



DEPARTMENT OF THE AIR FORCE  
HEADQUARTERS UNITED STATES AIR FORCE  
WASHINGTON DC

15 April 2008

MEMORANDUM FOR NRC REGION IV  
ATTENTION: MS. BROWDER

FROM: AFMOA/SG3PR  
110 Luke Avenue, Room 405  
Bolling AFB, DC 20032-7050

SUBJECT: Response to NRC Request for Additional Information Concerning McClellan Air Force Base

The Air Force Radioisotope Committee (RIC) Secretariat received a request from NRC Region IV, dated February 29, 2008, concerning data from the former McClellan Air Force Base (AFB). The RIC Secretariat also received a list of supplemental questions concerning the former McClellan AFB from the NRC via e-mail on March 19, 2008. This document serves as the RIC Secretariat's official responses to both sets of questions concerning the former McClellan AFB. The general question on Air Force Sites, however, (Question 4 of the 29 Feb 08 letter) will be answered under separate cover.

**NRC Letter Question 1:** "Please provide information regarding the final disposal site for the radioactive materials that were removed from CS 010. Additionally, please clarify whether all of the remediated soils from CS 010 site, excluding radium contaminated soils, have been disposed. For the radium contaminated soils which are currently being stored at CS 010, please provide the location where the soils were excavated and the basis for concluding that these soils only contain radium."

Response: All radioactive materials removed from CS 010 except a portion of the soils containing radium-226 ( $^{226}\text{Ra}$ ) have been disposed off site. The plutonium (Pu) found in one 20-gallon drum was transferred to the Massachusetts Institute of Technology (MIT) for academic research. Samples were sent to the Air Force Institute of Operational Health (AFIOH), which is now part of the School of Aerospace Medicine, for waste disposal profiling purposes. Those samples were disposed of by the laboratory pursuant to the lab's normal disposal practices. Resin columns were also sent to AFIOH, and were consumed by the analysis. Excavated material containing  $^{226}\text{Ra}$  but no other radioactive materials was sent to US Ecology in Idaho and to Envirocare (now EnergySolutions) in Utah. Excavated material containing other isotopes besides  $^{226}\text{Ra}$  was sent to Envirocare, Utah for disposal.

The radium-contaminated soils currently stored at CS 010 were removed from the northern half of the excavation. CS 010 was excavated in a terraced fashion from south to north. When the Air Force stopped shipping soil for off-site disposal, a little more than half of the pit (27,864 cubic yards) had been excavated. Approximately the southern 20 percent of the excavation had reached its full depth. The excavation was progressively shallower moving from north to south with a terraced

slope of about 4.5 percent. Approximately the northern 25 percent of the pit had not been excavated at all. The soil that had not been excavated at that time (23,409 cubic yards) is what is currently stored at CS 010. Since the excavation was divided into a 15 ft. x 15 ft. grid and careful accounting was made of the fate of materials from each grid, the Air Force has documentation showing which specific grid cells went into specific soil piles currently stored at CS 010.

The conclusion that the soils being stored at CS 010 contain only  $^{226}\text{Ra}$  is based on the gamma spectroscopy results from the on-site screening lab used during the excavation and on the known relationships between specific pairs of gamma-emitting and alpha-emitting radionuclides. Of the gamma emitting radionuclides, only  $^{226}\text{Ra}$  was detected at more than twice background levels in these soils. Plutonium-239 and  $^{238}\text{Pu}$  cannot be detected by gamma spectroscopy, but americium-241 ( $^{241}\text{Am}$ ) can be, and it exists only in a constant six to one ratio with  $^{239}\text{Pu}$ . Therefore,  $^{241}\text{Am}$  can be used as an indicator of the presence of  $^{239}\text{Pu}$ . Any plutonium present in the soils at CS 010 would be expected to be the result of the detonation of plutonium weapons, including transuranics (e.g.,  $^{238}\text{Pu}$ ). Therefore,  $^{241}\text{Am}$  can be used as an indicator for  $^{238}\text{Pu}$  as well. Americium-241 was not detected in the soils currently stored at CS 010.

