY
U.S. ARMY SOLDIER AND BIOLOGICAL CHEMICAL COMMAND
5183 BLACKHAWK ROAD
ABERDEEN PROVING GROUND, MARYLAND 21010–5424

REPLY TO ATTENTION OF

JUN 19 2000

Mr. John Contardi
Project Engineer
Decommissioning Branch
Division of Waste Management
Office of Nuclear Material Safety and Safeguards
U.S. Nuclear Regulatory Commission
Washington, DC 20555-0001

Dear Mr. Contardi:

References:

a. HQNRC Memorandum of January 31, 2000, subject: Request for Additional Information (RIA) on the Jefferson Proving Ground Decommissioning Plan and Risk Assessment.

b. SBCCOM Memorandum of May 18, 2000, subject: Response to Request for Additional Information (RIA) on the Jefferson Proving Ground Decommissioning Plan and Risk Assessment.

Our response to the RIA concerning the Risk Assessment for JPG, as requested in the memorandum referenced above, is provided as enclosure 1. This portion of our response has been delayed due to the inaccessibility of our contractor from Los Alamos.

Ms. Joyce Kuykendall, SBCCOM Radiation Safety Officer, maybe contacted for additional information at (410)436-7118, or by email at joyce.kuykendall@sbccom.apgea.army.mil.

Sincerely,

John M. Ferriter
Director, Operations, Remediation
and Restoration

Enclosure
RIA and Response on JPG RA

NMSS01 Public

Summary of Responses to NRC Questions of January, 2000: Outline of Proposed Risk Assessment Work in Support of Decommissioning of Jefferson Proving Ground

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13 June 2000

In January, 2000, the NRC submitted several questions to Los Alamos through Aberdeen Proving Ground regarding the revised risk assessment for exposure to depleted uranium (Ebinger and Hansen, 1998). Detailed responses to the NRC questions were prepared and are attached to this summary. On May 4, 2000, Army and Los Alamos staff met with NRC staff to discuss the future of decommissioning at Jefferson Proving Ground (JPG) and the status of current and future risk assessment efforts provided for the Army by Los Alamos. Since that meeting, a schedule for completion of the decommissioning plan has been developed and a similar schedule and scope for the risk assessment efforts is required. This summary will be followed by a complete schedule and detailed cost estimate for the risk assessment efforts this FY (through September 30, 2000) and beyond to support the EIS that will be completed by Army and NRC.

Comments on the revised JPG risk assessment (Ebinger and Hansen, 1998) were tied to one of two main shortcomings in the report: 1) that the current NRC regulations and guidelines were not addressed; 2) that default and field-specific parameters used in the modeling efforts were either not up to date or were not justified or referenced completely enough. This summary

outlines how the comments will be addressed as the JPG decommissioning proceeds and also shows the path we will follow in order to provide the type of well-documented, well-executed risk assessment needed to support decommissioning and release of JPG for restricted use.

The current guidelines published by NRC for use in seeking release of JPG for restricted use were highlighted at the May 4 meeting by NRC staff. The current Standard Review Plan for decommissioning will be used for decommissioning efforts and plan development, and risk assessment efforts will also follow the Standard Review Plan format as required. In addition, the applicable regulations and guidance set forth in 10 CFR 20, e.g., section 1403 ("Criteria for license termination under restricted conditions") will be the main guidance for the risk assessment. In particular, the dose limits to the critical group will be the fundamental diver in the risk assessment. These limits are doses not to exceed 25 mrem (0.25 mSv) per year distinguishable from background to the critical group if institutional controls remain in place or 100 mrem (1 mSv) per year if institutional controls fail. An ALARA analysis will also conducted as part of the risk assessment efforts, and the analysis will comply with NRC guidance.

Technical comments on the risk assessment report clearly indicated the need to refine the risk assessment along several lines. Underlying all the analyses was the need to tie site-specific parameters and default values used in the RESRAD code to either literature-based values or to values that were measured or estimated from fieldwork at JPG. Part of the documentation related to the model parameters was also an estimate of the uncertainty in the parameters included in any modeling, and then incorporating the uncertainty into the risk assessment itself. Also needed was additional analysis on the potential effects of depleted uranium (DU) on receptors who live off-site or outside the institutional controls at JPG. Previous efforts at JPG

were concerned only about DU exposure within the controlled area, and little was done to show the expected doses above background to members of the public who lived down stream from the DU impact area. These off-site exposures will be considered in the new risk assessment work. The following scope of work is proposed to complete the risk assessment in support of decommissioning at JPG.

