

Response to Comments on the Radiological Release Report for  
Hangar 296 & Hangar 297,  
Marine Corps Air Station (MCAS) El Toro, CA.

The following (4) enclosures are response to comments:

1. Response to MCAS El Toro Local Redevelopment Authority (LRA) Memorandum dated February 26, 2001.
2. Response to Department of Health Services (DHS) Memorandum dated March 20, 2001 and DTSC/DHS comments dated May 14, 1998.
3. Response to U.S. Environmental Protection Agency (EPA), Region IX Memorandum dated March 14, 2001.
4. Response to California Regional Water Quality Control Board, Santa Ana Region Memorandum dated April 2, 2001.

**Marine Corps Air Station (MCAS) El Toro**  
**Response to comments from the MCAS El Toro Local Redevelopment Authority (LRA)**  
**Memorandum of February 26, 2001**  
**Comments to MCAS El Toro Draft Radiological Release Report for Hangars 296/ 296 dated January 2001**

**Comments:**

1. On page 5 of the Draft Report, DON/USMC states: "The residual radioactivity associated with radium was removed to below the removable Limits of Reference (2.1), Regulatory Guide 1.86." Yet in the next paragraph, DON/USMC states: "The Residual <sup>226</sup>Ra found was only slightly above the Limits of Reference (2.1) maximum limit of 300 dpm/100 cm<sup>2</sup>." These two statements raise several questions. First, is the second statement intended for pre- or post- remediation conditions? Second, these two statements seem to contradict each other and therefore, need to be clarified. Third, DON/USMC needs to explain the significance of exceeding the Limits of Reference (2.1) maximum limit of 300dpm/100 cm<sup>2</sup> in terms of potential impacts on health and safety and the environment.

**Response:** First question: these are CLEANUP guides therefore limits that must be achieved before an area can be released. Second question: These are CLEANUP guides, if levels are above the guide remediation is done to bring levels below the guides. Third question: there was no impact to health and safety and the environment for the slightly elevated levels found in this area. Regulatory Guides are issued to describe and make available to the public methods acceptable for implementing specific parts of the Nuclear Regulatory Commission's regulations. Regulatory Guide 1.86 lists three acceptable surface contamination limits for <sup>226</sup>Ra, which must be met to eliminate any further radiological surveillance requirements and to release the area for unrestricted use. These limits are for removable contamination, average contamination over the survey unit area, and a maximum limit for any survey of 100 cm<sup>2</sup>. The limits for removable and for average contamination were never exceeded during the survey. The maximum limit, however, was exceeded in a small area in the common wall between the radium room and the adjacent room to the south during the initial survey. The remedial action taken was to remove the contamination to below the maximum limits, necessitating an asbestos controlled removal of the floor tile and wallboard. The area was then successfully post remediation surveyed to insure all three Regulatory Guide 1.86 limits were met.

The Release Report was clarified.

2. On Page 6 of the Draft Report, DON/USMC states that the ventilation system servicing the radium room was dismantled and removed from the room area. However, no information is provided regarding the ultimate fate of this ventilation equipment. Has any of this ventilation equipment been reused or recycled at MCAS El Toro, or was it disposed in one of the on-site landfills? DON/USMC needs to provide information regarding the ultimate fate of this ventilation equipment and should consider an additional investigation to evaluate the impact of the potential presence of that equipment if it is located anywhere at MCAS El Toro.