**NRC Letter Question 2 and Supplemental Questions 9 and 10:** Please clarify if the [radioactive materials placed in CS 010] are likely radioactive materials from a previously terminated license. Since the USAF performed extensive soil characterization for CS 010 as stated in the USAF RIC letter dated May 22, 2007, please confirm whether CS 010 is bounding or representative of the formerly licensed radioactive materials at the remaining burial sites. Would the characterization of the material in CS 010 be bounding or representative of the terminated AEC-licensed material at the remaining burial pits? Please describe the potential for radioactive contamination at each of the 11 burial pits...

Response: Most of the materials placed in CS 010 or likely to have been placed in the other disposal pits would not have been subject to an Atomic Energy Commission (AEC) or NRC license. As a matter of routine practice, the Air Force disposed of licensed material either by decay, transfer to another license or permit, or disposal in accordance with 10 CFR 20. The vast majority of the material placed in any of McClellan AFB's disposal pits would have been  $^{226}\text{Ra}$ , environmental samples from foreign weapons tests (subject to Section 91(b) of the Atomic Energy Act), or exempt quantities used as laboratory standards or for training. However, several activities at McClellan AFB were licensed, and it is impossible to definitively demonstrate that licensed material not was placed in the pits without exhuming them and exhaustively characterizing the contents.

The Air Force has concluded that CS 010 represents an upper bound for cases at McClellan AFB. CS 010 operated from 1960 to 1964, just after the end of radium dial painting operations conducted at Building 252, a period when disposal of stocks of  $^{226}\text{Ra}$ -based paint, contaminated materials, and materials used in the cleanup and closure of the radium paint shop would have occurred. This time period also covers the peak of the weapons monitoring laboratory's activities, and records show no indication that McClellan AFB was disposing of radioactive waste off base during this time. By 1965, however, all of these circumstances had changed. Radium painting ended at McClellan AFB in 1960, weapons monitoring activity decreased dramatically after 1963, and McClellan AFB began disposing of radioactive waste off base in 1965. Only three other disposal pits meet the unique combination of circumstances of having operated while radium painting operations were taking place, weapons monitoring activity was high, and off-base disposal of radioactive materials was not documented as occurring—CS 022, CS 024, and the Vadose Zone Site. None of McClellan AFB's

other disposal pits, especially those that were in operation after 1965 are likely to have  $^{226}\text{Ra}$ , 91(b) material, or licensed material from the weapons monitoring lab in quantities approaching those found in CS 010.

CS 022 might possibly contain a larger quantity of  $^{226}\text{Ra}$  than did CS 010. Concentrations ranging from approximately 1 pCi/g to 50 pCi/g of  $^{226}\text{Ra}$  have been found in samples from the site, and surface scanning results indicate areas of gamma emitting radionuclides in excess of two times background levels. A single sample detected 30,700 pCi/g of  $^{226}\text{Ra}$ , but this is believed to have been a discreet object, most likely a portion of a discarded and incinerated aircraft instrument, and not indicative of the general soil conditions at the site. In addition, the site's history is consistent with having received  $^{226}\text{Ra}$ -contaminated materials. The site was a burn pit and later a burial pit for ash from a co-located incinerator. The incinerated materials are likely to have included any of the materials from the radium paint shop that could be burned. The site, however, was not a burial pit for drummed waste. Records and interviews with personnel from the weapons monitoring lab indicate that all waste from lab operations was drummed for disposal. Therefore, it is likely that neither 91(b) material nor AEC licensed material from the lab was disposed of in CS 022.

The Vadose Zone Site consists of several trenches and pits that were used for disposal of primarily liquid waste (fuels, paint solvents, industrial waste water treatment sludge and filter cakes from the industrial waste water treatment plant). The radium paint shop disposed of some wastes through the sanitary sewer system, and the weapons monitoring lab disposed of some wastes through the industrial waste water system. Therefore, the material from the waste water treatment plant might have contained  $^{226}\text{Ra}$  from the paint shop and 91(b) material from the weapons monitoring lab. The material from the laboratory would have been at concentrations/activity levels consistent with the highly sensitive trace analyses being performed by the lab. The history of these sites does not indicate that they received drummed wastes, so glassware, resin columns, standards, and licensed materials from the weapons monitoring lab should not be present.