Develop exposure scenarios for DU at JPG. These efforts are required for the risk assessment modeling and to satisfy the NRC criteria of realistic release and exposure scenarios. While guidance from the NRC is available and will be used, it will be our responsibility to propose a set of scenarios to the NRC, then modify them as needed to address the concerns of NRC and the public. Exposure scenarios will be developed that include intact institutional controls at JPG and the possibility of failed institutional controls. As mentioned above, the potential exposure of individuals within the controlled area and off-site are of interest, so exposure scenarios that include both off-site and on-site exposures will be developed. Initially, the potential effects on human health are the important endpoints for the assessment, but also important for the EIS work later in the decommissioning are the potential effects of DU on ecological receptors. Environmental receptors and exposure pathways will be developed in order to evaluate the potential exposure to DU of various non-human receptors in the affected area.

Integral to all exposure scenarios is a pathway analysis. Pathway analysis ensures that credible exposure routes are developed that realistically reflect the possibilities of exposure of specific receptors. In short, without a complete exposure pathway, there can be no exposure and thus, no risk to receptors. Each exposure scenario, then, will also show the pathway from the contaminant through the environment to the receptor. If a receptor is a human user of the DU site or an off-site area, then relevant exposure pathways will be identified and used in the risk

modeling. As with exposure scenarios, the pathway analyses will be subject to review by NRC, Army and all concerned parties.

Risk Assessment Codes and Parameters Document. Previous analyses have relied upon RESRAD (Yu et al, 1993) for exposure and risk estimates. This code will continue to be important, questions beyond the scope of RESRAD, such as potential effects to off-site receptors, require a different modeling approach. Other codes such as MEPAS and BIOTRAN (Gallegos, 1996) will be employed to estimate potential effects to off-site receptors as well as to non-human receptors where applicable.

Each code will require a database of parameters used in the models. Many of these values are site-specific estimates of various parameters such as groundwater velocity, soil porosity, or the distribution coefficient, K_d, and some values are default values required by the code. All values will be documented during the risk assessment in order to estimate objectively the risk from DU exposure and to estimate the uncertainty in the resulting risk calculations. A document or catalog of values will also a valuable tool for review of the work by outside peers, approval that is required for the assessment to be a credible product. The preparation of the database will involve a review of all current literature that is applicable to the risk assessment at JPG. This review will assure that the most current information relevant to the risk estimates is incorporated in the proposed work.

Risk Assessment Endpoints and Receptors. Previous risk assessments have emphasized the risk to humans using the JPG area and the ecological receptors such as white-tailed deer. The current NRC guidelines and regulations specify that risk to a critical group of humans be the receptors, and this will be accommodated. In addition, the EIS will require an estimate of the impact of DU in the are to ecological receptors that are characteristic of the are. We will develop

the ecological risk assessment for DU in support of the EIS efforts and in concurrence with the EIS efforts. As part of the initial risk assessment work proposed for JPG, we will develop preliminary receptors lists based on previous work. The previous work includes the LANL risk assessments (e.g., Ebinger and Hansen, 1998) as well as JPG environmental monitoring information.

Documentation and Reporting of Results. We plan to prepare written reports and briefings for the U. S. Army and the various public interest groups that are affected by the decommissioning at JPG. A detailed reporting schedule will be provided with the scope of work and cost estimate, but a preliminary schedule and titles for deliverables is as follows:

Deliverable	**Preliminary Due Date**
Preliminary Description of Exposure Scenarios (for Army, NRC, Public comments)	24 July 2000
Description of Risk Estimation Codes and Data Needs (for Army, NRC approval)	24 July 2000
Review and Compilation of Applicable NRC Regulations and Guidelines for Decommissioning and Risk Assessment (for Review by Army, NRC)	24 July 20000
Outline of ALARA Analysis for JPG (Comments from NRC, Army)	15 August 2000
Potential Receptors for Ecological Risk Assessment in Support of EIS	15 August 2000
Resolve Comments on Exposure Scenarios and Release Scenarios Documents	22 September 2000
Resolve Comments on ALARA Analysis Plan and Release ALARA Analysis Plan document	22 September 2000

The questions about the risk assessments for JPG presented by NRC (January, 2000) form the basis of the proposed work. There is clear need to develop a more comprehensive, defensible risk assessment to support the decommissioning of the DU area at JPG. This summary is intended to show the outline of our plan to address the NRC questions and provide the required risk assessment documents that will allow release of the JPG DU area for restricted use under current NRC guidelines.