**Response:** Section 6.1.2.1 of the Final Historical Radiological Assessment (HRA) for the Marine Corps Air Station, El Toro provides the history of the radium room operation in

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hangar 296. DON/USMC conducted an extensive investigation to determine where all the El Toro equipment potentially exposed to radiological contamination may have been disposed. The results of this investigation are in the El Toro HRA, which was issued in May of 2000. The FINAL HRA was reviewed and concurred to by the BCT, which consists of representatives from the USEPA, DTSC and RWQCB. Summarizing, the final disposition of the ventilation ducting and equipment removed from the radium room is unknown. However, based on correspondence at the probable time of removal, which recognized the radioactive nature of the equipment to be removed, (see section 6.1.2.1 of the HRA), disposal of the ventilation equipment in a landfill as ordinary trash is considered highly unlikely. The remaining portions of the ventilation system were surveyed in 1998, and no portion of this remaining system exceeded the limits of Regulatory Guide 1.86. However, the few areas that showed elevated alpha levels were removed for ALARA considerations and disposed off-site in an approved landfill.

3. On page 6 of the Draft Report, DON/USMC states that the hangar roof has been re-surfaced and was not radiologically surveyed. However, since the ventilation system may have been exhausting potentially radioactive material on the roof, the roof material may contain radioactive material exceeding the Limits of Reference (2.1). If so, the roof material could represent a threat to health and safety and the environment, or require special handling when the hangar roof is replaced or when the hangar is demolished. DON/USMC needs to address this issue in more detail. Similarly, would other areas or materials in the hangar require similar special handling in the future?

**Response:** Materials in the hangar, including the roof material do not represent a radiological threat to health and safety and the environment. Radiological surveys were conducted in the areas most likely to contain radioactivity, and expanded to surrounding areas to confirm the absence of radium contamination. Therefore we conclude that no other materials in the hangar require special radiological handling

Gamma surveys were conducted (see paragraph 5.11, Appendix (B4) and Figure (24)) on the Hangar 296 roof where the ventilation exhaust ducting penetrated the roof. No elevated readings were found.

The Release Report was updated to include a more detailed radiological discussion of the hangar roof area. The additional information can be found in paragraphs 1.1, 1.3.1.2, 3.2.3.7 and 5.11 of the Release Report.

4. In different parts of the Draft Report, DON/USMC states that there are a number of uncertainties regarding the use of radiological material at MCAS El Toro. For example, DON/USMC states that a detailed history of some areas of the radium room area is unavailable (see, for example, Page 7 of Draft Plan). DON/USMC needs to discuss or explain the impact of these uncertainties on DON/USMC's confidence in the results and conclusions provided in the Draft Report. Likewise, to the extent possible, DON/USMC

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should quantify such uncertainties. Can additional work be conducted at each hangar to reduce these uncertainties? If so, DON/USMC needs to explain why such work is not being performed.

**Response:** Section 6.1.2.1 of the Final HRA for the Marine Corps Air Station, El Toro provides the available history of the radium room operation in hangar 296. The HRA concludes the area needs no further investigation for radiological issues. Uncertainties associated with room connectivity and personnel traffic patterns were reduced by conducting a comprehensive radiological survey, centered around the radium room, and expanding surveys from the center, regardless of area use, until confidence was established that radioactive contamination from the radium room was not present in the hangar above release limits. Except for the immediate radium room area, no additional contamination above release limits was found outside the radium room area from the expanded surveys.

The quantification of uncertainties is reflected in the large amounts of negative survey data taken in the hangars. Additional work is not warranted based on the survey data obtained in the hangar.

5. DON/USMC classified the radioactive material storage areas of Hangar 297 as Class 3 (see page 13 of Draft Report). Because radioactive material was stored in this area, it seems reasonable to expect that this area may have been radiologically impacted. As such, this area should have been classified and investigated as a Class 1 or 2 areas.

**Response:** Class 3 areas as defined by MARRSIM are impacted areas. Based on site operating history, Class 3 areas are not expected to contain levels of residual radioactivity, or are expected to contain levels of residual radioactivity at a small fraction of release limits. Hangar 297 does not have a history of radiological work. However, sealed and licensed radioactive material was stored in one area of hangar 297. The Marine Corps controlled the handling and storage of the material. All material was removed from the hangar when the hangar was decommissioned.

Because no elevated areas of radioactivity per the requirements of Regulatory Guide 1.86 were found in hangar 297, the original Class 3 areas were maintained throughout the survey.