CS 024 might be similar to CS 010 in some respects. It operated during the periods of radium painting, peak weapons monitoring activity, and on-base disposal of radioactive waste. There is also a report from a single witness that drummed waste from the weapons monitoring lab was taken to this pit. Survey and sampling results, however, indicate only one surface location where radiation exposure levels exceed twice background levels, and the radioactive material in that location is uranium in its naturally-occurring ratio. This is a marked contrast to CS 010, where radioactive material was clearly present at the surface. In addition, McClellan AFB disposed of its low level radioactive material wastes off-base during most of the period CS 024 was in operation, CS 010 was available and clearly in use for radioactive material disposal during the time-period of on-base disposal, and for much of CS 024's operational life the weapons monitoring lab was operating at a reduced volumetric pace. Therefore, although some amounts of  $^{226}\text{Ra}$ , 91(b) material, or licensed material might have been taken to CS 024, it is hypothesized that the total radioisotopic source term in this pit is less than in CS 010.

**NRC Letter Question 3 and Supplemental Questions 8 and 10:** Please clarify the difference between the two descriptions for "suspected" and "confirmed." Provide the basis for the confirmation at CS 022 and the basis for suspected at the other burial pits. Additionally, for each burial pit, please elaborate whether the suspected or confirmed radioactive contamination is previously AEC/NRC licensed material, 91 (b) material, radium-226, or whether it is commingled material. The May 22, 2007, Air Force letter to NRC mentioned that some of the radioactive material in burial pit CS 010

contained small quantities of traceable standards to assess radiochemistry efficiency and perform instrument calibration. Was this material under the AEC licenses? Please describe...the basis for being "confirmed" or "suspected". Also, which pits have the potential for AEC-licensed material, 91(b) material, radium-226, or whether it is commingled material?

Response: The term "confirmed" is used for sites where surface scanning and soil samples have definitively identified radionuclides at levels requiring remediation. Of the sites covered in the Focused Strategic Sites Proposed Plan, this applies to CS 010 and CS 022. The term "suspected but uncertain" is used for sites where the site conceptual model indicates that radioactive materials might have been disposed at the site but surface scanning and soil samples do not support the presence of radionuclides at levels requiring remediation. This applies to Focused Strategic Sites Proposed Plan sites CS 011, CS 012, CS 013, CS 014, CS 024, PRL 008, and Vadose Zone. These sites are considered "suspected" despite the fact that scanning and sampling results do not indicate the presence of radioactive materials because: they are disposal pits, it is known that McClellan AFB buried radioactive materials in at least two disposal pits (CS 010 and CS 022), and finally, because sampling cannot definitively rule out contamination in a heterogeneous environment such as a disposal pit.

Each of the standards and check sources used in the weapons monitoring lab were either exempt quantities or AEC licensed material. All of the AEC licenses have been properly terminated.

In CS 011-014 and PRL 008, some amount of 91(b) material and potentially licensed materials may be present. Each of these pits operated five or more years after radium painting operations ceased at McClellan AFB, making it unlikely that quantities of  $^{226}\text{Ra}$  on the scale of CS 010 are present.

In CS 022, only  $^{226}\text{Ra}$  is expected because there are no indications that drums were buried on this site, and all waste from the weapons monitoring lab, whether 91(b) material or licensed material, was disposed of in drums.

In CS 024, there is the potential for  $^{226}\text{Ra}$ , 91(b), and licensed material although likely in smaller quantities than found in CS 010 as described earlier in this document.

In the Vadose Zone Site, only  $^{226}\text{Ra}$  is expected in quantities that could be detected by ordinary laboratory methods. The potential source of radioactive materials in these pits would have been industrial waste water treatment plant sludges and filter cakes rather than drummed wastes from either the radium paint shop or the weapons monitoring lab. The sludge and filter cakes might have contained  $^{226}\text{Ra}$  precipitated from waste water originating at the radium paint shop. They might also contain 91(b) materials transported in the waste water from the weapons monitoring lab but only in the extremely small trace quantities that the lab was designed to detect. The absence of drummed waste would also mean that no licensed material would have been disposed of in these pits.

