DEPARTMENT OF THE ARMY
CORPUS CHRISTI ARMY DEPOT
308 CRECY STREET
CORPUS CHRISTI TX 78419-5260

27 September 2008

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Corpus Christi Army Depot
Safety & Environmental Division (Stop 23)
Radiation Safety Officer
Corpus Christi, TX 78419-5260

SUBJECT: Request to Expedite Corpus Christi Army Depot Radiological Survey Plan with intent to Decontaminate and Decommission for the purpose of terminating Nuclear Regulatory Commission Source Material License, STB-1168

Ms. Rachel Browder
Nuclear Materials Licensing Branch
U.S. Nuclear Regulatory Commission
Region IV
611 Ryan Plaza Drive, Suite 400
Arlington,TX 76011-8064

Dear Ms. Browder,

Request that the process to review and approve the enclosed plan prepared by Science Applications International Corporation (SAIC), Inc. in cooperation with Environmental Dimensions, Inc. be expedited to meet the needs of the U.S. Army production requirements at the Corpus Christi Army Depot. Documents included in this package for review:

a. Tab A: EDI, Inc. Agreement to provide Radiological D&D Services at the Corpus Christi Army Depot.

b. Tab B: Acceptance by EDI under License R-01103-C17

c. Tab C: Corpus Christi Army Depot Radiological Survey Plan, Dated September 08, 2008.

The CCAD Radiation Safety Program was last updated on 10 July 06. Table 1 which is referred to in the Glossary under "Contaminated Area" was left out. To correct this, CCAD Regulation will be amended to reference the contents of DA Pam 385-2, "The Army Radiation Safety Program", Table 5-2 (See Tab D).

No. 471956

The point of contact for this action is Mr. Eduardo Perez, 361.961.2326 Ext. 247 or e-mail at the following address eduardo.perez3@ccad.army.mil.

Sincerely,

EDUARDO PEREZ
Safety Engineer, Safety and
Environmental Division

REGULATORY REVIEW DRAFT

CORPUS CHRISTI ARMY DEPOT RADIOLOGICAL SURVEY PLAN

CORPUS CHRISTI, TEXAS

September 8, 2008

REGULATORY REVIEW DRAFT

CORPUS CHRISTI ARMY DEPOT RADIOLOGICAL SURVEY PLAN

CORPUS CHRISTI, TEXAS

September 8, 2008

prepared by Science Applications International Corporation, Inc.
in coordination with Environmental Dimensions, Inc.

SAIC®
From Science to Solutions

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1.0 INTRODUCTION

Corpus Christi Army Depot (CCAD) is the largest helicopter repair facility in the world consisting of more than 50 buildings that encompass more than 2 million square feet. Facilities include a number of hangars and associated overhaul and testing facilities centered around Building 8, a facility with about 1 million square feet which serves as the focal point for aircraft overhaul operations. CCAD is a major tenant organization on Naval Air Station (NAS), Corpus Christi, a facility in the Flour Bluff area, about 10 miles southeast of the central portion of the City of Corpus Christi. (See Figure 1-1)

CCAD and its predecessor, the U.S. Army Aeronautical Depot Maintenance Center, have performed mission-essential depot-level maintenance of army aircraft engines and their associated components since the early 1960s. Some of the aircraft engine components were produced using magnesium-thorium alloys based on the ability of thorium, a naturally occurring radioactive material, to increase the high temperature strength of the associated metal alloys. Although magnesium-thorium alloys containing less than four percent thorium can be possessed without a radioactive materials license, a source material license is required for any physical, chemical or metallurgical treatment or processing. As such, CCAD applied for and was issued Nuclear Regulatory Commission (NRC) Source Material License STB-1168. This license authorized the performance of those specific treatment and processing operations that were required to perform mission-essential maintenance and overhaul of the magnesium-thorium alloy aircraft engine components.

Given that maintenance of magnesium-thorium alloy aircraft engine components is no longer being performed at CCAD, action is being taken to effect decontamination and decommissioning (D&D) of impacted areas and equipment and the subsequent termination of CCAD's NRC license. The surveys defined herein will determine the nature and extent of radiological contamination present as a result of NRC licensed maintenance operations such that D&D plans can be developed to address the contamination. Upon completion of D&D and confirmatory final status surveys, a request for termination of NRC Source Material License STB-1168 and the associated unrestricted release of impacted facilities will be submitted to the NRC.

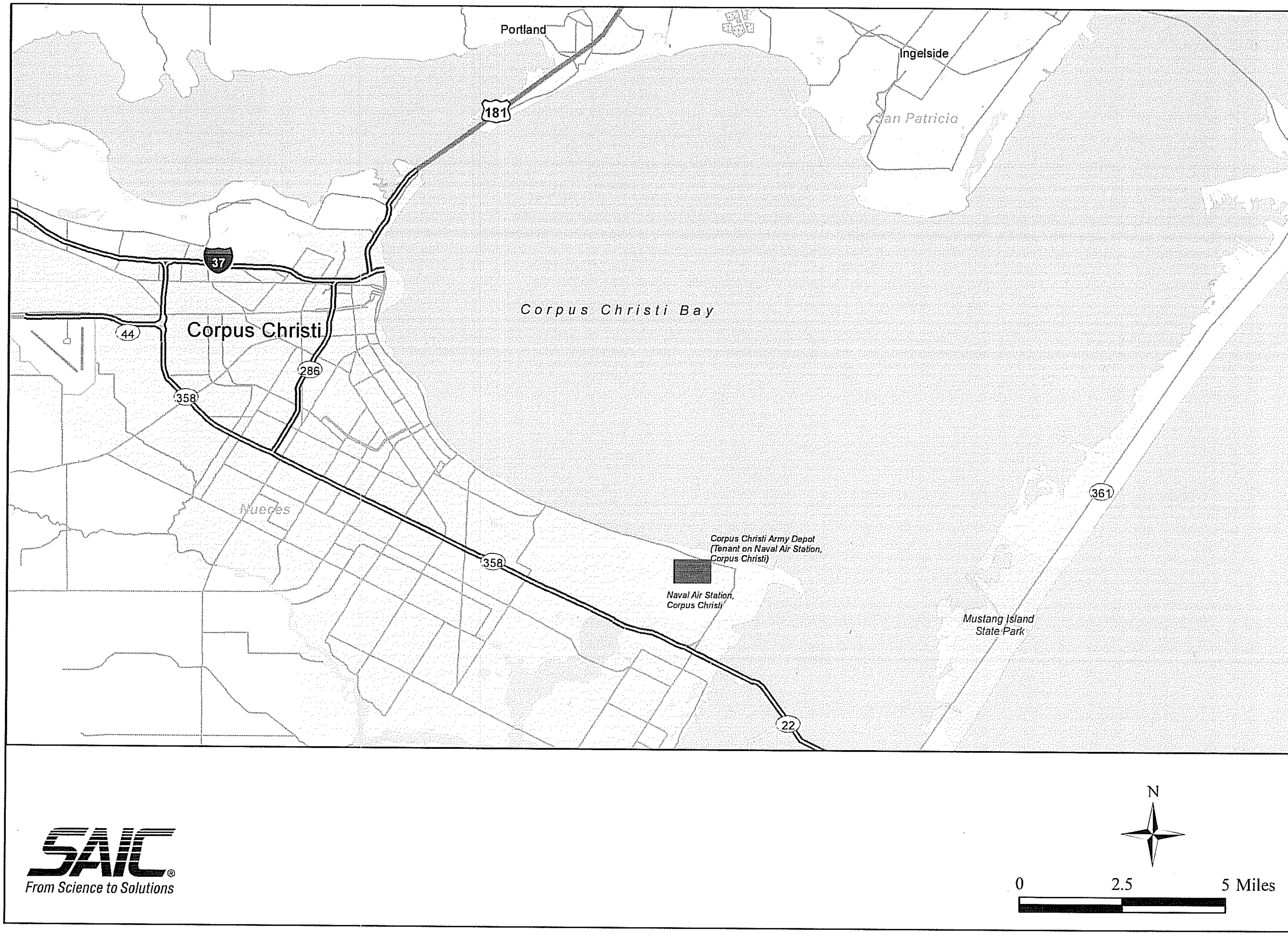

Figure 1-1
Location of Corpus Christi Army Depot

2.0 BACKGROUND

Established in 1961 as the United States Army Aeronautical Depot Maintenance Center, CCAD began as a depot-level maintenance facility for fixed and rotary wing aircraft with the first Bell Helicopter UH-1 (Huey) being overhauled in 1962. By 11 March 1964, 3600 aircraft engines had been overhauled in the 30 months of such operations and by 1968 repair and overhaul services were being provided to approximately 400 helicopters annually. These overhaul services included Army T-53, T-55 and T-63 aircraft engines used in AH-1 (Cobra), UH-1 (Iroquois or Huey), Ch-47 (Chinook) and OH-58 (Kiowa) aircraft.

Two magnesium-thorium alloys, HZ-32A and ZH-62A, were used in the production of aircraft engine components incorporated into the above-stated Army aircraft. HZ-32A is a magnesium alloy containing 3.3, 2.1 and 0.75 percent thorium, zinc and zirconium, respectively, while ZH-62A contains 1.8, 5.7, and 0.7 percentages of each of these constituents. The addition of 3.3 and 1.8 percent thorium, respectively, increased the high temperature strength of these metal alloys. Although possession of magnesium-thorium alloys containing four percent or less thorium is exempted from licensing by Title 10, Code of Federal Regulations, Section 40.13(c)(4), the exemption does not authorize any "chemical, physical or metallurgical treatment of processing". Given the requirement to perform such processing of the magnesium-thorium–containing engine parts, in 1973 CCAD applied for and was issued AEC (subsequently the NRC) Source Material License STB-1168. This license authorized CCAD to perform the required maintenance processes. Processes performed generally included but were not limited to removal and reapplication of protective coatings, corrosion treatment, drilling, machine and hand grinding, machining, welding, metal spray application and blasting using a variety of different media (e.g., plastic beads, walnut shells, etc).

In the late 1980s, Magnesium-Elektron, the Manchester, England company that produced the magnesium-thorium alloy feed stocks for castings, notified Department of the Army that they would make one last production run prior to permanently suspending production of the alloys. This last production run was intended to provide sufficient alloys to address needs for a period of time such that the Army could develop alternative alloys. Production was subsequently halted in 1991 and other alloys were developed and introduced into the Army supply system as replacements for magnesium-thorium alloys.

In addition to replacement of magnesium-thorium alloys with alloys which do not contain thorium, newer aircraft such as the UH-60 (Blackhawk) and AH-64 (Apache) were developed to replace older model aircraft. These aircraft represent the current overhaul workload for CCAD and were developed such that they have never utilized magnesium-thorium alloy components.

As a consequence of the elimination of magnesium-thorium, CCAD no longer has a requirement to perform maintenance on magnesium-thorium–containing engine components thus they are pursuing final cleanup and license termination. Results of radiological surveys performed pursuant to this plan will provide essential information for D&D of structures and impacted equipment. Consistent with paragraph 2.3 of NUREG-1757, Volume 2, it will also achieve data quality objectives such that it can be fully integrated into the final status survey process.

3.0 SURVEY PARAMETERS

3.1 CHARACTERISTICS OF MAGNESIUM-THORIUM ALLOY CONTAMINATION

Given that magnesium is a very soft metal, comparatively large particles are generated when magnesium alloys are subjected to grinding or machining. As such, most maintenance operations generate magnesium-thorium alloy fines (e.g., chips and filings) which are much larger than those commonly associated with most other metals. Such chips and filings offer limited potential to contaminate structural surfaces as they generally collect on surfaces rather than being absorbed into pores. In addition, contamination from this material generally does not become fixed. Any resultant contamination is, therefore, relatively easy to remove on a routine basis such that very limited contamination typically collects on surfaces and residual contamination occurs primarily in areas such as cracks and seams in concrete floors, etc. The fact that magnesium-thorium particles are generally relatively large also results in the ineffective use of smears/swipes as a good indicator of the presence of removable contamination because such contamination does not readily remain in place on the smear or swipe filter media. Further, given the nature of the removable contamination that results from magnesium-thorium alloy maintenance and the fact that alpha emissions are subject to major self-absorption within the alloy, scan and fixed point beta (or gamma) measurements generally must be used for the evaluation of the presence of magnesium-thorium alloy residuals. Nonetheless, although smears may not be fully effective in evaluating removable contamination, they can be utilized to augment fixed point and scan measurements. The potential for volumetric contamination is limited to impacted ceiling tiles in the Magnesium-Thorium Machine Room. Given that these ceiling tiles will be disposed of as radioactive waste due to the inherent issues associated with their survey and release, contamination is limited to surficial activity and surveys will be limited to evaluation of surface activity.

3.1.1 Exceptions

Exceptions to the nature of magnesium-thorium alloy contamination described above include effects from fires, welding, and chemical removal of thin layers of magnesium-thorium surfaces primarily by use of materials such as chromic acid. Although chemical removal of protective coatings and corrosion from magnesium-thorium alloys have not been performed in any existing areas of CCAD, welding on magnesium-thorium alloys has been performed in the Welding Shop area and may have been performed in the electron beam welder area. In addition, site information including anecdotal input from current and former employees indicates that several fires have occurred in the Magnesium-Thorium Machine Room as a result of the spontaneous ignition of magnesium metal fines. As such, horizontal surfaces such as I-beams above and adjacent to such operations will be subjected to comprehensive surveys to evaluate the potential for elevated contamination from smoke/fumes from fires and welding on magnesium-thorium alloys. In addition, ventilation exhaust systems servicing such areas will be subjected to comprehensive radiological surveys.