6. On page 14 of the Draft Report, DON/USMC refers to "records" regarding refinishing luminous dials. No reference is given for these "records." DON/USMC should provide references or citations for previous work or research cited in the Draft Report and used for the radiological release of the hangars.

**Response:** The records found are summarized in section 6.1.2.1 of the Final HRA for the Marine Corps Air Station, El Toro. This section provides the history of the hangar 296 radium room.

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The release report has been clarified to reference the specific section of the HRA that describes these records.

7. On various pages of the Draft Report (including pages 20 and 22, for example), DON/USMC states that material was shipped off station to an appropriate disposal facility or a licensed disposal facility. However, no specific disposal facility is identified in the Draft Report. DON/USMC should document in the Draft Report the disposal facilities to which radioactive and non-radioactive wastes generated as part of this work were shipped.

**Response:** Trained personnel stationed at El Toro in accordance with MCAS HAZMAT procedures removed non-radioactive wastes (asbestos). Radiological wastes were shipped by the NAVY to a licensed disposal facility outside the state of California.

8. DON/USMC indicates that parts of the hangars (such as the radium room) were remediated (see pages 21 and 22 of Draft Plan). However, little information is provided regarding the remediation methods, survey data, and documentation of remediation activities for the various remediated areas of the hangars. DON/USMC should provide this information (including reference 2.6) to the LRA for review.

**Response:** There were three areas remediated, all associated with the radium room that was remediated. These were the floor between the common wall of the radium room and the room, the ventilation system associated with the radium room and the plumbing system leading from the radium room. The remediation methods, survey data, and sampling results obtained from use of the work plan are provided in section 5 of the Release Report. Since the survey data generated from the work plan is incorporated in the Release Report, reference 2.6 has been deleted from the list of references in the Release Report.

9. Section 5.1.2 of the Draft Plan presents the "Radiological Status and Release of the Former Radium Room" (see Page 21 of Draft Report). DON/USMC concludes this section by referring the reader to Figures 8 and 8A. However, DON/USMC does not discuss in detail the survey data obtained for the radium room and their significance with regards to release of the hangar. DON/USMC needs to discuss the significance of the data presented in Figures 8 and 8A.

**Response:** Section 5.1.2 of the Draft Survey Report notes that the final survey data obtained (figures 8 and 8A) following the remediation of the common wall area is below the release criteria of Regulatory Guide 1.86. The significance of obtaining survey data below that of the Regulatory Guide is to radiologically release the former radium room for unrestricted use.

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10. DON/USMC indicates that slightly elevated alpha readings were discovered in the southwest corner of Room 221. However, DON/USMC did not perform remediation in Room 221 (see page 35 of the Draft Report). DON/USMC needs to explain the technical rationale why no remediation is being conducted.

**Response:** The slightly elevated readings were verified to be fixed contamination. ALARA was considered, but removal of the floor tiles would have resulted in an asbestos controlled procedure and was not considered warranted. The entire area meets the requirements of Regulatory Guide 1.86.

11. DON/USMC infers that elevated radioactivity levels in the enclosed manholes (S1, S2, IW1, and IW2) are due to natural radioactivity contained in concrete and brick (see pages 38 and 39 of Draft Plan). DON/USMC needs to provide back-up information regarding natural radioactivity contained in concrete and brick and compare this data to radioactivity levels measured in the enclosed manholes (S1, S2, IW1, and IW2).

**Response:** Cement, concrete and bricks contain varying amounts of uranium, thorium, potassium, and other naturally occurring radioactive elements. When building materials such as these are geometrically concentrated, (such as an enclosed manhole with concrete walls on all sides) elevated gamma levels are encountered and are consistent throughout the enclosed area. This is the case in the manholes, concrete rooms, and passageways surveyed at El Toro as well as other facilities.