Attachment: Answers to Individual Questions from NRC, January, 2000.

Response to Risk Assessment Report Questions, Nuclear Regulatory Commission

1 & 2. The default values for K_ds for U built into RESRAD were used in the risk assessment report (Ebinger and Hansen, 1998) first for conservatism and second as a starting point should additional investigation occur on the transport of DU in the environment at Jefferson Proving Ground (JPG). Several peer-reviewed literature sources were used for the report, and Sheppard and Thibault (1990a) provide a reasonably complete compendium of those values. The reported values for K_d ranged from 0.03 to 395,100 L kg^{-1} and depended largely on soil texture. For example, Sheppard and Thibault (Table 2, 1990) show that K_d decreased then increased dramatically as the soil texture changed from sand to silt to clay, and organic (peat) soils fall between loam (medium texture) and clay (heavy texture) soils. Data in the compendium were taken from several sources, some peer reviewed and two were not. Baes et al (1983), Sheppard (1985), Sheppard and Thibault (1990b), and Sheppard et al (1983), are all peer-reviewed studies from which K_ds were obtained. Baes et al (1984) and Sheppard et al (1984) are both examples of government-sponsored reports that have not been peer reviewed at the same level as articles in technical journals, nonetheless these sources are considered in this risk assessment report and elsewhere as peer review publications would be.

Use of K_ds is required in several models in addition to RESRAD, but none of the models specifically accounts for the process or factors that affect Kd. As mentioned above, K_ds depend on soil texture and may vary nonlinearly with soil texture. In addition, however, are several other considerations. First, Kd is not an intrinsic soil property in itself, but a simple ratio of the concentration of a chemical in a solid phase to that in solution. Thus, whatever affects the concentration in solution or in the solid also affects the Kd. Second, the K_d as defined does not account for precipitation of secondary phases such as U-containing oxides or hydroxides, coprecipitation with other compounds such as carbonates or sulfates, occlusion of U when other precipitates form, or for changes in the chemical environment such as redox. Third, K_d is only valid when thermodynamic equilibrium is attained a condition that is difficult to demonstrate in soils or many geologic materials. Fourth, the rate of dissolution of DU from metal and from large fragments has not been estimated and would determine the amount of DU that is available in the soil to precipitate, adsorb onto organic and inorganic materials, or transport through the system to groundwater. And fifth, K_ds or associated parameters are estimated from best fits to experimental data and not from strict stoichiometric chemical reaction theory. Thus, K_d is not a single measure of the sorptive capacity of soils, it is a measure of the effects of several soil processes lumped into a single parameter. As such, any use of any value of K_d should be made with caution.

We chose the RESRAD default for the 1998 risk assessment report based on the compendium and on the analysis of available data in the RESRAD literature (Yu et al, 1993). We also conducted simplistic sensitivity analyses to evaluate the effect of large changes in K_d on estimated doses to receptors. We showed no large changes in dose results when K_d values were varied by a factor of 10. This finding was surprising at first but was clear on further analysis. The scenarios tested in the 1998 risk assessment report did not include the consumption of drinking water that contained DU from the contaminated zone but water that

was presumably of sufficient quality and from an unaffected aquifer below the saturated zone of the affected area. The dose in these scenarios resulted from water-independent pathways, or pathways that did not involve the transport and consumption of DU via groundwater. Since K_d does not affect these pathways, a large change in K_ds had almost no effect on the dose received by humans in the test scenarios.

A final point for the first issue: no amount of literature research will provide a K_d or a distribution of K_ds that is appropriate for use at JPG or for any single site. Instead, a distribution of site-specific K_ds should be measured from the soils, unsaturated geologic material, and rocks from the saturated zone in order to set the K_ds for the model. In lieu of samples, however, K_ds were estimated. The compendium (Sheppard and Thibault, 1990) was used as well as the Jefferson County soil Survey (USDA SCS, 19XX) and samples of soils in the field in order to estimate the K_d as closely as possible. Estimation is imperfect at best, but given other uncertainties and no opportunity to systematically measure Kds, the estimations had to suffice.

3. Sensitivity analysis for K_ds of U daughter products would, most likely, show similar dose results as discussed above for U. However, the manufacture of DU munitions removes the daughter products and the resulting DU is not at secular equilibrium. Thus, daughter ingrowth from U decay starts over, and there are insignificant concentrations of daughter products that form in the time of the simulations (1000 years). A sensitivity analysis of the K_ds is a good idea for many problems, but in this case the sensitivity analysis for the K_ds of daughter products doesn't seem too useful. See the attached graph with the predicted concentration of daughter products through the simulations.