3.1.2 Characteristics of the Thorium Decay Series

Given that all magnesium-thorium alloys were produced prior to 1991, it is reasonable to assume that natural thorium and "all of the progeny are in secular equilibrium, that is, for each disintegration of ^{232}Th there are six alpha and four beta particles emitted in the thorium decay series" (DOD 2000). Beta measurements provide a more accurate evaluation of thorium contamination on structural surfaces due to the problems inherent in measuring alpha contamination on rough, porous, and/or dirty surfaces. For the thorium series in secular equilibrium, for each beta emission there are approximately 1.5 alpha emissions – a beta to alpha ratio of 0.67 (NRC 2003). For magnesium-thorium alloys, these considerations are compounded in that the thorium is contained within the alloy such that self-absorption of the alphas within the magnesium matrix makes it very difficult to accurately quantify activity based on alpha emissions. As such, beta particle emissions will be used as recommended in Section 4.3.2 of Multi-Agency Radiation Survey and Site Investigation Manual (MARSSIM) (DOD 2000) and Appendix O, Section O.3.3.5, Volume 2, NUREG-1757.

Given that four beta particles are emitted per disintegration of the thorium-232 parent and that many of the betas are relatively energetic, beta particles are used to quantify contamination that may be present from natural thorium. Thorium-232 progeny (Table 3-1) include several beta-emitters including actinium-228, bismuth-212 and thalium-208 with maximum energies exceeding 1 MeV as well as lead-212 which emits betas with maximum energies ranging from 158 to 573 KeV and radium-228 which emits betas with a maximum energy of 0.0389 MeV. The radium-228 betas are difficult to measure given their low energy. As such, the emissions of the other beta emitters will serve as the basis for activity measurements.

Table 3-1. Characteristics of Thorium-Series Radionuclides

Isotope	Half-life	Radiation*	Energy Level (MeV)*	Frequency %
Th-232	1.405 x 10^{10} y	Alpha	3.95	23
		Alpha	4.01	77
Ra-228	5.75 y	Beta	0.0389	100
Ac-228	6.13 h	Beta	0.983	7
			1.014	6.6
			1.115	3.4
			1.17	32
			1.74	12
			2.08	8
Th-228	1.913 y	Alpha	5.34	26.7
			5.42	72.4
Ra-224	3.66 d	Alpha	5.45	4.9
			5.686	95.1
Rn-220	55.6 s	Alpha	6.288	99.9
Po-216	0.15 s	Alpha	6.78	100
Pb-212	10.64 h	Beta	0.158	5.2
			0.334	85.1
			0.573	9.9
Bi-212	60.55 m	Alpha	6.05	25
			6.09	9.6
		Beta	1.59	8
			2.246	48.4
Po-212 (64%)	305 ns	Alpha	8.785	100

Table 3-1. Characteristics of Thorium-Series Radionuclides (Continued)

Isotope	Half-life	Radiation*	Energy Level (MeV)*	Frequency %
Tl-208 (36%)	3.07 m	Beta	1.28	25
			1.52	21
			1.80	50
Pb-208	Stable			

* Primary radiations and energies of interest

Although high backgrounds are not anticipated within planned survey areas correcting beta activity measurements for high ambient gamma background (as defined in NUREG-1757 Volume 2, Section O.3.3.5) is an optional approach to be used if required.

3.2 PRE-SURVEY ACTIONS

Reference areas will be surveyed to establish background conditions. Site background count rates necessarily depend on the radiological characteristics of construction materials (e.g. concrete, steel, dust-covered steel). To account for background conditions and the associated variability, reference areas will be identified consistent with MARSSIM Section 4.5 and subjected to radiological measurements. At least one reference area will be located in unimpacted portions of Building 8 with at least one additional reference area being located in a building other than Building 8 to provide information relative to expected background variability. Background measurements will be compared to survey data obtained in other portions of the facility. A minimum of 30 surface measurements (and smears) will be obtained within each of at least two concrete reference areas and one steel reference area to establish background conditions.

Given that thorium-series radionuclides also include significant gamma emissions, the presence of magnesium-thorium alloy process residuals can also affect background count rates and thus survey results. To preclude such impacts, each area will be subjected to visual investigation prior to the initiation of surveys to identify and remove any existing process residuals. Of special interest will be chips and filings in process machines, HEPA filter-equipped vacuum cleaners, and within bead blasting cabinets including HEPA filters for the cabinets. The concrete floor surfaces should be prepared, as necessary, to minimize damage to the sensitive window of the Ludlum Model 43-37 gas-flow floor proportional floor monitor. Removable equipment, shelves, palletized materials and debris must be removed to the extent practicable from floors prior to initiation of floor surveys. (Surveys to be used for final status survey purposes should not be attempted until magnesium-thorium residuals have been fully addressed within the area in question.)

3.3 GEOGRAPHIC SCOPE OF RADIOLOGICAL SURVEYS

Surveys will be performed to define the nature and extent of contamination in all impacted portions of CCAD (See Figure 3-1, CCAD Radiologically Impacted Areas). To assist in determining which areas have been impacted by the licensed maintenance of magnesium-thorium alloy aircraft engine parts, a Historical Site Assessment of Radiological Maintenance Operations at CCAD (SAIC 2008) was performed. This HSA updated the scope of the facilities and equipment which had been impacted by the physical, chemical and metallurgical treatment and processing of magnesium-thorium alloys. Potentially impacted areas as identified in the HSA include the following:

- Those portions of Building 8 including but not limited to: (See Figure 3-2, Building 8 Impacted Areas):
  - The Magnesium-Thorium Machine Room including the ventilation exhaust system and all equipment locations therein;
  - Building roof adjacent to Magnesium-Thorium Machine Room ventilation exhaust;
  - All portions of the Welding Shop to include the adjacent metal spray booth and bead blast booths, associated overhead support structures; ventilation exhaust ductwork; and equipment;
  - Engine disassembly and cleaning areas;
  - Temporary waste storage areas;
  - The area of formerly occupied by the Haas Mill;
  - Two bead blast rooms at the north end of Building 8 which previously supported engine disassembly and cleaning shops; I only remember one blast booth; which had the chain-linked gate;
  - The electron beam welder area; and
  - Grassy areas surrounding Building 8.
- Building 340 (Room 201) magnesium-thorium bead blast booths and associated ventilation system ductwork. (Bead blast booths consisting of two beige blasters connected to the ventilation exhaust system built specifically for magnesium-thorium alloy maintenance were part of the original area defined as impacted. Pursuant to input from the Plating Shop Supervisor an additional (green) blaster that was self-contained but used for magnesium-thorium alloy maintenance was added to the scope. (CCAD 2008)
- Building 1727, Room B101, Radiation Safety Officer Laboratory.
- Radioactive Material Storage Buildings and Areas including:
  - Building 132 Radioactive Material Storage and Handling Building (Both portions of the building and the adjacent grass areas);
  - Former Building/Area 339 Waste Storage Area (currently the motor pool); and
  - Former Building 258 (POL Area) Radioactive Waste Storage and Processing Areas.
- Building 1825 areas that had been designated for operations involving milling, grinding, welding, abrasive blasting, assembly, and disposal of thorium components in 1974. (AEHA 1974)

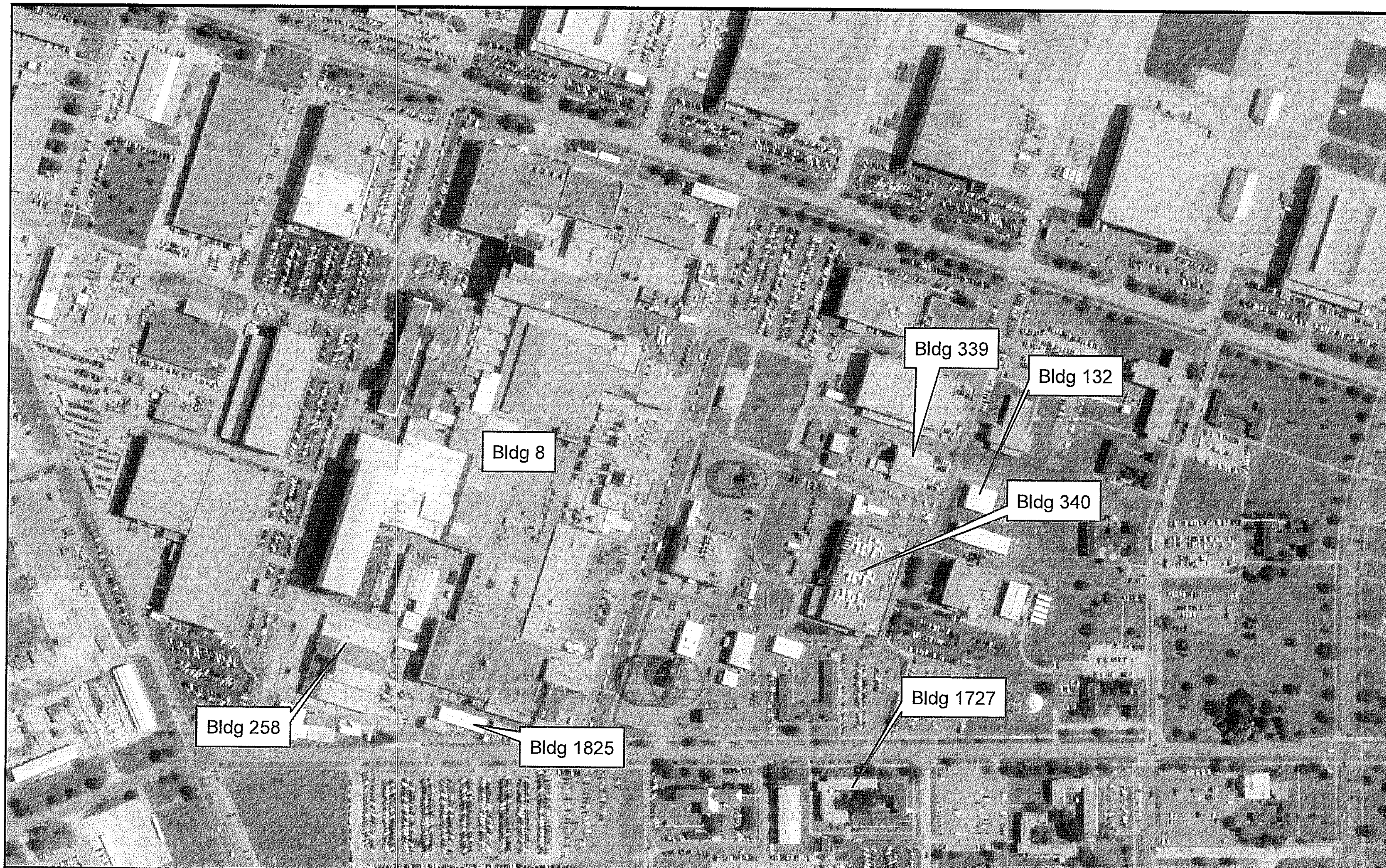

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Figure 3-1
CCAD Radlogically Impacted Areas

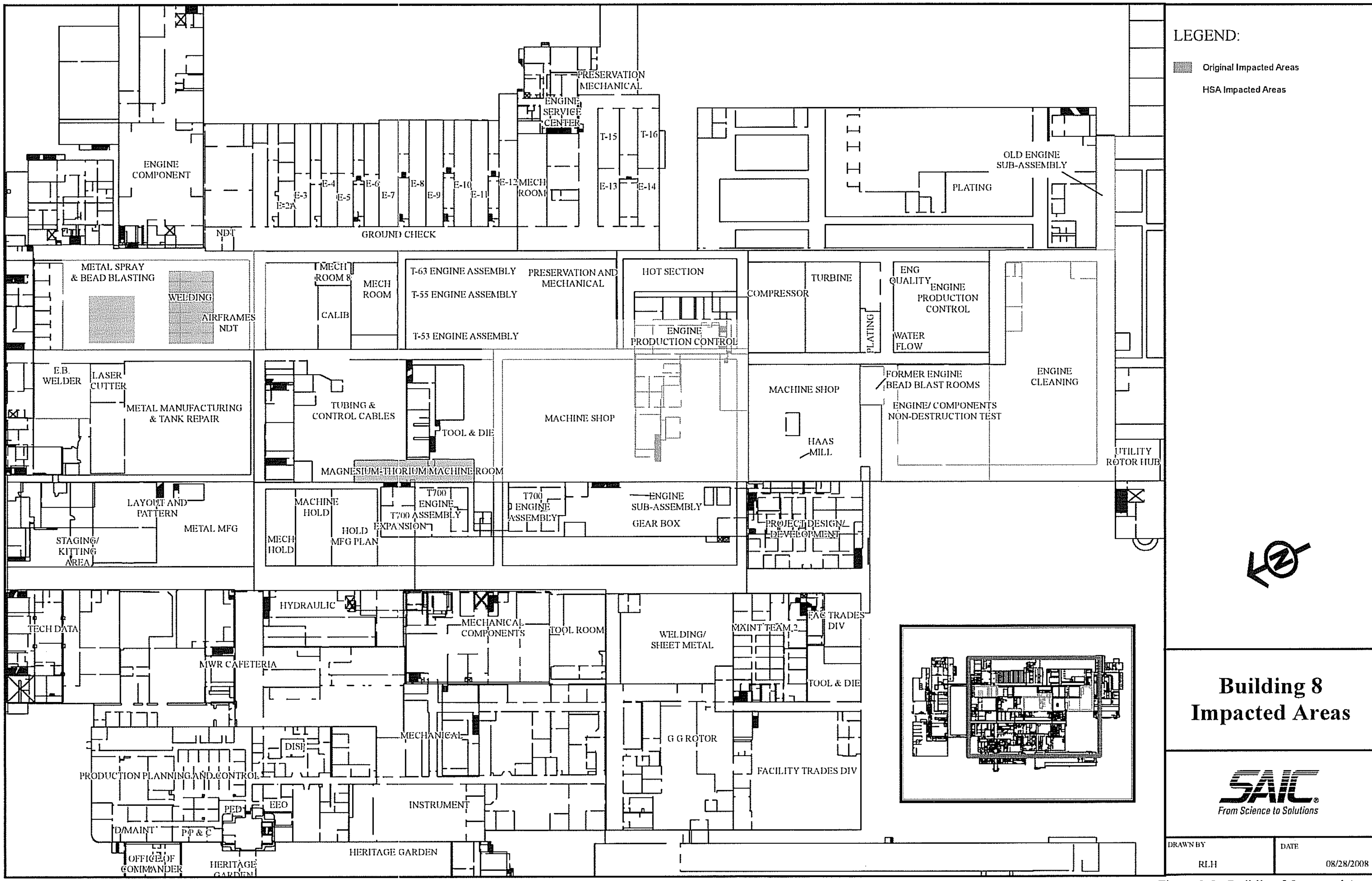

Figure 3-2. Building 8 Impacted Areas

3.3.1 Overview of Survey Approach

Initial scan surveys will be performed with a gas flow proportional counter or comparable detector system with results of this scan being used to determine the detailed survey requirements for the area. Investigation levels as defined in MARSSIM are "media-specific, radionuclide-specific concentration or activity level of radioactivity that: 1) is based on the release criterion, and 2) triggers a response, such as further investigation or cleanup, if exceeded." (DOD 2000) For those areas where scanning indicates that residual levels of radiological contaminants that are a small percentage of the investigation levels:

- Required scanning is up to 10%
- Sample (i.e., survey) locations are biased to locations most likely to exhibit residual radioactivity or, otherwise, are randomly generated

Scanning levels in all areas are expected to be within a small percentage of the investigation levels in most areas. (Section 5.1) Exceptions may include:

1) Magnesium-Thorium Machine Room (including exhaust ventilation etc)

2) Welding Shop (including adjacent bead blasting and metal spray areas as well as overhead I-beams and ventilation system exhaust duct work)

3) Radioactive Waste Storage Areas (Buildings 258, 339, and 132).