Additional gamma radiation background data was obtained in a manhole with similar geometry in a radiologically non-impacted area at El Toro. The additional background data is discussed in paragraph 5.12.2 of the Release Report and additional data is provided in Appendix (B5).

12. DON/USMC states that elevated radioactivity levels in the lower level work areas adjacent to the hangar bays area considered to be from natural radioactivity contained in concrete (see page 40 of Draft Plan). DON/USMC asserts that such natural radioactivity is originating from <sup>40</sup>K. To substantiate this assumption, DON/USMC needs to perform a survey of natural radioactivity in concrete used at MCAS El Toro. This survey should be used to establish background radioactivity levels for MCAS El Toro. Alternatively, background levels at MCAS El Toro have been established at Hangar 296 for the purpose of this Draft Report. The noted elevated radioactivity levels in the lower level work areas adjacent to the hangar bays should be compared to Hangar 296 background levels and should not be considered to originate from natural radioactivity.

**Response:** Cement, concrete and bricks contain varying amounts of uranium, thorium, potassium, and other naturally occurring radioactive elements. When building materials such as these are geometrically concentrated, (such as an enclosed room with concrete walls,

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ceilings and floors) elevated gamma levels are encountered and are consistent throughout the enclosed area. This is the case in the manholes, concrete rooms, and passageways surveyed at El Toro.

To confirm that the elevated gamma levels in the south work area of hangar 296 are due to building materials, a concrete sample and a wall sample were taken and analyzed for gamma producing radioactive elements. The results of the samples confirmed elevated concentrations of  $^{40}\text{K}$  (20 pCi/g  $^{40}\text{K}$  for the concrete sample and 188 pCi/g  $^{40}\text{K}$  for the sample) and very little concentrations of  $^{226}\text{Ra}$  (less than 1 pCi/g  $^{226}\text{Ra}$ ). This, as well as the geometry of the room (concrete walls, ceilings and floors) contributed to the gamma levels above the investigation level. In this case, the background area data for comparison purposes did not apply.

13. Radioactivity levels above investigation levels were found in the interior stairs and the storage areas for aircraft equipment containing radioactive material (see page 41 of Draft Report). DON/USMC states that these exceedances are attributable to naturally occurring radioisotopes in concrete and in the non-slip surface attached to the stair steps. As stated above, DON/USMC needs to provide evidence of the presence of radioisotopes as background in concrete and in the non-slip surface attached to the stair steps.

**Response:** Cement, concrete, bricks and other building materials and adhesives contain varying amounts of uranium, thorium, potassium, and other naturally occurring radioactive elements. When building materials such as these are geometrically concentrated, (such as an enclosed stairway with a concrete floor and concrete walls on two sides) elevated gamma levels are encountered and are consistent throughout the enclosed area. This was the case in the stairways leading from the north mezzanine to the hangar floor at El Toro.

Gamma radioactivity levels above investigation levels were found in the interior stairs and storage areas. The gamma levels were consistent throughout the stairway area. The survey protocol for elevated gamma levels is to take one-minute alpha and one-minute beta readings, and to compare the alpha and beta levels to Regulatory Guide 1.86 for release limits. No elevated alpha or beta above regulatory levels were found on the bare concrete stairs or the part of the concrete stairs covered with non-slip mastic.

Section 5.14.1 on the Release Report was expanded and clarified to incorporate the above explanation.

14. In Section 3.6.2, DON/USMC indicates that the center mezzanine of Hangar 296 was used as the background reference area for the surveys conducted. Radionuclides were used in various areas of Hangar 296. Therefore, while the area used as background reference area in Hangar 296, may not have been used directly for storage of radionuclides, it could have been impacted by radionuclides stored or used in the vicinity of the areas. Thus, the center

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mezzanine of Hangar 296 may not be representative of a "true" background. DON/USMC needs to select a location that does not have the potential to have been exposed to radionuclides related to MCAS El Toro activities and use that location as its measure of background levels of radioactivity.