4. RESRAD was developed from a "typical" Midwestern farm scenario. Soils in such scenarios would be derived from loess deposited on top of glacial till that overlies bedrock of various compositions. The soils of JPG are well described by this scenario (Nickell, 1985). Crops grown on such farms as well as livestock used for meat and dairy products would be consistent with crop and livestock production at JPG farms as confirmed in comparison of the JPG locality with the RESRAD model. Several soil parameters were modified from the RESRAD default values to account for local JPG soil properties, and these modification were based on field surveys or on published soil survey data (JPG Soil Survey REF). Soil porosity, bulk density, and erosivity, for example, were estimated from field samples and the soil survey. The "b" parameter related to soil porosity (see Yu et al, 1993 p. 200; Clapp and Hornberger, 1978) was modified to account for composition and porosity information on the limestone bedrock and glacial till from other studies. Overall, the default values alone provide a reasonable description of the JPG site, so there was little hesitancy to use them when other data were no more appropriate.

   Depth and composition of subsurface layers were mentioned in several JPG well logs. These data were the basis for changing some of the default parameters (like the "b" value), as well as the basis for assigning depths to the different horizons in the unsaturated and saturated zones. We modified any parameter for which we had enough information to do so

legitimately; we have confidence in all estimates and any default values only so far as we can back the estimates with field data or a literature source.

5. The basis to include U-238 and U-234 in the analysis was that these were the data that were reported. We have no scientific data outside nominal isotopic compositions (Shleien, 1992:286) that warrants inclusion of other isotopes or other elements. Analysis of DU munitions reported to us showed that total U was 99.75 % by weight and Be was the remaining 0.25% of the mass. Previous analyses of DU fragments could be used to support an assumption that U-235 is 0.25% of the mass (not activity) of total U in a penetrator. Adding this amount of U-235, however, should not alter the overall exposure as defined in the current risk assessment. We have no indication of traces of other materials in these penetrators such as Pu, Tc, or Co. If this is a concern, additional analyses will have to be done or unsupported assumptions will have to be made about additional elements for the risk assessment.

6. We can provide bounding calculations that will show the upper and lower bounds on the expected values of the doses. Those upper and lower bounds will be based on the uncertainty in the parameters in the model, at least the uncertainty that we can quantify from knowledge about the values, the RESRAD code, or our own data. The upper bounds will be conservative because the values chosen, when actual site data don't exist, are conservative. We will qualify the conservatism in the bounding calculations as appropriate.

   Since RESRAD has no capability for Monte Carlo simulations, we will not provide exhaustive uncertainty analysis.

7. We can evaluate the existing data on site contamination in the DU area at JPG. The size of the affected area and the concentration in JPG soils have been discussed in previous risk assessment reports (Ebinger and Hansen, 1994, 1996a, 1996b; SEG 1995, 1996). The area to be maintained by institutional controls can be estimated from those data and policy decisions from the Army.

8. This information was based on the odor as noted in the report as well as from several local farmers with farms on the uplands near JPG. The consensus was that if the farms were going to have water, they would either drill much deeper than the wells at JPG were drilled or they would use city-supplied water from the Ohio River and aquifers deeper than on farms.

9. The values of 5 kg/d for fodder and 5 L/d for water were derived from reports on white-tailed deer consumption of browse in wooded areas. These values were used for the occasional use scenario where the site user was a hunter. The IAEA or similar values were used for livestock in the farming scenarios.

10. It is assumed that the excluded pathway (as mentioned in Question 10 from NRC) was drinking water. We excluded this pathway because of information from local farmers that the upper aquifer that smell bad also taste bad and would not be used as drinking water. The

drinking water pathways can be simulated if the calculations are done again, but based on local information, the calculations do not reflect current or proposed use of groundwater for drinking.

The existence of sinkholes is confirmed at JPG or at least in the vicinity, and these could be potential transport pathways to sources of drinking water. These pathways, however, will be extremely difficult to include because we have no information on their hydrological characteristics or spatial extent and would have to guess about their effects. There is probably a reasonable amount of work completed on karst transport systems in Indiana, and a thorough literature review could provide the needed information. However, the dilution of DU from the source to a potential receptor would also have to be figured into the amount of DU that gets to the receptor. Including the effects of karst transport could be considered if calculations are completed again.