These three areas will be subjected to more comprehensive radiological investigations to include final status surveys of Building 132 (upon completion of D&D activities) to confirm achievement of DCGLs. Such investigations will include:

- A systematic sampling grid in lieu of the selection of randomly located sampling points. (See Section 7.5)
- An increase in the scanning coverage from 10% to 10-100%. (See Section 7.5)

If surveys result in the detection of contamination in any area not listed above at concentrations exceeding a small portion of the investigation levels, the survey approach will be reevaluated and more comprehensive surveys being required.

The areas to be surveyed will vary with the specific impacted area based on potential contamination but will include the following areas as applicable in each survey unit:

- Floors – Floors will be surveyed to the lateral boundaries defined in Figures 1 through 6. Floor surveys will specifically include areas within a minimum radius of 10 feet around any potentially contaminated equipment (i.e., equipment exhibiting elevated count rates).
- Walls – Walls within potentially impacted areas will be surveyed up to a height of 6 feet
- Ceilings – Ceiling tiles present in the Magnesium-Thorium Machine Room will be disposed of as radiological waste In the event that other, non-disposable, ceiling material is encountered, a minimum of 10% will be surveyed with areas surveyed being those with the greatest potential for contamination.
- Equipment located in the Magnesium-Thorium Machine Room and other known contaminated areas will be subjected to surveys consistent with EDi Health Physics Procedures and guidance contained within NUREG-1575 (DOD 2000

- Overhead structural supports. A minimum of 10% of the surface area of the overhead structural supports above both the Magnesium-Thorium Machine Room and the Welding Shop to include the adjacent metal spray and bead blasting portions of the Welding Shop.
- Internal contamination will be assessed on machinery and equipment by removing the air filter (if applicable) and swiping the air filter. If this is not possible or no air filter exists a small oil sample will be taken from the equipment's drain port. These ports of entry will also be surveyed to assess for potential internal contamination
- Drains / Drain Traps — Drains and traps will be dismantled, scanned, scraped and swiped (Sections 6.1 and 6.2)
- Duct work – Ventilation exhaust duct work for the Magnesium-Thorium Machine Room, Welding Shop, and machine shop will be subjected to 10 to 25 percent scanning with the higher percentages being applicable to the Magnesium-Thorium Machine Room and Welding Shop given their greater potential for contamination.
- Roof – The Building 8 roof immediately adjacent to the ventilation system exhaust from the Magnesium-Thorium Machine Room will be surveyed to evaluate the potential for deposition of contamination from fires that have occurred within the room. Special consideration will be given to areas (e.g., cracks, crevices, and porous materials) in which thorium could be deposited and retained.

A pre-survey evaluation was performed to determine the number of static counts required per MARSSIM. The minimum number of static counts required was determined to consist of nine survey and nine background measurements for the unconditional release of the structures located at CCAD (Section 4.4.1). This quantity was increased to forty to consist of 20 each for the area in question and for the reference area to assure that retrospective statistical evaluation exhibited the appropriate power. Survey locations will be biased toward those with the greatest potential for contamination, laid out using a random sample generator or defined using a systematic grid depending or scanning results. Special emphasis will be provided to assuring that locations most likely to exhibit elevated radioactivity are thoroughly investigated.

4.0 DETERMINING THE NUMBER OF SAMPLES PER SURVEY UNIT

This survey plan defines practices and procedures consistent with the MARSSIM (DOD 2000) for the implementation of the required radiological surveys of all impacted areas identified in the Historical Site Assessment of Radiological Maintenance Operations at CCAD (SAIC 2008). Although this is not a final status survey these radiological surveys are being designed such that survey results can potentially be carried forward into the MARSSIM final status survey process.

4.1 DERIVED CONCENTRATION GUIDELINE LEVELS (DCGLs)

The "Screening Values of Common Radionuclides for Building-Surface Contamination Levels" as defined in NRC SECY-98-242 lists "D&D Screening Values". The value specified as representing the 90th percentile of the output dose distribution as being equivalent to 25 mrem/year for thorium-232 is 7.3 dpm/100 cm^2. NRC guidance in "Re-Evaluation of the Indoor Resuspension Factor for the Screening Analysis of the Building Occupancy Scenario for NRC's License Termination Rule - Draft Report" (NUREG-1720) recommends a resuspension factor of 1×10^{-6} m^{-1}. With technical assistance from members of the NRC Headquarters staff (e.g., Messrs Dwayne Schmidt, Ralph Cady and Chris McKinney), the screening level DCGL was recalculated using D&D Version 2.1 with the only change being the aforementioned modification of the value of the resuspension factor. Using a 95 percent confidence level, this change resulted in an updated screening level DCGL of 102 dpm/100 cm^2 for thorium-232. Although thorium-series radionuclides consist of six alpha-emitting radionuclides and four beta-emitting thorium progeny (Table 1), only three beta-emitting thorium progeny have been used to calculate the DCGL given that Pb-212 beta emissions are at such a low energy as to be difficult to detect. Consequently, the total alpha and total beta activity of 612 and 306 dpm/100 cm^2, respectively, constitute the DCGLs for total alpha and total beta, respectively, with the beta DCGL serving as the basis for decommissioning and license termination decision-making. These DCGL values are rounded to 600 and 300 dpm/100 cm^2 for alpha and beta, respectively.

4.2 DECISION ERROR

There are two types of decision error: Type I (alpha) and Type II (beta). Type I error is described as the probability of determining that the median concentration of a particular constituent is below a criterion when it is actually not (false positive). Type II error is described as the probability of determining that the median is higher than criteria when it is not (false negative). The probability of making decision errors can be controlled by adopting an approach called hypothesis testing.

> H_0 = the median concentration in the survey unit exceeds that in the reference area by more than the DCGL.

This means the site is assumed to be contaminated above criteria until proven otherwise. The Type I error, therefore, refers to the probability of determining that the area is below the criterion when it is really above the criterion (incorrectly releasing the survey unit). The Type II error refers to the probability of determining that the area is above the criterion when it is really below the criterion (incorrectly failing to release the survey unit).

Based on the above null hypothesis, lowering the Type I error decreases the probability of residual contamination exceeding site criteria while increasing the Type I error would have the inverse effect. By contrast, lowering the Type II error decreases the probability of releasing a survey unit in which residual concentrations of contamination are below site criteria generally resulting in increased costs for the removal of residuals that actually achieve criteria. Increasing the Type II error, by contrast, typically results in increased sampling costs but a reduced probability of failing to release a survey unit that actually achieves cleanup criteria.

4.2.1 Specify the Decision Error

The Type I error for CCAD has been set at 0.05 and the Type II error has been set at 0.2. This means that there is a 5% probability of erroneously releasing a survey unit whose true mean is greater than the DCGL and a 20% probability of not releasing a site that has attained the DCGL. This implies that if the mean is at a concentration that would produce an exposure at the criterion level, there would be a 5% probability of erroneously finding it below the criterion or a 20% probability of erroneously finding it to be greater than the criterion.

4.3 RELATIVE SHIFT

The relative shift is defined as the Δ/σ where Δ is the DCGL - LBGR (lower bound of the gray region) and σ is the standard deviation of the contaminant distribution. MARSSIM recommends that the LBGR initially be set one half of the DCGL, but should be adjusted if necessary to provide a Δ/σ value between the recommended range of 1 to 3.

The value for σ can be estimated in a number of ways. Sometimes there is data from the site that is sufficient to calculate the standard deviation within the survey unit, σ_s (note that for Class 1 units σ represents the standard deviation just prior to release and after material above the criterion is thought to be removed). Data may also be available from a reference or background area. Reference area data can be used to estimate a standard deviation, σ_r, if the contaminant is present in background. The larger of σ_s and σ_r should be used when calculating Δ/σ.

For the CCAD survey areas sufficient preliminary data has not been obtained, thus by MARSSIM guidance it is reasonable to assume a coefficient of variance of 0.3 (30%). Experience implementing MARSSIM has demonstrated that this is a reasonable assumption.

4.3.1 Calculating the Relative Shift

The relative shift (Δ/σ) is calculated given values for the DCGL, LBGR, and σ. The DCGL has been set to 300 dpm/100 cm^2 (Section 4.1), so the LBGR = DCGL/2 = 150 dpm/100 cm^2. The value for Δ is, therefore, DCGL - LBGR = 300 – 150 = 150 dpm/100 cm^2.

Given that limited data exists for parts of the survey areas, consistent with MARSSIM, "It is reasonable to assume a coefficient of variance of 30%." (DOD 2000). Thus the standard deviation (σ) can be found by taking 30% of the DCGL, so 300 dpm/100 cm^2 (30%) = 90 dpm/100 cm^2.

Thus the relative shift can be determined as: (150 dpm/100 cm^2)/ (90 dpm/100 cm^2) = 1.67. Given that MARSSIM recommends a relative shift between 1.0 and 3.0, no adjustment is necessary.

4.4 THE NUMBER OF SAMPLES PER SURVEY UNIT

The calculated value for Δ/σ can be used to obtain the minimum number of samples/measurements necessary to satisfy requirements using the MARSSIM equation presented below:

$$N = \frac{(Z_{1-\alpha} + Z_{1-\beta})^2}{3(P_r - 0.5)^2}$$

The calculated value, N, is the combined number of samples/measurements from the reference area and each survey unit. $Z_{1-\alpha}$ and $Z_{1-\beta}$ are critical values that can be found in MARSSIM, EPA 1989, or statistics textbooks and handbooks, and P_r is a measure of probability available from MARSSIM Table 5.1.

Normally, N/2 samples/measurements are conducted in each survey unit and in the reference area. That is, N/2 samples/measurements are conducted in *each* survey unit *and* N/2 samples/measurements are conducted in the reference (background) area. However, the statistical methods are still valid if there are an unequal number of samples/measurements in the survey units and reference areas. A 20 percent increase in this number is recommended to account for lost or unusable samples/measurements. The calculated values apply to each survey unit.

4.4.1 Determining the Number of Samples per Survey Unit

The number of data points, N, for the Wilcoxen Rank Sum (WRS) test of each combination of reference area and survey unit is calculated using Equation 5-1 and Table 5.1 in MARSSIM, given 5% Type I error and 20% Type II error.

$$N = \frac{(Z_{1-\alpha} + Z_{1-\beta})^2}{3(P_r - 0.5)^2}$$

$$N = \frac{(1.645 + .842)^2}{3(.871014 - .5)^2} = 14.98\ samples = 15\ samples$$

The uncertainty associated with the calculation, N, should be accounted for during survey planning thus the number of data points is increased by 20% and rounded up. This is in order to ensure there are sufficient data points to allow for any possible lost or unusable data.

$$N = 15 + .2(15) = 18\ samples$$

The 18 samples include the combined samples/measurements from the reference area and one survey unit. Therefore nine samples/measurements are required in the reference area and nine in each survey unit. For the purposes of this survey the number of measurements (N) has been increased to 40 in order to increase the power associated with the survey with respect to required statistical tests.

4.4.2 Classification of Survey Units

Although this survey is not a final status survey as described in MARSSIM, it is being designed so that, if possible, the data collected can be used for final status survey. Because there is minimal data available at this time, certain assumptions will be made with regard to survey planning based on the contamination potential of each survey unit. These assumptions will be used to design the radiological survey so that a sufficient quantity and quality of data is collected for potential future use in a final status survey. The scanning coverage survey unit area and random verses systematic measurements are the primary issues that will be considered. Information from the HAS is the primary source for initial "classification" of survey units.

As described in the MARSSIM, survey units are broken into three classes. A survey unit is classified as a Class 1 survey unit if it meets any one of the following criteria:

1. The area is or was impacted (potentially influenced by contamination);
2. The area has potential for delivering a dose or risk above criteria;
3. There is potential for small areas of elevated activity; or
4. There is insufficient evidence to classify the area as Class 2 or Class 3.

A survey unit is classified as a Class 2 unit if:

1. The area has the potential to have been impacted;
2. The area has low potential for delivering a dose or risk above criteria; or
3. There is little or no potential for small areas of elevated activity.

A survey unit is classified as a Class 3 unit if:

1. The area has only minimum potential for being impacted;
2. The area has little or no potential for delivering a dose or risk above criteria; and
3. There is little or no potential for small areas of elevated activity.

Table 4-1 lists recommended surface areas for each class.