**Response:** The center mezzanine of Hangar 296 was approved by the BCT during the Survey Plan approval process for obtaining background data. The center mezzanine was chosen, because the area was similar in construction to the north mezzanine, and because the area had a history of use as administrative office spaces. Radioactive materials would not have been transported through or stored in the center mezzanine, since the radioactive work area was located in the north mezzanine, approximately 100 yards away.

In addition, forty background readings per instrument were taken throughout the center mezzanine (a total of 160 readings). All of the readings taken were consistent for each instrument with very little variation.

The DON/USMC appreciates the time spent reviewing this document.

**Marine Corps Air Station (MCAS) El Toro**  
**Response to comments from the Department of Health Services**  
**Memorandum of March 20, 2001**  
**Comments to MCAS El Toro Draft Radiological Release Report for Hangars 296/ 296 dated January 2001**

**General Comments:**

1. Once the Navy has adequately addressed DHS comments, DHS will need to conduct verification surveys and/or confirmation sampling at these hangars in order to provide a release for unrestricted use.

**Response:** Following response to comments to the Radiological Release Report for Hangars 296 & 297, DTSC/DHS may conduct verification surveys. NAVFAC Southwest Division will provide assistance as requested, once the schedule is set for the confirmation surveys. We encourage this verification to be performed in a timely manner to support the Base reuse needs of the local community.

2. DHS was unable to locate responses to the last DHS review comments dated April 16, 1999 regarding the Final Radiological Status Survey, El Toro Marine Corps Air Station, California. Please provide the responses or reference where in this document those responses can be found.

**Response:** NAVFAC Southwest Division forwarded the response to comments, dated May 27, 1999, to DTSC and the USEPA on June 14, 1999. A copy of the DHS comments with the responses follows as attachment (2a).

**Specific Comments:**

1. Page 36, Section 5.11.2: Please explain the 28 counts per minute per 100 square centimeters (cpm/100 cm<sup>2</sup>) value shown in this discussion. If these are in alpha cpm, please reference the location of this data in the document. The reviewer was unable to locate any cpm or equivalent disintegrations per minute (dpm) alpha values at these levels. It is not clear from what has been presented that the ventilation pathways have been sufficiently characterized. Has any attempt been made or is there a plan to evaluate whether radium was released from the ventilation system onto the roof, surrounding environment, etc?

**Response:** Initial one-minute stationary alpha and one-minute stationary beta readings were taken in the openings of the remaining ventilation ducting and disassembled expansion joints in the attic over the radium room. No levels were found that exceeded Regulatory Guide 1.86. However, one opening from the previously removed ducting leading from radium room individual hood exhaust system did have a non-removable alpha reading of 28 cpm/100 cm<sup>2</sup> (35.6 dpm/100 cm<sup>2</sup>). Even though the non-removable limit from Regulatory Guide 1.86 was 200 dpm/100 cm<sup>2</sup>, this ducting was removed and disposed of off the Station. Final radiological gamma survey scans were then conducted in accordance with Section 5.11.1 of the Release Report with negative results, and the data reported in Figure (18). One-minute alpha and beta readings were also conducted in accordance with Section 5.11.1 of the Release Report with negative results, and the data also reported in Figure (18).

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**Response to comments from the Department of Health Services**  
**Memorandum of March 20, 2001**

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Gamma surveys were conducted (see paragraph 5.11, Appendix (B4) and Figure (24)) on the Hangar 296 roof where the ventilation exhaust ducting penetrated the roof. No elevated readings were found.

The Release Report was updated to include a more detailed radiological discussion of the hangar roof area. The additional information can be found in paragraphs 1.1, 1.3.1.2, 3.2.3.7 and 5.11 of the Release Report.

2. Page 38, Section 5.12.2: Please explain the "release limits" of the residual radiation in the plumbing system. It is not apparent to DHS that the sewage/industrial waste line pathways have been sufficiently characterized.

