DEFENSE LOGISTICS AGENCY
DEFENSE NATIONAL STOCKPILE CENTER
8725 JOHN J. KINGMAN ROAD
FORT BELVOIR, VIRGINIA 22060-6223

IN REPLY REFER TO DNSC-ME

JUL 19 2007

U.S. Nuclear Regulatory Commission
Region 1, Nuclear Materials Safety Branch
Division of Nuclear Materials Safety
ATTN: Ms Betsy Ullrich
475 Allendale Road
King of Prussia, PA 19406-1415

SUBJECT: **Transmittal of Final Status Survey Plan (FSSP) for the Hammond Depot**

Dear Ms Ullrich:

The FSSP for the Defense National Stockpile Center depot at Hammond. IN. is enclosed for your review and approval. Please note that the plan delineates the application of a gross activity Derived Concentration Guideline Level (DCGL) per survey unit based upon approval of the request for radionuclide-specific DCGL's described in our letters of February 3, 2006, July 19, 2006 and January 12, 2007, and the Decommissioning/Remediation Plan described in our letters of September 29, 2006 and January 25, 2007.

Should you have any questions regarding this letter, please contact me. You may also call Mr. Tim Vitkus, CHP, at (865) 576-5073. Mr. Vitkus is the Senior Project Leader at the Oak Ridge Institute for Science and Education (ORISE), our decommissioning survey consultant.

Sincerely,

MICHAEL J. PECULLAN
Radiation Safety Officer

Attachment

ORISE
OAK RIDGE INSTITUTE FOR SCIENCE AND EDUCATION

July 12, 2007

Mr. Mike Pecullan
Defense Logistics Agency
Defense National Stockpile Center
8725 John J. Kingman Road, Suite 3229
Ft. Belvoir, VA 22060

SUBJECT: RADIOLOGICAL FINAL STATUS SURVEY PLAN FOR THE HAMMOND DEPOT, HAMMOND, INDIANA

Dear Mr. Pecullan:

The Oak Ridge Institute for Science and Education (ORISE) is providing the enclosed final status survey plan for the Defense Logistics Agency's Defense National Stockpile Center's Hammond Depot in Hammond, Indiana. Comments provided on the proposed plan have been incorporated.

Please contact me at 865.576.5073 or Sarah Roberts at 865.241.8893 should you require any additional information.

Sincerely,

Timothy J. Vitkus
Senior Project Leader
Health Physics and Training

TJV

Enclosure

c: B. Hermes, ORNL
E. Abelquist, ORISE
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P. O. Box 117
Oak Ridge, TN 37831

RADIOLOGICAL FINAL STATUS SURVEY PLAN
FOR THE
HAMMOND DEPOT
HAMMOND, INDIANA

Prepared by

T. J. Vitkus

Oak Ridge Institute for Science and Education
Oak Ridge, Tennessee 37831-0117

Prepared for the

Defense National Stockpile Center
Defense Logistics Agency

JULY 2007

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1.0 INTRODUCTION

1.1 OBJECTIVES

The objective of this final status (FSS) survey plan is to provide the site-specific data quality objectives (DQOs) and procedures that will be used in the planning and performance of the FSS at the Hammond Depot (HD) located in Hammond, Indiana. The implementation of this plan is intended to obtain the data necessary to demonstrate compliance with the site-specific derived concentration guideline levels (DCGLs) for both structural surfaces and outdoor areas (ORISE 2006a). The DCGLs were modeled such that any residual licensed material would not exceed the U.S. Nuclear Regulatory Commission's (NRC) basic dose limit for license termination of 25 mrem/y. Specifically, when the DCGLs are applied to the final status survey and the final survey results show that the DCGLs have been satisfied, the following requirements of 10 CFR 20.1402 are met:

> "**Title 10 CFR 20.1402:** *Radiological criteria for unrestricted use.* A site will be considered acceptable for unrestricted use if the residual radioactivity that is distinguishable from background radiation results in a TEDE to an average member of the critical group that does not exceed 25 mrem (0.25 mSv) per year, including that from groundwater sources of drinking water, and that the residual radioactivity has been reduced to levels that are as low as reasonably achievable (ALARA). Determination of the levels which are ALARA must take into account consideration of any detriments, such as deaths from transportation accidents, expected to potentially result from decontamination and waste disposal."