Table 4-1. MARSSIM "Suggested Survey Unit Areas" (DOD 2000)

Classification	Suggested Area
Class 1	Structure: up to 100 m^2 Land Area: up to 2,000 m^2
Class 2	Structure: 100 to 1,000 m^2 Land Area: 2,000 to 10,000 m^2
Class 3	Structure: No Limit Land Area: No Limit

4.4.3 Estimate the Sample/Measurement Grid Spacing

Class 1 and Class 2 grid spacing in overhead areas is calculated as follows:

$$B=LF/N$$

B = linear grid spacing between samples on main structural beams (feet)
LF = total linear feet of main structural beams in the survey unit
N = number of samples required in the survey unit

The appropriate spacing for each Class 2 grid on the floor level is calculated as follows:

$$L = \sqrt{\frac{A}{0.866 \times N}} = \sqrt{\frac{1000m^2}{0.866 \times 9}} = 128.3m$$

A = area factor (See Table 4.1)
A = $1000m^2$, maximum area for a Class 2 structure survey unit
L = linear spacing for a triangular grid survey unit
N = number of samples required in the survey unit (i.e., 9; see Section 4.4.1)

Based on MARSSIM, Class 3 survey unit measurement locations are commonly determined via random number generation.

In summary, grid spacing for overhead areas/structural steel is dependent upon the total linear length of main structural support beams in the survey unit and the number of samples required to be taken in the survey unit. The Class 2 spacing on the floor and wall area should not exceed 128.3m. Grid spacing for equipment will be dependent upon the size and survey unit grouping of the machinery and will be determined as more data becomes available.

In the difficult to access areas, sample locations will be determined as the opportunity presents itself to safely access these areas and at the discretion of the survey supervisor.

5.0 SURVEY IMPLEMENTATION

5.1 INSTRUMENTATION SELECTION

Survey instruments used for radiological measurements will be:

- selected based on the survey instrument's detection capability for natural thorium;
- calibrated in accordance with American National Standards Institute (ANSI) N323A, Radiation Protection Instrumentation Test and Calibration – Portable Survey Instruments (ANSI, 1997);
- calibrated with a National Institute of Standards and Testing (NIST) source to obtain a quantitative measurement ; and
- operated and maintained by qualified personnel, in accordance with Health Physics Program procedures (e.g., physical inspection, background checks, response/operational checks).

Radiological field instrumentation used for this site survey will have been calibrated in accordance with ANSI N323A within the past 12 months (or more frequently if recommended by the manufacturer). Daily quality control checks will be conducted on each instrument and operated in accordance with Health Physics Procedures. Only data obtained using instruments that satisfy these performance requirements will be accepted for use during this survey.

Thorium-232 in secular equilibrium has associated alpha, gamma and beta radiations, which can be used to identify the presence of residual contamination and estimate the concentrations present at CCAD. Surface scans for gross beta radiation will be performed to identify locations of elevated residual radiological contamination. Beta scans are being used because alpha radiation is a less reliable indicator of true surface activity levels due to greater attenuation. Instrument response will be continuously monitored during scanning through use of the audible instrument signal using earphones/head phones as appropriate. Scanning results will be recorded in counts per minute (cpm) which along with the appropriate instrument geometry and calibration information will be used to convert the data to dpm/100 cm^2 for comparison to cleanup criteria.

Screening scans will be performed consistent with MARSSIM (e.g., over 100% of accessible Class 1 survey units and 10% to 50% of accessible Class 2 and Class 3 survey units). For the purposes of this plan "accessible areas" are those where safety considerations or other restrictions do not prevent access for normal scanning activities (e.g., overhead areas immediately adjacent to high voltage power lines). The level of scanning effort in Class 2 areas will be proportional to the potential for the presence of elevated activity. Class 3 beta scan surveys will be biased to areas with the highest potential for contamination based on the professional judgment of the survey supervisor.

In accordance with Section 5.5.2.6 of MARSSIM, locations identified during the surface scans the exceed the investigation levels listed below will be investigated by taking further measurements to confirm and/or quantify contaminant levels in the area of elevated activity. (Investigation level, as used herein, is defined in Section 3.3.1.) Audible responses of the instrument will be monitored, and locations of elevated response above the investigation levels listed below will be measured with a fixed-point measurement. In Class 1 and Class 2 areas an investigation level of 300 dpm/100 cm^2 will be used, for Class 3 areas an investigation level of 150 dpm/100 cm^2 will be used. These levels will be recalculated and converted to counts per minute (cpm) based on site specific conditions at CCAD as required to correlate with instrument response and actual site background.

Beta scans of floor surfaces will be performed with a floor monitor using a scan speed of approximately 2-3 inches per second (in/s). Beta scans of floor surfaces, equipment surfaces, wall surfaces, and other locations inaccessible by the floor monitor will be performed with appropriate portable detectors. Scan speed with these smaller detectors will be approximately 1-2 in/s. Distance from the detector probe to the surface being scanned will be approximately 1/8th inch. The reference area background for a survey unit will be determined prior to the start of the survey and a scanning response detectable above the background level will be set as the investigation level, indicating potential contamination. Investigation levels will assure that any activity present above DCGLs is appropriately evaluated.

There may be locations where safety considerations or other restrictions prevent access for normal scanning activities in overhead areas or under equipment. Reasonable efforts to scan such locations will be made. Alternative and innovative approaches (e.g., use of extension poles, detectors mounted on platforms with wheels or skids, placing detectors in protective sleeves, etc.) will be evaluated and implemented, as appropriate.

5.1.1 Scan Minimum Detectable Concentrations (MDCs)

The minimum detectable concentration is an activity level, calculated a priori "before-the-fact", that a specific instrument and measurement technique can be expected to detect 95 percent of the time. Site-specific detection sensitivities (Scan MDCs) for CCAD have been calculated in accordance with the approach detailed in NUREG-1507. These calculations are provided in Appendix B of this document and are listed below in Table 5-1.

Table 5-1. Evaluation of Instruments for Use at CCAD[1,2]

Description	Application	Scan MDC (dpm/100cm^2)[2,3]	Static Count MDC (dpm/100cm^2)[3]
Ludlum Model 2350-1 coupled with a Ludlum 43-37 (floor monitor). Effective area 545 cm^2.	Beta surface scan on concrete	200 dpm/100cm^2 @ 3 in/s	150 dpm/100cm^2 (30s count)
Ludlum Model 2350-1 coupled with a Ludlum 43-106 (Gas flow proportional counter). Effective area 126 cm^2.	Beta surface scan on steel/equipment and concrete /cinderblock	440 dpm/100 cm^2 @ 2 in/s (steel and equipment) 430 dpm/100 cm^2 @ 2 in/s (concrete and cinder block)	320 dpm/100cm^2 (30s count)(steel and equipment); 310 dpm/100 cm^2 (30s count)(concrete and cinderblock)
Ludlum Model 2360 coupled with a Ludlum 43-89 (ZnS plastic scintillator)[4]. Effective area 126 cm^2.	Beta surface scan	410 dpm/100 cm^2 @ 2 in/s	260 dpm/100 cm^2 (30s count)(steel and equipment); 310 dpm/100 cm^2 (30-s count) (concrete and cinderblock)
Ludlum Model 2221 coupled with a Ludlum 44-10 (NaI scintillator)	Gamma scan	1.8 pCi/g @ 1.6 ft/s for Th-232 + progeny	N/A

Table 5-1. Evaluation of Instruments for Use at CCAD[1,2] (Continued)

Description	Application	Scan MDC (dpm/100cm^2)[2,3]	Static Count MDC (dpm/100cm^2)[3]
Ludlum Model 2221 coupled with a Ludlum 239-1F (floor monitor). Effective area 582 cm^2	Beta surface scan on concrete	200 dpm/100 cm^2 @ 3 in/s	150 dpm/cm^2 (30s count)

[1] Other equivalent or similar instruments may be selected for use. If other instruments are used, scan rates and counting durations will be adjusted as necessary to achieve data quality objectives.
[2]The derivation of site-specific scan MDCs are presented in Appendix B
[3] Scan and static MDCs are rounded to two significant digits.
[4] Given the lack of published data for beta background levels for ZnS detector, scan MDCs are for comparative use only and will be reevaluated based on site background as appropriate. For more information see Appendix B.

5.2 FIXED-POINT MEASUREMENTS

5.2.1 Fixed Point Measurement Calculations

The fixed-point measurement results in units of counts-per-minute (cpm) will be converted to the units of the surficial release criteria of dpm/100 cm^2 with the following equation:

Calculations will be performed for beta measurements.

$$\text{Result}\left(\frac{dpm}{100cm^2}\right) = \frac{(R_g) - (R_b)}{(\varepsilon_i)(\varepsilon_s)\left(\frac{\text{Probe Area}}{100}\right)}$$

where R_g is the static data point gross count rate (cpm)
R_b is the instrument field background count rate (cpm)
ε_i is the instrument 2 π efficiency (cpm/dpm)
ε_s is the surface efficiency
Probe Area is the open area of the detector face (cm^2)

5.2.2 Instrument Manufacturers' Fixed Point Minimum Detectable Activities (MDAs)

Ludlum Measurements, Inc. calculated fixed point MDAs for natural thorium for Ludlum Model 43-93 and Ludlum Model 44-142. The resultant MDAs were 201 and 197 dpm/100 cm^2, respectively, based on one-minute static counts. These instrument MDAs are based on background count rates of 143 and 229, respectively, and produce results which are consistent with those calculated herein. These instruments provide additional survey alternatives subject to background and count time limitations.

5.3 REMOVABLE CONTAMINATION EVALUATIONS

Removable activity is measured by smearing an area of approximately 100 cm^2 with a dry filter paper; alpha and beta activity on the smear sample is then measured. Removable alpha and beta surface activity samples (smears) will be collected at each fixed-point measurement location. The smear will be collected, counted for radioactivity, and documented prior to conclusion of the survey. Survey locations will be limited to those areas that are reasonably accessible for personnel and instrument safety. Areas to be considered for this survey include but are not limited to:

- entrances and exits;
- ventilation ducts;
- sumps and floor drains;
- high traffic areas;
- equipment;
- areas around process equipment;
- structural support beams;
- hand tools.

Removable contamination levels present on structures will be compared with the DCGL-based investigation levels. Removable contamination present on equipment will be compared to limits stated in NRC Source Material License STB-1168 as derived from Table 5-2, Department of the Army Pamphlet 385-24, dated 24 August 2007. Removable contamination should generally be 10% or less of the total activity. Computation of minimum detectable activity for Ludlum Model 2929 with 44-10-1 detector is incorporated into Appendix C.

5.4 EVALUATION OF SOIL AREAS

5.4.1 Gamma Walkover Survey Procedures

Relatively small areas of soils exist around buildings in which magnesium-thorium alloy aircraft engine maintenance is performed. To evaluate such areas for the potential presence of contamination, gamma walkover surveys will be performed using 2" x 2" NaI gamma scintillation detectors coupled with Global Positioning Systems (GPS) and a data logger. The surveyor will advance at a speed of approximately 1.6 feet per second (0.5 meters per second) while passing the detector in a serpentine pattern approximately 10 cm (4 inches) above the ground surface. Audible response of the instrument will be monitored by the surveyor and locations of elevated audible response investigated. Scanning results will be recorded in counts per minute (cpm). Survey results will be evaluated based comparison of count rates of potentially elevated areas with the applicable background count rates. As used herein, elevated areas are areas in which the count rate exceeds the applicable background count rate for the media of interest (e.g., soil, asphalt etc) by 2000 cpm. Gamma walkover survey results will be evaluated and plotted on a map of the area involved with color coding to depict the count rates present.

5.4.2 Gamma Walkover Survey Scan MDCs

Gamma walkover survey MDCs are a function of several variables including gamma emissions of the radionuclides of interest, detector characteristics, and surveyor efficiency. The assumptions used to calculate walkover survey MDCs in the NRC's NUREG-1507, *Minimum Detectable Concentrations with Typical Radiation Survey Instruments for Various Contaminants and Field Conditions*, are appropriate for this survey. Using 2"x 2" sodium iodide (NaI) detectors, the following assumptions apply:

- NaI 2"x 2" background count-rate of 10,000 cpm.
- NaI 2"x 2" detector count-rate vs. exposure rate values in NUREG-1507, Table 6.3.
- An observation interval of 1 second (based on a scan rate of 1.6 ft/s (0.5 m/s).
- A level of performance to yield a d' of 1.38

Based on these assumptions, walkover survey scan MDCs applicable at CCAD are 18.3 and 1.8 pCi/g for thorium-232 alone and for the thorium-232 decay in equilibrium, respectively. (Given that no alloys have been produced since 1991 and that parts were produced many years prior to that date, assuming equilibrium between parent and progeny is reasonable and the 1.8 pCi/g scan MDC is appropriate.)

5.4.3 Soil Sampling

Surface soil samples will be obtained from representative areas with elevated count rates to evaluate the concentration of thorium decay series radionuclides present. (Although surface soil is generally defined as the uppermost 6 to 12 inches, for the purposes of this plan, samples will be limited to the uppermost 6 inch interval.) Sample collection will be in accordance with EDi Health Physics Procedures. A total of ten samples will be obtained and submitted for laboratory analysis by gamma spectroscopy to evaluate the concentration of thorium-232 series radionuclides consistent with the Multi-Agency Radiological Laboratory Analytical Protocols Manual (MARLAP) (EPA 2004). If no areas of elevated radioactivity are detected by walkover surveys, the ten samples will be collected from random locations within the area. Soil concentrations will be compared to screening level DCGLs for soil for thorium-232. If soils exceed the screening level DCGL as determined by the sign test, 10 samples will be collected from a background reference area within the installation boundary but away from magnesium-thorium operations to enable comparison of the site data set with screening level DCGLs using the Wilcoxon Rank Sum Test and appropriately considering background concentrations of thorium series radionuclides.