**Response:** The majority of the plumbing system piping below the radium room was removed and disposed of off the Station. The survey method required gamma scans of the outside of the remaining piping with both an unshielded 2" x 2" NaI detector and a Micro-R meter and solid sampling from the end of each piping remnant. The release criteria would be a gamma reading below investigation limits listed in Table 3.7 and Figure 19B and a solid sample result of less than 5 pCi/gm (11.1 dpm) radium 226. This was achieved for the plumbing system and the results listed in Figure 19B.

3. Figure 18B: It is unclear how the investigation levels for alpha cpm and dpm are related. Is the alpha cpm investigation level (IL) equivalent to the alpha dpm investigation level? The cpm IL value does not appear to be consistent with other conversions. Please verify and show area units for the investigation levels.

**Response:** The conversion of cpm to dpm in the alpha probe column in Figure 18B has been corrected. The investigation level in cpm for the alpha probe is actually 17. The change in investigation level had no effect on the results of the survey. The formula used to convert cpm to dpm is found in MARRSIM page 6-30, equation (6-2). This formula can be used if the following three items are known:

1. alpha or beta probe efficiency
2. physical probe surface area
3. alpha or beta background level

The DON/USMC appreciates the time spent reviewing this document.

May 27, 1999

**Response to the April 16, 1999 DTSC/DHS Review of Responses to the May 14, 1998  
DTSC/DHS Comments to the April 23, 1998 Draft Final Survey Plan of Hangars 296 and  
297 at Marine Corps Air Station (MCAS), El Toro, California**

**General DTSC/DHS Comments:**

1. Once the Marines have determined that Hangars 296 and 297 are ready to be released for unrestricted use, DHS would like to conduct verification surveys and/or confirmation sampling at these hangars.

Answer to DTSC/DHS General Comment Number 1:

DTSC/DHS will be provided with a Draft Radiological Release Report for review based on the Final Survey Plan, including any remediation work that is accomplished. NAVFAC Southwest Division is available to provide assistance, when requested by DHS, for the verification surveys and/or confirmation sampling.

**Specific DTSC/DHS Comments:**

1. Page 2, "Answer to DTSC/DHS General Comment Number 1.f." It was not clear how "taking a one-minute stationary alpha reading in every other upper wall grid at any area of elevated activity" would ensure that the highest alpha reading would be acquired. DHS suggests taking the one-minute alpha reading at the area(s) within the grids showing elevated readings.

Answer to DTSC/DHS Specific Comment Number 1:

The Survey Plan will be clarified to state that one-minute alpha readings will be taken in all areas where elevated scan readings are detected.

2. Page 2, "Answer to DTSC/DHS General Comment Number 1." Please provide answers to the following:
  - a. How 100 counts per minute (cpm) above background for a beta/gamma (pancake) probe relates to disintegrations per minute (dpm) by providing the efficiencies of the instruments.
  - b. and how cpm or dpm of the beta/gamma readings relate to the alpha readings.

Answer to DTSC/DHS Specific Comment Number 2:

- a. The efficiencies and therefore the relation of cpm to dpm for the beta/gamma (pancake) probe will be provided in the Appendix Section to the Survey Plan.
- b. The relatively small area of the beta/gamma (pancake) probe and the efficiency make this instrument only effective in detecting higher levels of radioactivity. As such, it is not intended that the beta/gamma (pancake) probe results be used as a releasing criteria. The intent of using a beta/gamma (pancake) is to provide additional scan check data to ensure

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that no areas with unusually high levels of radioactivity are left in place. The pancake data obtained does not relate directly to alpha measurements taken with the ZnS(Ag) scintillation instrument. A high level reading from the beta/gamma (pancake) probe, or any of the scanning instruments, will be cause for the surveyor to take a direct one-minute stationary alpha and one-minute stationary beta reading in the elevated area.