Inputs to the design of this plan were obtained through the performance of an historical site assessment (HSA), a scoping survey, and a detailed characterization survey (ORISE 2005a, 2005b and 2006b). Furthermore, the survey plans implemented for the scoping and characterization surveys were designed following the process detailed in this plan in order to satisfy the FSS DQOs for data quantity and quality such that some or all of the data generated for those areas of the site with little potential for residual contamination may be used as FSS data (ORISE 2005c and 2006c).

1.2 SITE HISTORY

In 1946, the National Stockpile program began with the goal of mitigating dependence on foreign sources of vital materials during times of national emergencies. The Hammond Depot in Hammond, Indiana was established as part of this program in 1948. The land area for the Hammond Depot originally consisted of approximately 130.5 acres of land leased on June 24, 1948 from the Indiana Harbor Belt Railroad Company. On June 27, 1969 the General Services Administration (GSA) purchased the entire site. The original site had eight warehouses and 80 above ground storage tanks. GSA sold portions of the property, including three warehouses, during the 1970s. The current site consists of 57.3 acres.

The Defense National Stockpile Center (DNSC) used the Hammond Depot to store strategic materials (bulk ores, minerals, and metals). The materials stored in outdoor piles either on the ground or on pads were chrome, ferrochrome, ferromanganese, lead, tin, and others.

Beginning in approximately 1958, additional stored materials included monazite sand comprised of 2.4 to 3.4% thorium dioxide (ThO_2) and bastnesite with 0.01 to 0.11% of ThO_2. Storage of thorium nitrate (reactor grade consisting of 46.0 to 47.15% by weight of ThO_2) began in 1962, followed by sodium sulfate, tantalum pentoxide, and columbium tantalum minerals in the 1980s. These latter materials contained from <0.001 to 0.053% and 0.012 to 0.156% by weight ThO_2 and uranium oxide, respectively. All of these materials were contained in fiber and steel drums and stored in warehouses. Some materials contained radioactive material at concentrations that required a U.S. Atomic Energy Commission (AEC)—predecessor to the U.S. Nuclear Regulatory Commission (NRC)—source material license (License STC-133).

The DNSC of the Defense Logistics Agency (DLA) is now in the process of closing out many of its depots across the country and seeking to terminate its NRC license for those facilities. In the early 1970s, warehouses (Warehouses 1, 2, and 3) where source or other materials were stored, were emptied and remediated and surveyed, if contaminated. These warehouses were then sold as excess property. All current site clean-up work at the HD is sponsored by the DNSC Thorium Nitrate Stewardship and Disposition Program – Phase 4 – Decontamination & Decommissioning and is being supported under the Department of Energy (DOE)-Oak Ridge Operations Work for Others Program. The project is supported and coordinated by the Oak Ridge National Laboratory (ORNL), per DOE Proposal Number # 1872-M171-A1. Removal of ThN source material from the site, Phase 3 of the project, was completed in fiscal year 2005, which completed the initial phase of the current cleanup activities by removing the remaining source material that had been stored within two of the current site warehouses. In conjunction with site cleanup, at the request of ORNL, the Oak Ridge Institute for Science and Education (ORISE) performed an HSA of the Hammond Depot in order to plan for future site investigations and eventual remediation activities (ORISE 2005a). Additionally, ORISE was tasked to conduct scoping and characterization surveys of the site to validate the results of the HSA and to provide radiological information for the development of a decontamination scope of work for areas of the site identified with excess residual radioactivity levels (ORISE 2005b and 2006b, ORNL 2006). These surveys were designed in an integrated, graded approach following the radiological survey guidance and data quality objective (DQO) process provided in the *Multi-Agency Radiation Survey and Site Investigation Manual* (MARSSIM) (NRC 2002).

1.3 SITE DESCRIPTION

The Hammond Depot site is located on the west side of Hammond, Indiana on Sheffield Avenue—about 500 feet east of the Indiana-Illinois state line. The 57 acre property currently consists of ten structures, mostly in good condition, including the three current warehouses used to store raw materials, and outdoor storage areas (Figure A-1). The depot is bounded on the east and southeast by the Indiana Harbor Belt railway, the Wolf Lake Industrial Center access road on the east, the Wolf Lake industrial/commercial complex on the north, Wolf Lake on the northern one-third of the western property boundary, and a drainage ditch on the west and southwest property boundary. A security fence encloses the facility. A number of road and railroad tracks provide access on the site. Drainage ditches on site direct surface runoff water to Wolf Lake.