6.0 SPECIAL INTEREST AREAS

6.1 FLOOR DRAIN SAMPLING

In impacted areas, there is potential for a buildup of magnesium-thorium fines that may have collected in drains. Floor drains will be uncovered in or near impacted areas if surveys detect count rates that elevated with respect to background. In this case, a smear will be obtained from the inside of the drain. Removable contamination samples will be air dried and subjected to alpha-beta counting. In addition, an effort will be made to obtain a representative sample of any residue present by scraping the inside of the drain. (Sample media will be wetted prior to scraping to preclude potential for airborne release of any contamination that may be present.)

Although floor drain scrape samples will generally be composited, individual scrapings will be separately collected pending evaluation by the survey supervisor as to whether the activity exhibited by a specific sample warrants individual laboratory evaluation of that drain sample. This decision will be based on health physics judgment considering count rates encountered and results of smear samples.

6.2 DRAIN TRAP SAMPLING

Drain traps in locations which service impacted areas will be subjected to beta surveys and will be evaluated with a composite drain trap sample. This sample will be collected from common areas which may include but are not limited to:

- break rooms;
- restrooms;
- cleaning stations.

Drain traps will be drained of liquid if encountered with the liquid being held for disposition as normal waste upon confirmation that detectable contamination is not present within the liquid or associated solids from the inside of the pipe. The residual buildup of solids will be sampled with a smear for removable contamination. Removable contamination samples will be air dried and subjected to alpha-beta counting.

6.3 CEILING TILES

Impacted ceiling tiles are the only potential source for volumetric contamination of building materials. In Building 8, ceiling tiles are present in the Magnesium-Thorium Machine Room. Given the occurrence of fires involving magnesium-thorium alloys in the room; the porous nature of the ceiling tiles with the associated potential for contamination; and the potential errors involved in quantifying contamination present due to the porous nature of the filters, they will be disposed of as radioactive waste as an integral part of D&D activities.

6.4 INVESTIGATION DERIVED WASTE (IDW)

Planning will be used to minimize the generation of Investigation Derived Waste (IDW). Potentially contaminated waste will be segregated from other waste materials to the extent practicable. Excess soil from soil sampling will be disposed of in the place of origin by returning it to the shallow hole from where it came. Hole size will be minimized to as small as practicable to accomplish the desired task. PPE and other waste items that cannot be decontaminated or reused will be disposed of as IDW. Any waste generated will be containerized in appropriate drums and will be staged, appropriately labeled, and transferred to the Radioactive Waste Storage Building (Building 132) for future disposal as radioactive waste by transfer to a properly permitted disposal facility.

6.5 CONTAMINATION CRITERIA FOR EQUIPMENT

Contamination levels for equipment to be released without radiological restrictions must not exceed those specified in NRC Source Material License STB-1168. Contamination criteria stated in Table 5-2, Department of the Army Pamphlet 385-24 apply. The stated limits for thorium-232 are 600 and 60 dpm/100 cm2 for total and removable activity, respectively. These limits were derived in ANSI N13.12-1999 and "were protective of 10μSv/y (1.0 mrem/y)" (ANSI 1999).

7.0 SUMMARY OF SURVEYS TO BE PERFORMED

7.1 GENERAL

Radiological surveys are performed for a variety of reasons to obtain information to: evaluate whether existing concentrations of site contaminants exceed DCGLs (and relatedly as part of the final status survey process); to identify the lateral and vertical extent of identified contaminants of concern exceeding DCGLs and thus to enable the scope of remedial actions to be defined; and to evaluate the effectiveness of decontamination. Surveys performed pursuant to this survey plan will address each of these objectives and thus are necessarily subject to change.

The following is an overview of minimum measurements to be performed for the associated CCAD areas that have been impacted by magnesium-thorium alloy aircraft maintenance operations. Measurements as used herein are made up of fixed point surveys and removable contamination (smear) evaluations. The specified measurements for each area or portion thereof will be augmented by scan surveys of 10 to 50 percent of the surface area as specified for each area with the relative rate of scan surveys contingent on availability of existing survey information and evaluation as to the likely results of each given survey. For example, comprehensive surveys are not required for areas that are known to exhibit contamination exceeding DCGLs and for which the range of contamination is reasonably well defined. More detailed surveys, by contrast, are appropriate for areas in which concentrations of site COCs are present at concentrations close to background and/or DCGLs.)

7.2 BUILDING 8 IMPACTED AREAS

7.2.1 Magnesium-Thorium Machine Room

Given that significant additional surveys of the Magnesium-Thorium Machine Room will be required upon completion of D&D as an integral part of the final status survey process, surveys of the floors and walls within the room will be limited to those areas for which information is required to determine the scope of D&D required and to evaluate decontamination options. Similarly, surveys of hand tools and small pieces of equipment will be performed as needed to evaluate decontamination options with equipment release surveys being incorporated into D&D activities as an integral part of Phase II actions. Survey data applicable to other portions of the area to include the ventilation system, roof, and elevated support structures may be carried forward in the final status survey process and thus will be of the appropriate scope and quality for use in that process, as appropriate. As such, scans surveys will include a minimum of:

- 10% of the floor area in its current configuration
- 10% of the floor area subsequent to the removal of recently installed floor tile.
- 50% of wall areas to 6 feet above the floor
- 50% of roof areas within 10 feet in all directions from the ventilation system exhaust outlet
- 50% of the surface area of the air intakes and adjacent reasonably accessible interior portions of ventilation ducts;
- 10% of the surface area of elevated support structures; and
- The covers of any floor drains identified in the area and traps of drain lines.

Fixed point and removable contamination surveys will include:

Floors – 20 random measurements each prior to and after floor tiles are removed with special emphasis on areas that are more likely to contain contamination;

Walls – 20 systematic measurements within the lower 6 feet of wall area and 20 additional random measurements within the area more than 6 feet above the floor;

Equipment – 20 measurements per major piece of equipment; at least one measurement from any single item and scan surveys consistent with license requirements for release of equipment;

Ventilation System – 20 measurements from the air intakes and adjacent, reasonably accessible interior portions of ventilation ducts;

Roof – 20 measurements;

Elevated support structures – 20 measurements concentrating on horizontal surfaces; and

(Ceiling tiles will be disposed of as radioactive waste with surveys being limited to assessment for waste characterization.)

7.2.2 Welding Shop Including Metal Spray and Co-located Bead Blast Cabinet Areas

Given that the Welding Shop is not fully segregated from adjacent areas by walls etc., and that the operations performed in the shop involved the potential for airborne contamination, areas adjacent to the Welding Shop have been classified as potentially impacted and incorporated into the scope of the surveys to be performed. (Historical documentation confirms the potential for airborne contamination concurrent with welding.) Although leakage of the bead blast booths in this area has not be confirmed, bead blast booths used for the processing of magnesium-thorium alloys have historically been noted to leak around access points during operation and to exhibit the potential for contamination during filter change out etc. As such, and given the potential for relatively small particle sizes of contamination from bead blasting, special consideration will be given to investigating the areas surrounding all bead blast booths used for magnesium-thorium alloy processing. In addition, bead blast booths not authorized for processing of magnesium-thorium alloys will also be spot checked to confirm the absence of contamination.

Scan surveys will include a minimum of:

- 50% of the floor area within 50 feet of the welding and metal spray booths and bead blast cabinets;
- 50% of wall areas within the area in question to a height of 6 feet above the floor;
- 10% of floor areas more than 50 feet from the welding and spray booths and bead blast cabinets but within the area identified as impacted in Figure 3-2, Building 8 Impacted Areas;
- 50% of the surface area of the air intakes and adjacent reasonably accessible interior portions of ventilation ducts;
- 10% of the surface area of elevated support structures; and
- The covers of any floor drains identified in the area and traps of drain lines.

Fixed point and removable contamination surveys will include:

Floors – 20 measurements within the area of the welding and metal spray booths; an additional 20 measurements within the geographic area defined as impacted;

Walls – 20 systematic measurements within the lower 6 feet of wall area and 20 additional random measurements within the area more than 6 feet above the floor;

Equipment – 20 measurements per major piece of equipment; at least one measurement from any single item and scan surveys consistent with license requirements for release of equipment;

Ventilation System – 20 measurements from the air intakes and adjacent, reasonably accessible, interior portions of ventilation ducts (if the ventilation system exhibits detectable contamination, the ventilation exhaust and adjacent roof areas will be subjected to surveys as specified for the Magnesium-Thorium Machine Room); and

Elevated support structures – 20 measurements concentrating on horizontal surfaces.

Note: Given that the welding area to include metal spray down draft booth and bead blast booths and the associated area in which they are located identified in this section are expected to require remedial action, surveys are limited to those required to provide information for D&D. Final status surveys will be accomplished upon completion of D&D activities

7.2.3 Machine Shop Area

As maintenance was transferred from the Machine Shop into the Magnesium-Thorium Machine Room many years ago, the potential for contamination is very limited. This is particularly true given routine, thorough cleanings to which the area has been subjected over time. As such, surveys will concentrate on areas such as seams and cracks in the floor, floor drains etc, which have the greatest potential for residual contamination. Surveys will be performed assuring compliance with data quality objectives for use of data in final status survey processes. Scan surveys will include a minimum of:

- 10% of the floor area with the impacted area of the Machine Shop;
- 10% of wall areas within the area in question to a height of 6 feet above the floor;
- 50% of the surface area of the air intakes and 10% of the adjacent, reasonably accessible, interior portions of ventilation ducts; and
- 10% of the surface area of elevated support structures.
- The covers of any floor drains identified in the area and traps of drain lines

Fixed point and removable contamination surveys will include:

Floors – 20 measurements within the designated geographic limits of the impacted area from locations with the greatest potential for contamination (e.g., cracks and seams in the floors,

Walls – 20 random measurements within the lower 6 feet of wall area and 20 additional random measurements within the area more than 6 feet above the floor;

Equipment – Scan surveys will be performed for each major piece of equipment. Surveys will also consist of at least one random fixed point and one removable contamination measurement on each major piece on equipment.

Ventilation System – 20 measurements from the air intakes and adjacent, reasonably accessible, interior portions of ventilation ducts (if the ventilation system exhibits detectable contamination, the ventilation exhaust and adjacent roof areas will be subjected to surveys as specified for the Magnesium-Thorium Machine Room); and

Elevated support structures – 20 measurements concentrating on horizontal surfaces

7.2.4 Engine Disassembly and Cleaning Areas

The Engine Disassembly and Cleaning Areas used for the processing of magnesium-thorium alloy components were taken out of service and the tanks, piping and associated process equipment were subjected to appropriate radiological surveys and released consistent with license provisions. As such, the potential for contamination is very limited. Surveys will be performed concentrating on areas with the greatest potential for residual contamination. Surveys will be performed assuring compliance with data quality objectives for use of data in final status survey processes. Scan surveys will include a minimum of:

- 10% of the floor area with the impacted area of the Machine Shop;
- 10% of wall areas within the area in question to a height of 6 feet above the floor;
- 50% of the surface area of the air intakes and 10% of the adjacent, reasonably accessible, interior portions of ventilation ducts; and
- 10% of the surface area of elevated support structures.
- The covers of any floor drains identified in the area and traps of drain lines

Fixed point and removable contamination surveys will include:

Floors – 20 measurements within the designated geographic limits of the impacted area from locations with the greatest potential for contamination (e.g., cracks and seams in the floors,

Walls – 20 random measurements within the lower 6 feet of wall area and 20 additional random measurements within the area more than 6 feet above the floor;

Equipment – 20 measurements per major piece of equipment; at least one measurement from any single item and scan surveys consistent with license requirements for release of equipment

Ventilation System – 20 measurements from the air intakes and adjacent, reasonably accessible, interior portions of ventilation ducts (if the ventilation system exhibits detectable contamination, the ventilation exhaust and adjacent roof areas will be subjected to surveys as specified for the Magnesium-Thorium Machine Room); and

Elevated support structures – 20 measurements concentrating on horizontal surfaces

7.2.5 Temporary Waste Storage Areas

Temporary Waste Storage Areas were utilized for magnesium-thorium alloy waste generally in the immediate area in which the waste was being generated (e.g., the waste for the bead blast area would be located within the bead blast area). Such areas were very limited in size (typically a small area capable of storing not more than two each 55-gallon drums). Temporary waste storage areas will be evaluated as an integral part of the survey of the associated areas.

7.2.6 The Area Formerly Occupied by the Haas Mill

The area formerly occupied by the Haas Mill will be incorporated into surveys of the Machine Shop. A minimum of 10% of the associated floor area and immediately adjacent wall areas (where applicable) to a height of 6 feet above the floor will be subjected to scan surveys and fixed point and removable contamination measurements will be obtained from the potentially impacted area.

7.2.7 Two Bead Blast Rooms at the North End of Building 8 That Previously Supported Engine Disassembly and Cleaning Shops

Two bead blast rooms that supported the Engine Disassembly and Cleaning Shops were taken out of service when no longer needed to support mission requirements. Surveys will be performed concentrating on areas with the greatest potential for residual contamination, assuring compliance with data quality objectives for use of data in final status survey processes. Although leakage of the bead blast booths in this area has not be confirmed, bead blast booths used for the processing of magnesium-thorium alloys have historically been noted to leak around access points during operation and to exhibit the potential for contamination during filter change out etc. As such, and given the potential for relatively small particle sizes of contamination from bead blasting, special consideration will be given to investigating the areas surrounding all bead blast booths used for magnesium-thorium alloy processing. In addition, bead blast booths not authorized for processing of magnesium-thorium alloys will also be spot checked to confirm the absence of contamination. Scan surveys will include a minimum of:

- 10% of the floor area with the impacted area of the Machine Shop;
- 10% of wall areas within the area in question to a height of 6 feet above the floor;
- 50% of the surface area of the air intakes and 10% of the adjacent, reasonably accessible, interior portions of ventilation ducts; and
- 10% of the surface area of elevated support structures.
- The covers of any floor drains identified in the area and traps of drain lines

Fixed point and removable contamination surveys will include:

Floors – 20 measurements within the designated geographic limits of the impacted area from locations with the greatest potential for contamination (e.g., cracks and seams in the floors,

Walls – 20 random measurements within the lower 6 feet of wall area and 20 additional random measurements within the area more than 6 feet above the floor;

Equipment – There is no equipment located in the subject areas.