Since records indicate that McClellan AFB routinely disposed of radioactive materials off base since 1965, it is also quite possible that none of the pits that operated exclusively after 1965 (CS 011-014, PRL 008) contain any radioactive materials above background levels.

**NRC Supplemental Question 1:** What organizations are involved with the remediation under CERCLA and what are their roles?

Response: The Air Force is the lead agency, executes the CERCLA process, and selects and

executes remedies. The U.S. Environmental Protection Agency (EPA) advises the Air Force on CERCLA compliance, joins in remedy selection, and resolves disputes. The State of California advises the Federal agencies on State laws, reviews remedies, and has right to dispute selected remedies.

**NRC Supplemental Question 2:** What are the general remediation schedules?

Response: There are four CERCLA records of decision (ROD) planned that will address radiological sites: the Initial Parcel 3 ROD scheduled for 2009, the Focused Strategic Sites ROD tentatively scheduled for 2009, the Small Volume Sites ROD tentatively scheduled for 2010, and Follow-on Strategic Sites ROD tentatively scheduled for 2011. The actual schedule for the Focused Strategic Sites ROD is dependent on resolution of the NRC jurisdictional issue and agreement on a remedy. The actual schedules for the Small Volume Sites and Follow-on Strategic Sites RODs are dependent on resolution of Focused Strategic Sites ROD issues. Implementation of remedies typically follows the ROD by 1-2 years.

**NRC Supplemental Question 3:** Has a Historical Radiological Assessment consistent with MARSSIM guidance been prepared?

Response: A basewide HSA consistent with MARSSIM was published in 2005. CERCLA Preliminary Assessments (PA) were published for the entire base at various times during the 1980s. MARSSIM identifies HSAs and PAs as analogous.

NRC Supplemental Questions 4 and 5: Although AEC licenses were terminated, are the records clear about how the material or sources were dispositioned (offsite disposal, transferred to another site, onsite disposal)? Are there historical records documents that document the amount and type of radiological material in each of the burial pits?

Response: For each license or permit, the types of material and disposition but not quantities are documented. The historical records document radiological disposal shipments from McClellan AFB from 1955 through 2002. The historical records, however, do not document the amount and type of radiological material in each of the burial pits at McClellan AFB.

**NRC Supplemental Question 6:** What characterization has been done or is planned for each of the burial pits?

Response: CS 010 has been characterized by complete excavation, sampling, and laboratory analysis of the soils and other materials found in the pit. Just over half of the soil (27,864 cubic yards) was characterized by gamma spectroscopy and alpha and beta spectrometry. The remainder of the soil (23,409 cubic yards) was characterized by gamma spectroscopy alone. CS 011-014, CS 022, CS 024, PRL 008, and the Vadose Zone Site were characterized by multiple gamma surface scans and surface and subsurface soil samples analyzed by gamma spectroscopy. CS 024, PRL 008, and the Vadose Zone Site were also characterized by in-situ gamma spectroscopy.

**NRC Supplemental Question 7:** How were the contents of excavated burial pit C10 (sic) characterized? What were the results?

Response: The contents of CS 010 were characterized in two stages. First the site was divided

into a 30 ft. x 30 ft. grid then each of the grid cells was quartered into 15 ft. x 15 ft. plots. Before excavation of the 30 ft. x 30 ft. cells, a soil sample was taken from each 15 ft. x 15 ft. plot. These samples were composited and analyzed by gamma spectroscopy in the on-site screening lab. If the results exceeded the criteria for disposal at US Ecology in Idaho, the individual samples from each 15 ft. x 15 ft. plot were then analyzed separately. The 30 ft. x 30 ft. cell was then excavated to a depth of 1 ft., and the soils were segregated based on the results of the screening samples. During excavation, a sample was taken from each excavator bucketload of soil. These samples were composited for each bin of soil. The composites for each two bins of like soils were then composited, and the two-bin composite sample was sent to an off-site lab for complete isotopic identification including gamma, beta and alpha analysis. This complete process was performed for the 27,864 cubic yards of soil sent off-site for disposal. Only the on-site screening was performed for the 23,409 cubic yards currently stored at CS 010. The pre-excitation screening involved 6,622 soil samples and 1,736 gamma spectroscopy analyses. The off-site lab analyzed 900 samples for gamma, alpha, and beta emitting radionuclides. The results are shown in Table 1, "Radionuclide Analytical Results for CS 010 in Curies (Ci)."