The three current site warehouses are located in the central area of the site and are designated as Buildings 100W, 100E, and 200E. The dimensions of the three warehouses are each 126 feet by 401 feet (38 meters by 122 meters) and construction is cinder block walls on a concrete slab floor with steel beams, columns, and roof joists. Building 200E is divided by a cinder block wall into a northern and southern half. The southern half has been used for radioactive material storage and also has an asphalt overlayment covering the building floor where remediation was previously conducted. Building 100W was used for radioactive material storage with no history of any previous remedial activities. Building 100E had no history of radioactive material storage. For storage purposes, the interior of each warehouse was subdivided into 20 bay areas which correspond to the support column lines.

1.4 SUMMARY OF PRIOR SURVEY RESULTS

The contaminant of concern for the Hammond Depot is primarily thorium with the potential for lesser quantities of uranium. All scoping and characterization survey results for the northern half of Building 200E, Building 100W, and the majority of the exterior areas satisfied the $DCGL_W$s of 400 dpm/100 cm^2 for Th-232 surface activity or the soil $DCGL_W$s of 2.9 pCi/g and 2.5 pCi/g for Th-232 and U-238, respectively, and supported the initial survey classifications. However, the scoping and characterization surveys identified residual contamination within the southern half and a closet area on the northwest corner of Building 200E, and a localized area within Building 100E. Several site soil areas of concern (AOCs) were determined to be present over a broad area near the former Burn Cage area as well as several smaller AOCs that were also on the western portion of the site. The locations of each of these AOCs, together with the previously discussed contaminated buildings, are shown on Figure A-2.

1.5 PLANNED DECONTAMINATION ACTIVITIES

A detailed decontamination/remediation plan has been prepared and submitted to NRC for review and approval (ORISE 2006d). The information provided in this plan was used to develop the scope of work requirements to be followed by the decontamination and remediation contractor. The requirements of the scope of work are to remove contamination from structures using proven remedial technologies and the excavation of contaminated soils to levels that are below the $DCGL_W$s (ORNL 2006).

2.0 FINAL STATUS SURVEY QUALITY ASSURANCE

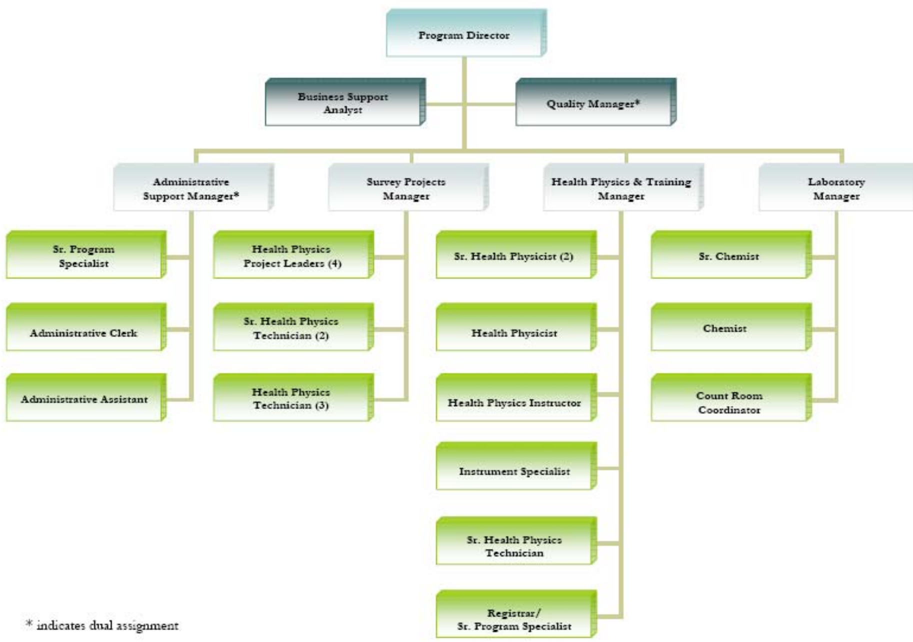
The FSS project responsibilities, training requirements, and quality assurance are described below.