Ventilation System – 20 measurements from the air intakes and adjacent, reasonably accessible, interior portions of ventilation ducts (if the ventilation system exhibits detectable contamination, the ventilation exhaust and adjacent roof areas will be subjected to surveys as specified for the Magnesium-Thorium Machine Room); and

Elevated support structures – 20 measurements concentrating on horizontal surfaces

7.2.8 The Electron Beam Welder Area

The Electron Beam Welder may have been used for mission-critical welding of magnesium-thorium alloys thus the area in which the welder is located is being subjected to radiological surveys to confirm the absence of contamination. Surveys will concentrate on areas with the greatest potential for contamination, assuring compliance with data quality objectives for use of data in final status survey processes. Scan surveys will include a minimum of:

- 10% of the floor area with the impacted area of the area;
- 10% of wall areas within the area in question to a height of 6 feet above the floor;
- 50% of the surface area of the air intakes and 10% of the adjacent, reasonably accessible, interior portions of ventilation ducts; and
- 10% of the surface area of elevated support structures.
- The covers of any floor drains identified in the area and traps of drain lines

Fixed point and removable contamination surveys will include:

Floors – 20 measurements within the designated geographic limits of the impacted area from locations with the greatest potential for contamination (e.g., cracks and seams in the floors,

Walls – 20 random measurements within the lower 6 feet of wall area and 20 additional random measurements within the area more than 6 feet above the floor;

Equipment – 20 measurements per major piece of equipment;

Ventilation System – 20 measurements from the air intakes and adjacent, reasonably accessible, interior portions of ventilation ducts (if the ventilation system exhibits detectable contamination, the ventilation exhaust and adjacent roof areas will be subjected to surveys as specified for the Magnesium-Thorium Machine Room); and

Elevated support structures – 20 measurements concentrating on horizontal surfaces

7.2.9 Floor Drains and Drain Traps

Sewers to include floor drains and drain traps will be investigated as an independent survey unit consistent with the provisions of Sections 6.1 and 6.2. Subject to the number of drains encountered within impacted areas, up to 20 fixed point and removable contamination measurements will be made of floor drains. Similarly, drain traps in areas in the vicinity of impacted areas will be investigated. This investigation will include scan surveys of the exterior of drain traps and fixed point and removable contamination measurements from the open portion of the trap for up to 20 drain traps.

7.2.10 Grass Areas Surrounding Building 8.

Grass areas surrounding Building 8 will be combined with other potentially impacted soil areas and will be surveyed in accordance with Section 5.4 of this survey plan.

7.3 BUILDING 340 (ROOM 201) MAGNESIUM-THORIUM BEAD BLAST BOOTHS AND ASSOCIATED VENTILATION SYSTEM DUCTWORK

Although leakage of the bead blast booths in this area has not be confirmed, bead blast booths used for the processing of magnesium-thorium alloys have historically been noted to leak around access points during operation and to exhibit the potential for contamination during filter change out etc. As such, and given the potential for relatively small particle sizes of contamination from bead blasting, special consideration will be given to investigating the areas surrounding all bead blast booths used for magnesium-thorium alloy processing. In addition, bead blast booths not authorized for processing of magnesium-thorium alloys will also be spot checked to confirm the absence of contamination. Scan surveys will include a minimum of:

- 10% of the floor area within the room;
- 10% of wall areas within the area in question to a height of 6 feet above the floor;
- 50% of the surface area of the exhaust air intakes and adjacent reasonably accessible interior portions of ventilation ducts (additional surveys of the interior of ductwork may reasonably be required and may be performed concurrent with this survey or at the time of D&D);
- 10% of the surface area of elevated support structures; and
- The covers of any floor drains identified in the area and traps of drain lines.

Fixed point and removable contamination surveys will include:

Floors – 20 measurements within the area of the

Walls – 20 systematic measurements within the lower 6 feet of wall area and 20 additional random measurements within the area more than 6 feet above the floor;

Equipment – 20 measurements per major piece of equipment; at least one measurement from any single item and scan surveys consistent with license requirements for release of equipment;

Ventilation System – 20 measurements from the air intakes and adjacent, reasonably accessible, interior portions of ventilation ducts (if the ventilation system exhibits detectable contamination, the ventilation exhaust and adjacent roof areas will be subjected to surveys as specified for the Magnesium-Thorium Machine Room); and

Elevated support structures – 20 measurements concentrating on horizontal surfaces.

Note: Given that the bead blast booths and associated area identified in this section are expected to require remedial action, surveys are limited to those required to provide information for D&D. Final status surveys will be accomplished upon completion of D&D activities.

7.4 BUILDING 1727, ROOM B101, RADIATION SAFETY OFFICER LABORATORY

Given that radioactive materials present within the RSO Laboratory have consisted of sealed sources and check sources used to determine the counting efficiency of laboratory radiation measurement instrumentation, the potential for contamination is extremely limited. As such, surveys currently being performed are limited to confirmation that unexpected contamination does not exist. Final status surveys will be performed upon completion of D&D activities which may involve use of the laboratory for sample storage, analysis or processing. Scan surveys will include a minimum of:

- 10% of the floor area within the room;
- 10% of wall areas within the area in question to a height of 6 feet above the floor;
- Spot check of air intakes and ductwork;
- 10% of the surface area of elevated support structures; and
- The covers of any floor drains identified in the area and traps of drain lines.

Fixed point and removable contamination surveys will include:

Floors – 20 measurements;

Walls – 20 random measurements;

Office and laboratory equipment: 20 random measurements;

Ventilation System – spot check measurement from the air intakes; and

7.5 BUILDING 132 RADIOACTIVE MATERIAL STORAGE AND HANDLING BUILDING

Building 132 is a separate industrial building constructed specifically to store and process radioactive waste generated at CCAD. As the size of the structure exceeded radioactive waste mission needs, approximately half has been reallocated for other use. Both portions of the building (including ventilation exhaust fans etc) and surrounding soil areas will be subjected to characterization surveys as part of these surveys and to final status surveys upon completion of D&D of magnesium-thorium processing facilities. Soil areas will be surveyed in accordance with Section 5.4 of this survey plan with soil samples to be integrated with grassy areas surrounding other impacted areas (e.g., Buildings 339 and 258). Scans surveys will include a minimum of:

- 10% of floor areas
- 10% of wall areas to 6 feet above the floor
- 50% of the surface area of the air intakes and adjacent reasonably accessible interior portions of ventilation ducts;
- 10% of the surface area of elevated support structures; and
- The covers of any floor drains present in the area and traps of drain lines.

Fixed point and removable contamination surveys will include:

Floors – 20 random measurements each prior to and after floor tiles are removed with special emphasis on areas that are more likely to contain contamination;

Walls – 20 systematic measurements within the lower 6 feet of wall area and 20 additional random measurements within the area more than 6 feet above the floor;

Equipment – 20 measurements per major piece of equipment; at least one measurement from any single item and scan surveys consistent with license requirements for release of equipment;

Ventilation System – 20 measurements from the air intakes and adjacent, reasonably accessible interior portions of ventilation ducts;

Elevated support structures – 20 measurements concentrating on horizontal surfaces; and

7.6 BUILDING/AREA 339 FORMER WASTE STORAGE AREA.

Although Building 339 currently serves as a motor pool, historical records indicate that it was used for the storage of radioactive waste. It will therefore be surveyed as a radiologically impacted area.

Scan surveys will include a minimum of:

- 50% of the floor area within the room;
- 50% of wall areas within the area in question to a height of 6 feet above the floor;
- 50% of the surface area of the air intakes and adjacent reasonably accessible interior portions of ventilation ducts (additional surveys of the interior of ductwork may reasonably be required and may be performed concurrent with this survey or at the time of D&D);
- 10% of the surface area of elevated support structures; and
- The covers of any floor drains identified in the area and traps of drain lines.

Fixed point and removable contamination surveys will include:

Floors – 20 measurements within the area of the

Walls – 20 systematic measurements within the lower 6 feet of wall area and 20 additional random measurements within the area more than 6 feet above the floor;

Equipment – 20 measurements per major piece of equipment; at least one measurement from any single item and scan surveys consistent with license requirements for release of equipment;

Ventilation System – 20 measurements from the air intakes and adjacent, reasonably accessible, interior portions of ventilation ducts (if the ventilation system exhibits detectable contamination, the ventilation exhaust and adjacent roof areas will be subjected to surveys as specified for the Magnesium-Thorium Machine Room); and

Elevated support structures – 20 measurements concentrating on horizontal surfaces.

7.7 FORMER BUILDING 258 (POL AREA) RADIOACTIVE WASTE STORAGE AND PROCESSING AREAS

The northwest quarter of Building 258 was used in the 1970s and early 1980s to house the CCAD Safety Office and associated functions including the Rad Lab, Safety Store and Radioactive Waste Storage Area. The radiologically impacted portion of the building (i.e., that portion used for radiological operations) will be subjected to surveys/investigations to confirm the absence of contamination.

Scan surveys will include a minimum of:

- 50% of the floor area within the room;
- 50% of wall areas within the area in question to a height of 6 feet above the floor;
- 50% of the surface area of the air intakes and adjacent reasonably accessible interior portions of ventilation ducts (additional surveys of the interior of ductwork may reasonably be required and may be performed concurrent with this survey or at the time of D&D);
- 10% of the surface area of elevated support structures; and
- The covers of any floor drains identified in the area and traps of drain lines.

Fixed point and removable contamination surveys will include:

Floors – 20 measurements within the area of the

Walls – 20 systematic measurements within the lower 6 feet of wall area and 20 additional random measurements within the area more than 6 feet above the floor;

Equipment – 20 measurements per major piece of equipment; at least one measurement from any single item and scan surveys consistent with license requirements for release of equipment;

Ventilation System – 20 measurements from the air intakes and adjacent, reasonably accessible, interior portions of ventilation ducts (if the ventilation system exhibits detectable contamination, the ventilation exhaust and adjacent roof areas will be subjected to surveys as specified for the Magnesium-Thorium Machine Room); and

Elevated support structures – 20 measurements concentrating on horizontal surfaces.

7.8 BUILDING 1825

Building 1825 was used in the 1970s for the processing of magnesium-thorium alloys to include milling, grinding, welding abrasive blasting, assembly and disposal. Given the characteristics of magnesium-thorium alloy maintenance and the fact that it has not been used for such operations for many years, it is unlikely to exhibit detectable contamination but will be subjected to final status surveys to confirm the absence of contamination.
Scan surveys will include a minimum of:

- 50% of the floor area within the room;
- 50% of wall areas within the area in question to a height of 6 feet above the floor;
- 50% of the surface area of the air intakes and adjacent reasonably accessible interior portions of ventilation ducts (additional surveys of the interior of ductwork may reasonably be required and may be performed concurrent with this survey or at the time of D&D);
- 10% of the surface area of elevated support structures; and
- The covers of any floor drains identified in the area and traps of drain lines.

Fixed point and removable contamination surveys will include:

Floors – 20 measurements within the area of the

Walls – 20 systematic measurements within the lower 6 feet of wall area and 20 additional random measurements within the area more than 6 feet above the floor;

Equipment – 20 measurements per major piece of equipment; at least one measurement from any single item and scan surveys consistent with license requirements for release of equipment;

Ventilation System – 20 measurements from the air intakes and adjacent, reasonably accessible, interior portions of ventilation ducts (if the ventilation system exhibits detectable contamination, the ventilation exhaust and adjacent roof areas will be subjected to surveys as specified for the Magnesium-Thorium Machine Room); and

Elevated support structures – 20 measurements concentrating on horizontal surfaces.

8.0 CONTAMINATION CRITERIA FOR EQUIPMENT

Contamination levels for equipment to be released without radiological restrictions must not exceed those specified in NRC Source Material License STB-1168. Action is ongoing to assure that limits specified in Table 5-2, Department of the Army Pamphlet 385-24 (DOA 2007) are formally incorporated into NRC License STB-1168. In the event that NRC concurrence with these limits is not received prior to mobilization for D&D efforts, equipment will be surveyed and staged/stored in a radiologically restricted area pending receipt of NRC-approved contamination limits.

9.0 REFERENCES

ANSI 1999. *Surface and Volume Radioactivity Standards for Clearance*, ANSI/HPS N13.12-1999, Health Physics Society, August

CCAD 2008. Email, 19 March 2008, from Mr. Eduardo Perez to Messrs. Earl (Joe) Hart and Dennis R. Chambers, Subject: Rock Island Visit, adding an additional bead blast booth to the scope of impacted areas.

DOD 2000. *Multi-Agency Radiation Survey and Site Investigation Manual (MARSSIM)*, NUREG-1575, EPA 402-R-97-016, Department of Defense et al. August with June 2001 updates

EPA 2004. *Multi-Agency Laboratory Analytical Protocols Manual*, NUREG-1576, EPA 402-B-04-001A, EPA et al. July

NRC 1992. *Manual for Conducting Radiological Surveys in Support of License Termination*, NUREG/CR-5849 (draft), Nuclear Regulatory Commission. June.

NRC 1998. *Minimum Detectable Concentrations with Typical Radiation Survey Instruments for Various Contaminants and Field Conditions*, NUREG-1507, Nuclear Regulatory Commission. June.