In the present RESRAD scenarios, the "drinking water" pathway starts from a well located at the edge of the affected area at a user-specified depth. Modeling this pathway for dose could be done within this context, and would represent a far greater dose to receptors than if actual flow through karst systems were modeled. We suggest that this scenario be considered to avoid adding great uncertainty to calculations of transport in karst topography.

11. We excluded the irrigation pathway after considering the type of farming that occurs in the JPG area. Little to no irrigation is used on the upland areas near JPG, and only small plots on sandy soils of the Ohio River terraces and floodplains are irrigated. Since the irrigated areas are small and hydrologically separate from JPG, we suggest that irrigation not be considered in the risk assessment.

12. The erosion data is based on erosion rates for Indiana soils of the loess-over-till variety, one of the most common soil series in the state of Indiana and Jefferson County (Nickell, 1985). The rate of 1 mm per year is difficult to document since erosion rates are never linear. The observation that the contaminated material will erode from the site in 150 years is accurate. Unfortunately, RESRAD (other codes as well) allow erosion modeling but do not take into account soil formation. In addition, DU (or other contaminants) that erode from an affected area are lost from the system and do not show up again in the mass balance. The scenarios can be designed to not allow erosion, thus all DU will remain onsite until it leaches through the soil.

    Another note on erosion. The DU that transports from the affected area through the soil is not affected by the loss of the soil from which the contamination came. Thus, the DU that leaves the affected area via leaching, uptake, or wind deposition will remain in the calculations throughout the duration of the simulations, where as DU that erodes with the soil is removed from the risk considerations.

13. The main justification for the thickness of the contaminated zone, 15 cm, was from previous sampling of DU in soils at Aberdeen Proving Ground. Ebinger et al (1990) showed that DU was detectable to 20 cm in soils at APG. Excavation below 20 cm was limited by the ability

to detect UXO below this depth. However, the concentrations of DU below a penetrator decreased to nearly background at 20 cm, suggesting that the contaminated zone at APG was not significantly greater than this amount. The concentration with depth profile in the APG samples decreased exponentially with depth from the surface.

We chose to use the APG information at JPG for two reasons. First, no sampling was planned for JPG and measurements could not be taken. Second, in lieu of measurements, we noticed similar soil characteristics at APG and JPG such as texture (silt loam surface horizons) and poor drainage, and we assumed that the physical characteristics of APG soils were at least similar to those at JPG. In addition, JPG was farmland before 1943, then was converted to forest through vegetative succession. The top 15 cm, therefore, would have been the "plow layer" or that part of the upper soil horizons that were mixed by plowing. We assumed that the plow layer would also be the most actively mixed layer during Army activities, thus we chose 15 cm as the contaminated zone depth. Without better information to support or refute the assumptions, the choice of 15 cm contaminated zone was reasonable.

The distance from the contaminated zone to a hypothetical well used in the RESRAD calculations is fixed by the model. The well is located at the edge of the contaminated zone that is on the down-gradient end of the groundwater flow path (Yu et al, 1993). Thus, the size of the contaminated zone determines the location of the well, and the depth to the first saturated zone determines the depth of the well. This is a fixed attribute of the RESRAD code.

14. The thicknesses of the two unsaturated zone layers were estimated from the Jefferson County Soil Survey (Nickell, 1985), from well logs provided by the Army (Abbott, 1983), and from data south of the DU area from wells installed in the 1990s (REI, 1994). The upper unsaturated zone was the top meter that was comprised of the soils at JPG. Most of the soils within the DU area were Avonsburg silt loam, Cobbstock silt loam, Rossmoyne silt loam, and Cincinnati silt loam. These soils are typically about 1 meter in depth, and consist of loess (approx. 40 cm) over weathered glacial till (about 60 cm) (Nickell, 1985). Since most of the DU area is covered by these soils, selecting the upper part of the unsaturated zone as 1 meter in depth was warranted.

    The second unsaturated zone layer was from 1 to 4 meters below the surface. Well logs (Abbott, 1983; Rust, 1994) were used to estimate the lower boundary to the unsaturated zone. Usually, limestone bedrock and groundwater were found at about 4 meters in the available well log data. Field sampling after the 1996 risk assessments (Ebinger and Hansen, 1996 a, b) indicated that groundwater at greater depths was encountered in some locations, as was shallower groundwater. Without a means in the RESRAD code to vary the depth of the unsaturated zone, though, the variation in depth to groundwater could not be accommodated and the average of 4 meters was used.

15. NRC is correct on this. Figure 5 in the 1998 report should read "Farming Scenario" instead of "Occasional Use Scenario".

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