2.1 Organization and Responsibility

ORISE conducts radiological survey activities as one of its core competencies through the Independent Environmental Assessment and Verification Program (IEAV). Figure 2-1 represents the generic organizational structure of the IEAV survey staff.

Detailed responsibilities for various staff positions are documented in Position Questionnaires, which have been developed for all employees. Additional detailed information regarding various staff position responsibilities is included in the IEAV Quality Assurance Manual (ORISE 2007a).

Figure 2-1: IEAV Organizational Chart



Work described in this FSS plan will be performed by the same technical team who were responsible for the FSS activities at the DNSC's Curtis Bay Depot. The technical team will be under the overall direction of Eric Abelquist, Program Director. Tim Vitkus, Sr. Project Leader will be responsible for planning activities, staff direction for the implementation of this plan, and interpretation and reporting of the results. Sarah Roberts, Acting Survey Projects Manager of ORISE, provides management of field staff and logistical support and direction. The cognizant ORISE site coordinator has the authority to make appropriate changes to the survey procedures as deemed necessary, after consultation with DNSC personnel. Site Coordinator is a generic title which applies to any individual designated as ORISE's representative and on-site supervisor. Any changes to the scope of this survey plan or procedures will be documented in the site logbook to include the technical basis for the change.

2.2 QUALITY ASSURANCE

The ORISE Survey Program conducts field surveys in a manner that assures the quality and accuracy of developed data and provides auditable documentation of activities. Details of the field quality assurance and quality control procedures are documented in the IEAV Quality Assurance Manual (2007a).

Quality control procedures include:

- Daily instrument background and check-source measurements to confirm that equipment operation is within acceptable statistical fluctuations.

- Laboratory participation in the Mixed Analyte Performance Evaluation Program (MAPEP), NIST Radiochemistry Intercomparison Program (NRIP), and Intercomparison Testing Program (ITP) Laboratory Quality Assurance Programs.

- Training and certification of all individuals performing procedures.

- Periodic internal and external audits.

2.3 CERTIFICATION TRAINING

New employee indoctrination and orientation training is conducted to provide new survey staff with basic information about IEAV survey activities. This initial training is followed by survey and quality assurance procedure training. The training consists of studying all applicable manual procedures, oral instruction, hands-on training, written testing, and demonstration of proficiency.

The veteran staff members participate in annual procedure refresher training and additional training when a procedure is revised or new procedure introduced.

In addition to survey and quality assurance procedure training, field personnel participate in training to satisfy regulatory requirements such Occupational Safety and Health Administration HAZWOPER and U.S. Department of Energy radiological worker, site-specific and generic safety, first aid and CPR, transportation, and other related requirements.

2.4 Control of Measurement Equipment

Radiological survey instruments are calibrated in accordance with IEAV Survey Procedures Manual requirements (ORISE 2006e). Procedures include electronic and NIST-traceable source calibration as well as daily operational check out requirements. Additional information on calibration and survey instrumentation is provided in Section 5.1.

2.5 Health and Safety

The project area has been evaluated for potential health and safety issues. Additionally, the proposed survey and sampling procedures are evaluated to ensure that any hazards inherent to the procedures themselves are addressed in current job hazard analyses (JHAs). The procedures entail minimal potential hazards that are addressed in current IEAV JHAs. FSS survey activities will be performed in accordance with the ORISE Radiation Protection Manual and radiation work permits as required (ORISE 2005d). Site remediation activities may result in the creation of additional hazards that are not currently specified in the programmatic JHAs, such as the excavations. Identification of previously unaddressed hazards that are not included in existing IEAV safety procedures will require development of task-specific JHAs prior to beginning work.

3.0 FINAL STATUS SURVEY REQUIREMENTS

There will be an FSS planned and conducted for each survey unit associated with the buildings and outdoor soil areas. The FSS plans are prepared in accordance with the guidance presented in MARSSIM. The plans follow the DQOs process and ensure that all buildings and land areas are surveyed with the necessary rigor that corresponds with a given building or land area contamination potential. The DQO process includes the following seven steps:

Step 1: State the problem
Step 2: Identify the decisions
Step 3: Identify inputs to the decisions
Step 4: Define the study boundaries
Step 5: Develop a decision rule
Step 6: Specify the decision errors
Step 7: Optimize the survey design

The following sections provide the requirements for the planning phase of the FSS including DCGLs, site classification and survey unit designations, survey planning parameters, instrumentation, measurement and sampling procedures, and the data quality assessments that will be implemented.