NRC 2003. *Consolidated Decommissioning Guidance: Characterization, Survey, and Determination of Radiological Criteria* (NUREG-1757, Vol. 2, Rev. 1), September

SAIC 2008. *Historical Site Assessment of Radiological Maintenance Operations at Corpus Christi Army Depot*

APPENDIX A

D&D VERSION 2.1 THORIUM-232 DCGL SCREENS

D&D VERSION 2.1 THORIUM-232 DCGL SCREENS

The "Screening Values of Common Radionuclides for Building-Surface Contamination Levels" as defined in NRC SECY-98-242 lists "D&D Screening Values". The value specified as representing the 90^{th} percentile of the output dose distribution as being equivalent to 25 mrem/year for Thorium-232 is 7.3 dpm/100 cm^2. NRC guidance in "Re-Evaluation of the Indoor Resuspension Factor for the Screening Analysis of the Building Occupancy Scenario for NRC's License Termination Rule - Draft Report (NUREG-1720)" currently recommends a resuspension factor of $1 \times 10^{-6}\ m^{-1}$ as being adequately conservative. With technical assistance from members of the NRC Headquarters staff (e.g., Messrs Dwayne Schmidt, Ralph Cady and Chris McKinney), the screening level DCGL was recalculated using D&D Version 2.1 with the only change being the aforementioned modification of the value of the resuspension factor. Using a 95 percent confidence level, this change resulted in an updated screening level DCGL of 102 dpm/100 cm^2 for Thorium-232. Although thorium-series radionuclides consist of six alpha-emitting radionuclides and four beta-emitting thorium progeny (Table 3-1), only three beta-emitting thorium progeny have been used to calculate the DCGL given that Pb-212 beta emissions are at such a low energy as to be difficult to detect. Consequently, 600 and 300 dpm/100 cm^2 constitute the DCGLs for total alpha and total beta, respectively, with the beta DCGL serving as the basis for D&D and subsequent license termination decision-making.

The following screens (Figures A-1 through A-3) reflect the input and output from D&D Version 2.1 for modification of the DCGL for thorium-232 based on use of the prescribed resuspension factor.

Distribution: CONSTANT

Units of Measurement: dpm/100 cm**2

Value: 7.3

Area of Contamination

- (•) Unlimited Area
- ( ) Contained in Limited Area

Area ______ m ²

Enter Justification for Site Specific Value

Value recommended by NUREG-1720

Restore to Default

Print

OK

Cancel

Distribution: CONSTANT

Units of Measurement: 1/m

Value: 1e-06

Enter Justification for Site Specific Value

Change in RF value as authorized by Region IV and NRC HQ pursuant to NUREG-1720

Restore to Default

Print

OK

Cancel

Dose modeling completed
TEDE = 1.79E+00 mRem (with 95% CI of 1.79E+00 to 1.79E+00 mRem)

Run Simulation

Abort Simulation

Options...

Close

APPENDIX B

SCAN MDCs FOR RADIOLOGICAL CONTAMINANTS OF CONCERN AT CORPUS CHRISTI ARMY DEPOT

SCAN MDCS FOR RADIOLOGICAL CONTAMINANTS OF CONCERN AT THE CORPUS CHRISTI ARMY DEPOT

NUREG 1507, *Minimum Detectable Concentrations with Typical Radiation Survey Instruments for Various Contaminants and Field Conditions* (NRC, 1998), and NUREG 1575, *Multi-Agency Radiation Survey and Site Investigation Manual* (MARSSIM) (DoD, 1997) provide methodology for calculation of minimum detectable concentrations (MDCs). The following details the approach for calculating site specific MDCs for Thorium-232 for use in the scoping survey process at the Corpus Christi ARMY Depot.

The steps utilized for calculating MDCs for the CCAD follow the approach detailed in NUREG 1507. The steps include:

1. Calculating the minimum detectable count rate (MDCR) by selecting a given level of performance, scan speed, and background level of the detector; and
2. Selecting a surveyor efficiency, if applicable.

For determining the CCAD MDCs, average background values for the Ludlum Model 43-89 of 322 cpm for steel surfaces, 344 cpm for concrete surfaces, and the Ludlum Model 43-37 (for concrete surfaces) of 1488 cpm were selected. These numbers may change based on background measurements taken during scoping survey. The observable background counts (*b'*) is defined as the number of background counts observed within the observation interval (*i*). The observation interval was selected as the time that 25% of the probe is over a 4"×4" area of interest. The equation used for calculating *b'* is as follows:

b' = (background count rate) × (observation interval) × (1 min/60 sec) = counts/interval

The minimum detectable number of net source counts in the interval is given by s_i. Therefore, for an ideal observer, the number of source counts required for a specified level of performance can be arrived at by multiplying the square root of the number of background counts by the delectability value associated with the desired performance (d') as shown below:

$$s_i = d' \sqrt{b_i}$$

The MDCR is defined as the increase above background recognizable during a survey in a given period of time. The variable, *d*', is defined as the index of sensitivity and is dependent on the selected decision errors for Type I (alpha) and Type II (beta) errors. A true positive error ($1-\beta$) of 95% and a false positive error (alpha) of 60% were selected to be consistent with NUREG 1507. The value of 1.38 was obtained from Table 6.1 in NUREG 1507 (Table 6.5 in MARSSIM).

$$\text{MDCR} = s_i \times (60/i) = \text{cpm}$$

Finally, the scan MDCs for structure surfaces may be calculated:

$$\text{Scan MDC} = \frac{MDCR}{\sqrt{p}\,\varepsilon_t \frac{probe\ area}{100\ cm^2}}$$

$$\varepsilon_t = \varepsilon_i \times \varepsilon_s$$

where

MCDR = minimum detectable count rate
ε_t = total efficiency
ε_s = surface efficiency
ε_i = instrument efficiency
p = surveyor efficiency

The fixed point measurement MDC is calculated as follows:

$$\text{MDC} = C\left[3 + 4.65\sqrt{b'}\right]$$

$$C = \frac{1}{(\text{total efficiency})(\text{probe area})}$$

Ludlum 43-37 Gas Flow Proportional Floor Scanner

$$b' = (\text{bkg count rate})(\text{observation internal})(1\ \text{min/60 sec})$$

Surface: Concrete
Background = 1594 cpm
Probe dimensions: 1" x 6.25" x 18.25"
Probe active area: 584 cm^2
Scan Speed = 3 inches/sec
ε_t = 0.31
p = 0.50
d' = 1.38
i = (8.3 inches/3 inches per second) = 2.77 seconds
b' = (1594 cpm) (1 min/ 60 sec) (2.77 sec) = 73.6 counts/observation interval

$$s_i = 1.38\sqrt{73.6} = 11.84 \text{ net source counts}$$

$$\text{MDCR} = 11.84\ (60/2.77) = 256.5 \text{ cpm}$$

$$\text{Scan MDC} = \frac{256.5}{\sqrt{0.50}(0.31)(5.84)} = 200.39 > 200 \text{ dpm/100 cm}^2$$

Fixed Point Measurement

b' = (1594 cpm)(30 seconds)(1 min/ 60 sec) = 797 counts/interval

$$\text{MDC} = C\left[3 + 4.65\sqrt{b'}\right]$$

$$MDC = \frac{\frac{60sec}{min}}{(30sec)(.31)(5.84)}\left(3 + 4.65\sqrt{797}\right) = 148.4 > 150\frac{dpm}{100cm^2}$$

Ludlum 43-106 Gas Flow Proportional Counter

Background = 323 cpm (steel), 344 cpm (concrete)
Probe dimensions = 3.8" × 6.5"
Probe active area = 126 cm^2
Scan Speed = 1 in/second
ε_t = .33 (concrete), 0.31 (steel)
P = 0.50
d^1 = 1.38

Scan Measurement (dust covered steel) – Scan MDC for dust covered steel will be calculated as site survey data is collected and evaluated, currently insufficient information exists calculate. Total efficiency has been determined from MARSSIM Table 5.3.

Scan Measurement (steel/equipment surfaces)

i = (5in/2in/sec) = 2.5sec
b' = (323cpm)(1min/60sec)(2.5sec) = 13.46

$$s_i = 1.38\sqrt{13.46} = 5.06 \qquad \text{net source counts}$$

$$\text{MDCR} = 5.06\left(\frac{60\text{sec/min}}{2.5\text{sec}}\right) = 121.44\,\text{cpm}$$

$$\text{Scan MDC} = \frac{121.44\ \text{cpm}}{\sqrt{.50}\,(0.31)(1.26)} = 439.69 > 440\,\frac{\text{dpm}}{100\text{cm}^2}$$

Scan Measurement (concrete/cinder block surfaces)

i = (5in/2in/sec) = 2.5sec
b' = (344 cpm)(1min/60sec)(2.5sec) = 14.33

$$s_i = 1.38\sqrt{14.33} = 5.22 \qquad \text{net source counts}$$

$$\text{MDCR} = 5.22\left(\frac{60\text{sec/min}}{2.5\text{sec}}\right) = 125.28\ cpm$$

$$\text{Scan MDC} = \frac{125.28\text{cpm}}{\sqrt{.50}(.33)(1.26)} = 426.1 < 430\frac{\text{dpm}}{100\text{cm}^2}$$

Fixed Point Measurement (steel/equipment surfaces)

$b^{'}$ = (323 cpm)(30 seconds)(1 min/ 60 sec) = 161.5 counts/interval

$$\text{MDC} = C\left[3 + 4.65\sqrt{b^{'}}\right]$$

$$\text{MDC} = \left[\frac{(60\text{sec/min})}{(30\text{sec})(0.31)(1.26)}\right]\left[3 + 4.65\sqrt{161.5}\right] = 318.5\frac{\text{dpm}}{100\text{cm}^2}$$

Fixed Point Measurement (concrete/cinderblock surfaces)

$b^{'}$ = (344 cpm)(30 seconds)(1 min/ 60 sec) = 172 counts/interval

$$\text{MDC} = C\left[3 + 4.65\sqrt{b^{'}}\right]$$

$$\text{MDC} = \left[\frac{(60\text{sec/min})}{(30\text{sec})(0.33)(1.26)}\right]\left[3 + 4.65\sqrt{172}\right] = 307.8\frac{\text{dpm}}{100\text{cm}^2}$$

Note: Use of this instrument for routine survey use may require longer count times and/or slower scan rates to achieve the required data quality objectives.

<u>Ludlum 43-89 (ZnS plastic scintillator)</u>

Surface: Steel structural beams
Background = 275 cpm
Probe dimensions: 3.0" x 6.5"
Probe active area: 126 cm^2
Scan Speed = 2 inches/sec
Fixed point measurement time = 30 seconds
ε_i = 0.43 (steel), 1.03 (concrete)
ε_s = 0.81 (steel surfaces), 0.30 (concrete surfaces)
p = 0.50
d' = 1.38

As discussed in Table 1, no available data for beta background count rates (published or directly from previous investigations at CCAD) were available for the ZnS plastic scintillator. The use of 275 cpm as a background rate is used only to compare the ZnS detector to the other available detectors. The 275 cpm was chosen arbitrarily from previous investigations into areas with similar contaminants of concern. Instrument and surface efficiencies from previous investigations at similar properties are being used until suitable data from CCAD is available.

Scan Measurement (concrete surfaces)

i = (5in/2in/sec) = 2.5 seconds
b' = (275 cpm) (1 min/ 60 sec) (2.5 sec) = 11.4 counts/observation interval

$$s_i = 1.38\sqrt{11.4} == 4.66 \text{ net source counts}$$

$$\text{MDCR} = 4.66\,(60/2.5) = 112 \text{ cpm}$$

$$\text{Scan MDC} = \frac{112 \text{ cpm}}{\sqrt{0.50}(1.03)(0.3)(1.26)} = 406.83 \text{ dpm/100 cm}^2$$

Fixed Point Measurement (steel surfaces)

b' = (275 cpm)(30 seconds)(1 min/ 60 sec) = 138 counts/interval

$$\text{MDC} = C\left[3 + 4.65\sqrt{b'}\right]$$

$$\text{MDC} = \left[\frac{(60\sec/\min)}{(30\sec)(0.43)(0.81)(1.26)}\right]\left[3 + 4.65\sqrt{138}\right] = 262.61\,\frac{dpm}{100cm^2}$$

Fixed Point Measurement (concrete surfaces)

b' = (300 cpm)(30 seconds)(1 min/ 60 sec) = 150 counts/interval

$$\text{MDC} = C\left[3 + 4.65\sqrt{b'}\right]$$

$$\text{MDC} = \left[\frac{(60\sec/\min)}{(30\sec)(1.03)(0.30)(1.26)}\right]\left[3 + 4.65\sqrt{150}\right] = 307.96\,\frac{dpm}{100cm^2}$$

Note: Use of this instrument for routine survey use may require longer count times and/or slower scan rates to achieve the required data quality objectives.