**Table 1**  
**Radionuclide Analytical Results for CS 010 in Curies (Ci)**

Radionuclide	Soil (Ci)	Drums & Debris (Ci)	Total (Ci)
<sup>226</sup> Ra	7.30E-01	1.32E-02	7.43E-01
<sup>137</sup> Cs	2.00E-05	7.21E-07	2.07E-05
<sup>238</sup> Pu	ND	3.27E-04	3.27E-04
<sup>239/240</sup> Pu	3.47E-05	9.67E-03	9.70E-03
<sup>241</sup> Pu	ND	7.25E-03	7.25E-03
<sup>241</sup> Am	1.32E-05	2.43E-03	2.44E-03
<sup>152</sup> Eu	2.52E-05	3.01E-06	2.82E-05
<sup>155</sup> Eu	3.11E-04	ND	3.11E-04
<sup>237</sup> Np	8.16E-04	ND	8.16E-04
<sup>230</sup> Th	ND	1.01E-06	1.01E-06
<sup>232</sup> Th	2.82E-02	ND	2.82E-02
<sup>233</sup> U	ND	1.35E-07	1.35E-07
<sup>235</sup> U	4.19E-05	4.69E-08	4.19E-05
<sup>238</sup> U	1.72E-03	ND	1.72E-03
<sup>108m</sup> Ag	ND	5.11E-08	5.11E-08

Notes:

ND = non detect (e.g. below MDA (minimum detectable activity))  
The <sup>226</sup>Ra results include 3.88E-01 Ci of material currently stored at CS 010 and the material shipped off-site for disposal.

The Pu results include the material found in the 20-gallon drum and transferred to MIT.

The other results represent 91(b) material extracted from environmental samples (primarily atmospheric samples) for nuclear weapons monitoring and laboratory standards used in the weapons monitoring lab.

The <sup>108m</sup>Ag was activated silver found on a resin column.

**First NRC Supplemental Question 11:** What groundwater monitoring is ongoing or planned around the burial pits?

Response: McClellan has a robust groundwater monitoring program for volatile organic compounds, including wells down-gradient from CS 010–014, CS 022, CS 024, PRL 008, and the Vadose Zone Site. The groundwater monitoring program does not currently include any analyses for radionuclides. Previous groundwater sampling results did not indicate the presence of radionuclides in excess of naturally occurring levels, nor did any soil samples taken at more than 30 sites at McClellan AFB find any radionuclides in excess of naturally occurring levels from soil samples obtained 20 ft. or more below ground surface. Given the low mobility of the radionuclides in question and their decay rates, it is unlikely that groundwater regulatory limits will be exceeded in the future. This information has been presented to the regulatory agencies and coupled with the fact that radionuclide analyses can be added to the groundwater monitoring program at any time if necessary, the regulators agreed not to monitor for radionuclides at this time. If the Air Force's preferred remedy for these sites is selected, groundwater monitoring for radionuclides will be a required element of the remedy.

**First NRC Supplemental Question 12:** What ARARs are being considered and are NRC decommissioning regulations potential ARARs? If so, which requirements?

Response: NRC regulations are candidate ARARs. Whether NRC regulations are applicable depends on NRC's decision concerning its jurisdiction. Details of which NRC requirements are ARARs will be determined by the CERCLA ARAR solicitation and analysis process. The Air Force's initial impression is that parts of 10 CFR 20 are ARARs.

**Second NRC Supplemental Question 11:** What dose assessments have been done?

Response: DOE *RESRAD* models have been run for dose at the surface of CS 024, PRL 008, and the Vadose Zone Site. Two *RESRAD* models have also been run to evaluate the protectiveness of a potential capping remedy for McClellan AFB's disposal pits. In the first model, a disposal pit similar in size to CS 010 was presumed to contain all of the radionuclides present in CS 010 at the average concentrations detected in CS 010. In the second model, a disposal pit similar in size to CS 010 was presumed to contain all of the radionuclides present in CS 010 at the maximum concentrations detected in CS 010. In both cases an engineered cap was assumed to be in place and it was assumed that receptors would not intrude into the pit and be exposed directly to the material in the pit (i.e., exposure would be indirect exposure through the cap). None of the model runs found doses in excess of 15 mRem/year.