3.1 DERIVED CONCENTRATION GUIDELINE LEVELS

Th-232 and its associated decay products and U-238 and its associated decay products have been identified through process knowledge and characterization survey results as the contaminants of concern. The proposed site-specific $DCGL_W$s for both Th-232 and U-238 on building surfaces and within soils were developed using the RESRAD-BUILD and RESRAD computer codes (ORISE 2006a). These $DCGL_W$s have accounted for all important decay products found in secular equilibrium, including, the slight natural contribution from U-235 and its decay products. The above background $DCGL_W$s for structural surfaces are 400 dpm/100 cm^2 for Th-232 and its decay products and 800 dpm/100 cm^2 for U-238 and decay products. The building FSS planning and data quality assessment will use only the site-specific surface activity $DCGL_W$ for Th-232. Use of only the more restrictive Th-232 surface activity $DCGL_W$, rather than modifying the $DCGL_W$ to also account for any small percentage of natural uranium activity that may be present, will allow for simplification of the survey process yet provide an overall more conservative approach for determining remediation and FSS requirements. For soil area FSS planning, confirmation that U-238 is present in insignificant concentrations, relative to the Th-232, was achieved by evaluating the

Th-232 to U-238 ratios in scoping and characterization survey soil samples. Only those samples containing greater than 5 pCi/g of Th-232 were selected in determining the average net ratio which was approximately 11 to 1. Soil survey unit planning and data quality assessment will be compared with the above background $DCGL_W$s of 2.9 pCi/g for Th-232 and 2.5 pCi/g for U-238. In addition, FSS planning and data quality assessment (DQA) for soils will include an appropriate application of the unity rule in accordance with the equation:

$$\frac{Conc._{Th-232}}{DCGL_{Th-232}} + \frac{Conc._{U-238}}{DCGL_{U-238}} < 1$$

Lastly, the potential for the concentration of Th-230 from the raw materials into the ThN product was evaluated with no impact on the Th-232 or U-238 DCGLs.

3.2 CLASSIFICATION OF AREAS BY CONTAMINATION POTENTIAL

The HD site has been subdivided into three categories, based on contamination potential, as either Class 1, 2, or 3 in accordance with MARSSIM. A description of each is as follows:

Class 1: Buildings or land areas that have a significant potential for radioactive contamination (based on site operating history) or known contamination (based on previous radiological surveys) that exceeds the expected $DCGL_W$.

Class 2: Buildings or land areas, often contiguous to Class 1 areas, that have a potential for radioactive contamination but at levels less than the expected $DCGL_W$.

Class 3: Remaining buildings and land areas that are expected to contain little or no residual contamination based on site operating history or previous radiological surveys.

Furthermore, buildings and land areas have been or will be further subdivided into survey units, which will provide the fundamental unit for demonstrating compliance with the DCGLs. Survey unit size restrictions will generally follow the recommended size limitations provided in MARSSIM. With the exception of the southern section of Building 200E (Bays 1 through 10), the investigations of upper walls and overhead structures for all Class 2 and 3 building areas were determined to be non-impacted.

3.3 IDENTIFICATION OF SURVEY UNITS

All impacted buildings and land areas have been or will be subdivided into Class 1, 2, or 3 survey units. Each survey unit represents a portion of the site with similar contamination potential. Table 3-1 provides the MARSSIM-recommended survey unit areas.

Table 3-1: MARSSIM-Recommended Survey Unit Sizes

Class	Recommended Survey Area	
	Structures	Land Areas
1	Up to 100 m^2	Up to 2,000 m^2
2	100 to 1,000 m^2	2,000 to 10,000 m^2
3	No limit	No limit

3.3.1 Land Area Survey Unit Identification

Land area survey units for FSS have been identified and are illustrated on Figure A-3. There are five Class 3 land area survey units identified, 11 Class 2 land area survey units, and seven Class 1 land area survey units. The characterization surface scan surveys for the Class 2 and 3 areas were conducted such that the DQOs developed and procedures implemented would meet or exceed FSS requirements. The DQOs implemented are provided in Sections 3.6 and 4.0. The scoping and characterization data collected will be used for the DQO inputs for each Class 2 and 3 survey unit. In general, survey unit sizes will follow the MARSSIM guidance. Table B-2 provides land area survey unit designations, classifications, and areas.