3. Page 4, "Answer to 8/5/98 USEPA, Region IX Comment1." DHS cannot agree with the method of holding an unshielded (2" x 2") NaI probe at waist level to perform scans of the stairwells or any other area where surface contamination is being evaluated. All readings should be taken at the surface of the area being surveyed.

Answer to DTSC/DHS Specific Comment Number 2:

The Survey Plan will be changed to include a surface gamma scan and one-minute stationary alpha and one-minute stationary beta surveys of the Hangar 296 North Mezzanine interior stairs and elevator leading from the radium paint room complex to the hangar floor.

Radium-226 surface contamination was expected to be found in and around the radium paint room complex. Radioactive contamination was not expected in the remaining areas of Hangar 296 or in Hangar 297. The intent of the waist level gamma and micro-R scans in the areas not associated with the radium paint room was to provide an added check that other radioactive materials were not left in either Hangar. However, the floors of the hangar areas were scan surveyed at the floor surface, using shielded (3" x 3") NaI detectors.

Note: The El Toro Draft HRA notes that there are three aircraft items containing radioactive material recently in use and associated with Hangars 296 and 297. These are:

- a. In-flight Blade Inspection System (IBIS) helicopter components containing Strontium-90 in Hangar 296.
- b. Ice-Detector helicopter components containing Strontium-90 in Hangar 296.
- c. In-flight refueling (paradrogue) fixed-wing aircraft components containing Krypton-85 in Hangar 297.

In order to obtain an unrestricted radiological release of Hangars 296 and 297, the El Toro Survey Plan has been changed to include surveys of the radioactive material storage and issue areas for these components. Since the radioactive material is an integral part of the aircraft component, and no reports of leak test failures of contamination have been documented, the surveys are aimed at detecting intact components that may have been inadvertently left when the Hangars were recently vacated.

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**Response to comments from the United States Environmental Protection Agency, Region IX**  
**Memorandum of March 14, 2001**  
**Comments to MCAS El Toro Draft Radiological Release Report for Hangars 296/ 296 dated January 2001**

**Comments:**

1. **Section 3.2.3.6, Page 12:** This paragraph is unclear. Were the alpha measurements taken at a height of one centimeter? If so, was attenuation due to the air space between the probe and the survey surface in question considered in the instrument's alpha detection sensitivity?

**Response:** The alpha detector used was a Ludlum probe 43-89 attached to a Ludlum Model 2224 Scaler/Ratemeter. The stationary alpha and beta measurements were taken with the probe touching the surface, which puts the detector approximately 1 centimeter from the surface being surveyed. The probe efficiency was determined using the same surveying technique with the probe touching the surface of the source. Since the efficiency measurement technique was the same as surveying technique, the alpha attenuation due to air space between the probe and the survey surface was an integral part of the detection sensitivity.

2. **Section 3.5.5, Page 16:** The last sentence in the paragraph states that shielded 3" x 3" NaI detectors provide an MDC for <sup>226</sup>Ra less than 2.8 pCi/gm which is the MDC for a 2" x 2" NaI detector. Please calculate the MDC for the 3" x 3" to demonstrate how much less its MDC is than that of the 2" x 2" detector.

**Response:** Ludlum representatives were contacted and they provided stationary efficiency measurements for both the unshielded 2" x 2" and shielded 3" x 3" NaI detectors using a 5 uCi Ra-226 source. The efficiencies measured were as follows:

- a. 22% for the unshielded 2" x 2" NaI probe
- b. 29% for the shielded 3" x 3" NaI probe

Since the sensitivities of the detectors are proportional to the efficiencies, and since the sensitivity of the unshielded 2" x 2" NaI probe is shown in table 6.7 of the MARSSIM to be 2.8 pCi/gm, then the sensitivity of the shielded 3" x 3" would be 2.1 pCi/gm.

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**Response to comments from the California Regional Water Quality Control Board, Santa Ana Region**  
**Memorandum of April 2, 2001**  
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**Comments:**

No comments received. The DON/USMC appreciates the time spent reviewing this document.