Ludlum 2221 Gas Flow Proportional Floor Scanner

$b^{1''} = (\text{bkg count rate})(\text{observation internal})(1\ \text{min}/60\ \text{sec})$

Surface: Concrete
Background = 1588 cpm
Probe dimensions: 9" x 4.3" x 10"
Probe active area: 582 cm^2
Scan Speed = 3 inches/sec
$\varepsilon_t = 0.31$
$p = 0.50$
$d' = 1.38$
i = (8.3 inches/3 inches per second) = 2.77 seconds
b' = (1588 cpm) (1 min/ 60 sec) (2.77 sec) = 73.3 counts/observation interval

$$s_i = 1.38\sqrt{73.3} = 11.81 \text{ net source counts}$$

$$\text{MDCR} = 11.81\ (60/2.77) = 255.8 \text{ cpm}$$

$$\text{Scan MDC} = \frac{255.8}{\sqrt{0.50}(0.31)(5.82)} = 200.5 > 200 \text{ dpm}/100 \text{ cm}^2$$

Fixed Point Measurement

b' = (1588 cpm)(30 seconds)(1 min/ 60 sec) = 794 counts/interval

$$\text{MDC} = C\left[3 + 4.65\sqrt{b'}\right]$$

$$MDC = \frac{\frac{60sec}{min}}{(30sec)(.31)(5.82)}(3 + 4.65\sqrt{794}) = 148.5 > 150\frac{dpm}{100cm^2}$$

APPENDIX C

COMPUTATION OF SMEAR/SWIPE DETECTION LIMITS WITH A LUDLUM MODEL 2929 SCALER AND LUDLUM MODEL 43-10-1 DETECTOR

COMPUTATION OF SMEAR/SWIPE DETECTION LIMITS WITH A LUDLUM MODEL 2929 SCALER AND LUDLUM MODEL 43-10-1 DETECTOR

$$MDC = \frac{(3 + 3.29\sqrt{R_B T_{S+B}(1 + \frac{T_{S+B}}{T_B})})}{K T_{S+B}}$$

NUREG 1507 (equation 3-11)

$$K = (total\ efficiency)(probe\ area)$$

$$\varepsilon_t = \varepsilon_i \times \varepsilon_s$$

R_B = background count rate
T_{S+B} = sample and background count times
T_B = background count time
K = proportionality constant
ε_t = total efficiency
ε_s = surface efficiency
ε_i = instrument efficiency

ε_t = .31
probe area = 20.3 cm^2

$$K = (.31)(20.3cm^2) = 6.29cm^2$$

R_B = 60cpm (beta) 1 cpm (alpha)
T_{S+B} = 11 min, 6 min, 2 min (1 minute sample count times)
T_B = 10 min, 5 min, 1 min

Beta count, 10 min background count time:

$$MDC = \frac{(3 + 3.29\sqrt{60(11)(1 + \frac{11}{10})}}{6.29(11)} = 1.81\ dpm/100cm^2$$

Beta count, 5 minute background count time:

$$MDC = \frac{(3 + 3.29\sqrt{60(6)(1 + \frac{6}{5})}}{6.29(6)} = 2.53\ dpm/100cm^2$$

Beta count, 1 minute background count time:

$$MDC = \frac{(3 + 3.29\sqrt{60(2)(1 + \frac{2}{1})})}{6.29(2)} = 5.2\ dpm/100cm^2$$

Alpha count, 10 minute background count time:

$$MDC = \frac{(3 + 3.29\sqrt{1(11)(1 + \frac{11}{10})})}{6.29(11)} = 0.27\ dpm/100cm^2$$

Alpha count, 5 minute background count time:

$$MDC = \frac{(3 + 3.29\sqrt{1(6)(1 + \frac{6}{5})})}{6.29(6)} = 1.19\ dpm/100cm^2$$

Alpha count, 1 minute background count time:

$$MDC = \frac{(3 + 3.29\sqrt{1(2)(1 + \frac{2}{1})})}{6.29(2)} = 0.87\ dpm/100cm^2$$

The Ludlum 2929 Dual Channel Scaler is most commonly used with the Ludlum 43-10-1 detector, thus MDCs were calculated using this detector model. If other detectors are chosen calculations will be re-performed. The use of 60 cpm (beta) and 1 cpm (alpha) are being used due to lack of site specific background data from CCAD. These numbers have been conservatively chosen from technical manual data and comparative site data.

APPENDIX D

RADIOACTIVE MATERIAL LICENSE AGREEMENT BETWEEN CORPUS CHRISTI ARMY DEPOT AND ENVIRONMENTAL DIMENSIONS, INC.

RADIOACTIVE MATERIAL LICENSE AGREEMENT BETWEEN CORPUS CHRISTI ARMY DEPOT AND ENVIRONMENTAL DIMENSIONS, INC.

September 8, 2008 L2008-177

Mr. Eduardo Perez, CCAD/RSO
Corpus Christi Army Depot
Stop 23
Safety & Occupational Health Division
L2000
Corpus Christi, TX 78419-5260

Subject: Agreement to Provide Radiological D&D Services at the Corpus Christi Army Depot under U.S. Nuclear Regulatory Commission (NRC) Source Material License STB-1168

Agreement Number: CCAD 2008-01

Dear Mr. Perez:

This letter establishes a written agreement between Environmental Dimensions, inc., (EDi), and the U.S. Army at the Corpus Christi Army Depot (CCAD), for EDi to provide radiological services in accordance with the EDi Tennessee Radioactive Material License (TRML) R-01103-C17 for both phases (characterization survey and Decontamination and Decommissioning (D&D) and associated final status surveys).

This Agreement is related to EDi license condition 13 which states, in part:

> *13.* - - -
> *Before radioactive materials can be used at a temporary job site in another State, authorization shall be obtained from the State if it is an Agreement State, or from the NRC* (Nuclear Regulatory Commission) *for any non-Agreement State, either by filing for reciprocity or applying for a specific license.*

Given that CCAD operates under NRC Source Material License STB-1168 and that EDi operates under TRML R-01103-C17, this Agreement is provided pursuant to requirement that licensee responsibilities must be clearly delineated to reflect the responsible party. Such responsibilities will consist of the performance of radiological surveys under CCAD's Source Material License STB-1168 and performance of all D&D activities under EDi's TRML R-01103-C17 (and reciprocity agreement with the NRC). License responsibility will be conveyed from one organization in writing to include the date and time of such conveyance (with no associated transfer of property or responsibility for physical security).

This agreement will remain in effect for a period not to exceed one year from the date of finalization or until D&D activities are completed, whichever comes first. The agreement may also be cancelled by either party with 30 days notice in writing to the other party.

If you have any questions, please call me at (865) 482-7789 or email me at mmarable@edi-nm.com.

Sincerely,

Michael C. Marable

Michael Marable, Vice President
Environmental Dimensions, inc.

AGREEMENT

BACKGROUND

The possession of, and operations with, source material at the CCAD is authorized and governed by the NRC Source Material License STB-1168. The most recent **Amendment 24, dated 03 Dec 07** authorizes possessions of up to 5400 kg. The source material, in this case, is a magnesium-thorium alloy that was used in aircraft components. Although exempt (10 CFR 40.13 (c) (4)), a Source Material License is required for any physical, chemical or metallurgical treatment or processing.

The U.S. Army has requested that EDi perform site characterization and clearance surveys and any D&D that may be required to allow uncontrolled release of the site and termination of the NRC Source Material License. This Agreement will authorize those activities with EDi Source Material License R-01103-C-17 which has a limit of 10,000 kg of any form of uranium and thorium, instead of the CCAD Source Material License STB-1168.

EDi, with the assistance of Science Applications International Corporation, has performed and reported a Historical Site Assessment. Similarly, a cooperative effort has produced a detailed Radiological Survey Plan. An acceptable Cost Proposal with a Statement of Work was submitted to the CCAD. All of these documents will be provided to the NRC for their review and approval. All plans, activities, and any discovery will be coordinated with the NRC.

SCOPE OF SERVICE PROVIDERS LICENSE USE AT CCAD

While EDi personnel are physically present at the CCAD, and are executing work for the CCAD under an approved Plan, EDi will accept radiological responsibility for the conduct of the work under License R-01103-C17 subject to the following:

1. The CCAD NRC License STB-1168 remains in full effect at all times. Implementation of the EDi License does not negate or supersede any of the STB-1168 provisions or requirements; and

2. The CCAD remains fully responsible for all aspects of the implementation of License STB-1168, compliance with 10 CFR 20, and U.S. Army guidance documents in all areas and for all activities not performed by EDi.

ACCEPTANCE AND RETURN OF RESPONSIBILITY TO THE CCAD

EDi will accept radiological responsibility for the activities described in the approved Plans and will execute work under License R-01103-C17. Additionally and concurrently, EDi will comply with all provisions and limitations of License STB-1168 while executing its approved work.

Acceptance of radiological responsibility for the activities from the CCAD and implementation of License R-01103-C17 under this agreement will be documented through use of Attachment 1 to this Agreement. Section 1 of Attachment 1 will be completed upon mobilization to the site.

EDi's Radiation Safety Officer (RSO), equivalent to the CCAD RSO, or Radiation Staff Officer, may require an inspection of the working areas pursuant to the performance of EDi work activities.

Generally, one Senior Health Physics Technician must be assigned to the site and be present in the local areas under EDi responsibility. This may be waived for periods when EDi personnel are not on site to perform work.

Completion of the activities under the EDi License will be documented by completion of Section 2 to the current copy of Attachment 1 prior to EDi demobilization from the CCAD. Responsibility may be accepted from, and returned to, the CCAD several times, if necessary, through use of successive new copies of Attachment 1.

The CCAD retains radiological responsibility for all other aspects of the CCAD and any CCAD personnel that may visit the EDi work sites.

CONTROL OF ACCESS UNDER EDI'S JURISDICTION

EDi reserves the right to refuse access to personnel who may wish to gain entry to active work areas under the radiological responsibility of EDi. EDi recognizes that it must not restrict access to EDi work areas for Federal regulators and key U.S. Army personnel.

Should EDi work areas be accessed without EDi authorization , or should visitors refuse to follow EDi direction while within areas that are under the radiological responsibility of EDi, then EDi will immediately stop work and notify CCAD personnel and, if necessary, initiate efforts to return the working area to CCAD control and responsibility.

COMMITMENTS

1. EDi and CCAD commit to the continued and on-going maintenance of a radiological safety program that fully meets regulatory requirements, license requirements, and generally accepted standards of professional conduct.

2. EDi commits to providing the CCAD the assistance necessary for the clean-up of temporary job sites under EDi control should any radiological accident occur.

ACCEPTANCE OF THE AGREEMENT

For Environmental Dimensions, inc.

Michael Marable	Michael C. Marable	9/5/08
Name	*Signature*	*Date*

For Corpus Christi Army Depot

Eduardo Perez	[signature]	16 Sep 08
Name	*Signature*	*Date*

ENVIRONMENTAL DIMENSIONS, inc.
710 S. Illinois Ave., Ste. F-105, Oak Ridge, TN 37830 • (865) 482-7789 • (FAX) (865) 482-7105

Section 1 – Acceptance by EDi Under License R-01103-C17

EDi Form No.: CCAD 2008-01

Task Description

Perform radiological characterization survey as defined in *Corpus Christi Army Depot Radiological Survey Plan* (SAIC and EDi, September 2008).

Decontaminate any areas exceeding Action Levels described in the Survey Plan.

Dispose of any properly characterized stored or created radioactive wastes.

Clearance survey to permit uncontrolled release of areas and to support termination of License STB-1168.

Work to commence on October 16, 2008.

Anticipated Termination: December 31, 2008.

Governing Work Documents

Corpus Christi Army Depot Radiological Survey Plan and referenced documents.

Client Representative Contacted	Method of Notification and Authorization
Eduardo Perez	SIGNATURE, CCAD RSO

EDi Approval to Accept

Name (Print)	*Signature*	*Date*

CCAD Follow-on Approval to Remit

EDUARDO PEREZ CCAD RSO	[signature] *Signature*	16 Sep 08 *Date*

Section 2 Remittance by EDi to the CCAD under License STB-1168

CCAD Representative Contacted	Method of Notification and Authorization
EDUARDO PEREZ CCAD RSO	SIGNATURE, CCAD RSO

EDi Approval to Remit

EDi Representative

Name (Print)	Signature	Date

Follow-on CCAD Approval to Accept

CCAD Representative

EDUARDO PEREZ	[signature]	10 Sep 08
CCAD RSO	*Signature*	*Date*

471956

ACCEPTANCE REVIEW MEMO (ARM)

Licensee:	Dept of the Army, (Corpus Christi)	**License No.:** STB-1168	
Docket No.:	040-08177	**Mail Control No.:** 471956	
Type of Action:	Decommissioning	**Date of Requested Action:** 09-27-08	
Reviewer Assigned:		**ARM reviewer(s):** Rachel	

Response	**Deficiencies Noted During Acceptance Review**
	[ ] Open ended possession limits. Submit inventory. Limit possession. [ ] Submit copies of latest leak test results. [ ] Add IC L.C./Fingerprint LC, add SUNSI markings to license. [ ] Confirm with licensee if they have NARM material.

Reviewer's Initials: __________ **Date:** __________

☐Yes ☐No Request for unrestricted release Group 2 or >. Consult with Bravo Branch.

☐Yes ☐No Termination request < 90 days from date of expiration

☐Yes ☐No Expedite (medical emergency, no RSO, location of use/storage not on license, RAM in possession not on license, other)

☐Yes ☐No TAR needed to complete action.

Branch Chief's and/or HP's Initials: ______________ **Date:** __________

(Decommissioning Final Status Survey Plan)

SUNSI Screening according to RIS 2005-31

☐Yes ☑No **Sensitive and Non-Publicly Available** if any item below is checked

General guidance:

______RAM = or > than Category 3 (Table 1, RIS 2005-31), use Unity Rule
______Exact location of RAM [suite #, bldg. #, location different from mailing address] (whether = or > than Category 3 or not)
______Design of structure and/or equipment (site specific)
______Information on nearby facilities
______~~Detailed design drawings and/or performance information~~
______Emergency planning and/or fire protection systems

Specific guidance for medical, industrial and academic (above Category 3):

______RAM quantities and inventory
______Manufacturer's name and model number of sealed sources & devices
______Site drawings with exact location of RAM, description of facility
______RAM security program information (locks, alarms, etc.)
______Emergency Plan specifics (routes to/from RAM, response to security events)
______Vulnerability/security assessment/accident-safety analysis/risk assess
______Mailing lists related to security response

Branch Chief's and/or HP's Initials: DBB **Date:** 11/7/08

(FOR LFMS USE)
INFORMATION FROM LTS

Program Code: 11800
Status Code: 0
Fee Category: 2C
Exp. Date: 20110228
Fee Comments: 2C IS THORIUM
Decom Fin Assur Reqd: N

BETWEEN:

License Fee Management Branch, ARM
and
Regional Licensing Sections

LICENSE FEE TRANSMITTAL

A. REGION

1. APPLICATION ATTACHED
   Applicant/Licensee: ARMY, DEPARTMENT OF THE
   Received Date: 20080930
   Docket No: 4008177
   Control No.: 471956
   License No.: STB-1168
   Action Type: Decommissioning

2. FEE ATTACHED
   Amount: /
   Check No.: /

3. COMMENTS

Signed Colleen Brenahan
Date 9-30-08

B. LICENSE FEE MANAGEMENT BRANCH (Check when milestone 03 is entered /__/)

1. Fee Category and Amount: ______________________

2. Correct Fee Paid. Application may be processed for:
   Amendment ________
   Renewal ________
   License ________

3. OTHER ______________________
   ____

Signed ______________________
Date ______________________