3.3.2 Building Survey Unit Identification

The original building classifications are presented in Table B-1. Building survey units for FSS have also been identified and are listed in Table B-3. Buildings originally classified as Class 2 or 3 where contamination was identified during the scoping survey were reclassified, or a portion thereof, as Class 1. For the FSS phase, there are two buildings that will have at least one associated Class 1 survey unit. Of the remaining buildings areas, six survey units were surveyed during scoping/characterization as Class 2 and three as Class 3. The scoping surveys were designed and conducted in such a manner that the results for Class 2 and 3 building areas would meet FSS requirements. The DQOs implemented are provided in Sections 3.6 and 4.0. The characterization and remedial action support data collected from within building areas with Class 1 areas requiring remediation will be used for the DQO inputs to design the FSS.

3.4 BACKGROUND REFERENCE AREA AND MATERIALS

A background soil reference area was selected and sampled/measured for comparing site soil sample data to and in evaluation of the FSS data in accordance with the planned non-parametric Wilcoxon Rank Sum (WRS) statistical test that will be used for land area survey units. The original background reference area selected, and discussed in the characterization survey report, did not appropriately represent the geo-physical properties of the site as the ubiquitous surface slag backfill deposits were not evident (ORISE 2006b). Since the time of the characterization survey, a new background reference area has been identified that has not been impacted by site operations. This background reference area is shown on Figure A-3 and will be sampled during the FSS. The Th-232 and U-238 concentrations determined from the preliminary samples collected from this reference area will be used for FSS planning.

Structural survey units will be evaluated using the non-parametric Sign test. Construction material-specific backgrounds were determined during scoping surveys in areas of similar construction but without a history of radioactive material use. These construction material-specific measurements will be used to correct direct measurement for background contributions, prior to converting data to the DCGL compliance unit of dpm/100 cm^2.

3.5 REFERENCE SYSTEM

FSS measurement and sampling locations will be referenced as follows. Direct measurements on structural surfaces will be referenced to prominent building features, typically in meters from the southwest building corner, or the 5 meter × 5 meter reference grid established during scoping/characterization surveys. Soil sampling locations will be referenced to global positioning system (GPS) coordinates obtained using hand-held GPS units.

3.6 SURVEY DESIGN

Structural surfaces will be assessed by collecting the required number of gross beta surface activity measurements within each survey unit. The basis for assessing Th-232 surface activity levels via gross beta measurements is provided in Section 5.1.3. The Sign test will be applied as the non-parametric statistical test for demonstrating compliance with the $DCGL_W$. Land area compliance with the $DCGL_W$s is demonstrated through the application of the WRS test to soil sample results collected from each survey unit. Both Th-232 and U-238 activity concentrations are measured by gamma spectroscopy. Class 1 land area survey units are expected to have all soil removed that overlies the monolithic sub-surface slag layer discussed in the characterization report and remediation scope-of-work (ORISE 2006b and ORNL 2006). Therefore, both surface activity data and slag volumetric concentration data will be collected as the slag shares the characteristics of a structural surface yet is present within a soil environment. However, only the slag surface activity data will be used in the data quality assessment (DQA) phase. Slag volumetric data will be evaluated only to confirm the results of the characterization that contamination had not penetrated the slag surface. Data will be planned and evaluated for the two statistical tests.

The two statistical tests are performed to evaluate the survey unit mean concentration relative to the null hypothesis (H_0). Simply stated, H_0 is that the residual contamination in the survey unit exceeds the release criterion. Provided that the statistical test is satisfied at the desired confidence level, then H_0 is rejected and the alternate hypothesis (H_a), that residual contamination meets the release criterion, is accepted. The data needs for the statistical tests will be determined in accordance with the following processes.