In addition to the modeling, dosimetry was conducted for all individuals working inside the tent during the CS 010 excavation. These individuals performed operations in CS 010 and many were in close proximity to the excavated material during most of their work day. A public dose assessment was also performed during the CS 010 excavation by placing thermoluminescent dosimeters (TLDs) on the fence surrounding the site. These external exposure measurements at the site boundary indicated a maximum exposure for full time occupancy below the public dose limits for uncontrolled occupancy described in 10 CFR 20.132 (b) (2) (ii). The single largest TLD result for any of the perimeter dosimeters was 25.2 mRem per year in 2003.

**Second NRC Supplemental Question 12 and NRC Supplemental Question 16:** What are the overall plans for remediation for the radioactive contamination? What are the plans for covers of the burial pits?

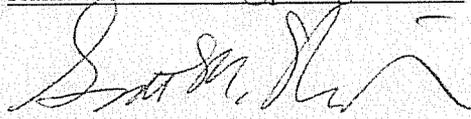
Response: The Air Force's proposed remedy for CS 011-014, CS 022, and PRL 008 is to cap the sites in place with an engineered cap consisting of a low-permeability geomembrane layer, low permeability clay layer, and soil cover. The proposed remedy for CS 010 and CS 024 is to put the material currently stored at CS 010 and the material from CS 024 into CS 010. This consolidation unit would have an engineered cap as described above plus a clay liner and leachate collection system. The Vadose Zone Site would be left in its current capped condition. At all of these sites, the remedy would include landfill monitoring pursuant to California Code of Regulations (CCR) Title 27, including groundwater monitoring for radionuclides. These remedies are consistent with U.S. EPA's presumptive remedy for disposal pits, and are protective based on likely concentrations, known surface doses, and modeled doses.

**NRC Supplemental Questions 13, 14, 15, 17, and 18:** What are the plans for institutional controls? Is a similar approach to the "model" restrictive covenant approach in the Navy California MOA [memorandum of agreement] being considered? Who will be future owners of the restricted release areas—Air Force, local government or private owners? Will areas with radium-226 remain under military control or be transferred to non-military ownership? What organizations will be responsible for operations and maintenance of institutional and engineering controls as well as long-term monitoring? Would the Air Force conduct Five-Year Reviews? What regulatory oversight organization will be responsible for review and inspection of the effectiveness of the restrictive covenant?

Response: The future owner of the area will be local government. The area with  $^{226}\text{Ra}$  contamination will be transferred to the new owner, but with engineering and institutional controls in place, and the Air Force will retain ownership of  $^{226}\text{Ra}$  requiring any action or control. The specific institutional control for Air Force retention of the  $^{226}\text{Ra}$  is still to be determined. If the Air Force's proposed remedy is selected, institutional controls to protect and maintain the physical remedy will be part of the remedy. The Air Force will maintain all institutional controls linked to the physical remedy such as inspection and maintenance of engineering controls and landfill monitoring under CCR Title 27. The Air Force will follow the Air Force-California MOA which is similar but not identical to the Navy-California MOA. The new owner will be required to sign and record a State Land Use Covenant (SLUC) at property transfer and will be responsible for complying with the deed and SLUC. The State is responsible for verifying compliance with SLUC. The Air Force, U.S. EPA, and State will review and inspect effectiveness of the selected remedial action inclusive of institutional controls. The Air Force will conduct five-year reviews of these controls.

The RIC Secretariat would like to thank and acknowledge the following individuals for their assistance and support in answering these questions: Air Force Real Property Agency (AFRPA) - Mr. Philip Mook (Permittee), Mr. Bill Hall (Permit RSO) and Mr. Buddy Walser (Contract Support); Defense Microelectronics Agency (DMEA) - Mr. David Green (Former permit RSO); and USAFSAM/SDR - Mr. Brian Harcek, health physics technical support.

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