3.6.1 Calculation of Required Number of Measurements

The relative shift (Δ/σ) is calculated for each survey unit where:

$$\Delta = \text{DCGL - LBGR}$$

DCGL = the gross or radionuclide specific guideline

LBGR = Lower Bound of the Gray Region; should be established as the estimated mean activity within the survey unit, but may be adjusted to maximize survey design

σ = variability in concentration where:

1) The larger variability between the survey unit, σ_s, and the background reference area, σ_r, is selected for the WRS test and;

2) The survey unit and construction material-specific background count rate errors are propagated for the Sign test.

The DQOs are evaluated for each survey unit or survey area and the decision errors selected. The Type 1 decision error—the probability of incorrectly rejecting H_0 when it is true—will be 0.05 and the Type II errors—the probability of incorrectly accepting H_0 when it is false— are expected to be 0.05 or 0.10. Once the above parameters are established, the number of data points required by the statistical test will be obtained either from Tables 5.3 (WRS test) or 5.5 (Sign test) in MARSSIM or otherwise generated using either COMPASS or Visual Sampling Plan (VSP) software. Tables B-4 and B-5 provide the estimated mean and standard deviation for the background and Class 2 and 3 land survey units. These results were determined from scoping and characterization survey data. Collection of remedial action support data will be required for determining the data needs for Class 1 land areas. The preliminary results for the new background reference area are provided in Table B-4. The preliminary σ given will be used in DQO development processes.

For building structural survey units, the mean activity and variability were estimated for Class 2 and 3 structures prior to the implementation of the scoping survey. These estimates were used to determine the number of direct measurements required to satisfy FSS requirements. Collection of remedial action support data, in conjunction with already acquired scoping/characterization survey data, will be required for determining the data needs for Class 1 structural survey units.

3.6.2 Determining Measurement/Sampling Locations

Measurement/sampling locations have been or will be established in either a random-start/systematic fashion for Class 1 and Class 2 survey units or at randomly generated locations for Class 3 survey units. Random start/systematic determinations will follow the recommended guidance using a triangular measurement or sampling pattern to increase the probability of identifying small areas of residual activity. The spacing (L) between data points on a triangular pattern is determined by:

$$L = [(\text{Survey Unit Area})/(0.866 \times \text{number of data points})]^{1/2}$$

The spacing between rows is calculated as: $0.866 \times L$

For land areas, a unique GPS coordinate location will be generated for each sample location. The VSP software application will be used in plotting sampling coordinates for both structures and soil areas.

4.0 INTEGRATED SURVEY STRATEGY

FSS data collected for structural surfaces consist of gamma and alpha plus beta or beta scans to identify locations of residual contamination and direct measurements of beta surface activity. Smear samples, although not used in the final data quality assessment, will be collected from judgmental locations to measure removable alpha and beta surface activity. Final status surveys of open land areas consist of gamma scans to identify locations of residual contamination and samples of soil, analyzed for potential contaminants. Additional judgmental measurements and samples will be obtained, as necessary, from locations where scans indicate potential residual contamination. Tables B-2 and B-3 provide survey unit information for land areas and buildings, respectively.

4.1 SURFACE SCANS

Surface scans have been or will be performed using NaI scintillation detectors for direct gamma radiation over land areas and structures and also gas proportional detectors for direct alpha plus beta or beta radiation for structures. The exposed, exterior monolithic slag surface will also be scanned for alpha plus beta radiation. Detectors are coupled to ratemeters or ratemeter-scalers with audible indicators. Characterization gamma surface scan data will also serve as the FSS data for those land areas that will not require remediation. Table 4-1 shows the recommended surface scan coverage discussed in MARSSIM.

Table 4-1: MARSSIM-Recommended FSS Survey Scan Coverage

Class	Structures	Land Areas
1	100%	100%
2	10 to 100% floors and lower walls 10 to 50% upper walls and ceilings	10 to 100%
3	Judgmental	Judgmental

4.1.1 Class 1 Land Area Survey Units

All Class 1 land survey areas were scanned 100% during characterization. These areas will be subdivided into survey units and scanned 100% following the completion of the remediation and satisfactory remedial action support surveys. Based on the characterization survey results demonstrating that contaminated soil extended to the slag interface, the decommissioning scope of work requires that all soil be removed from within contaminated zones to the slag monolith. The FSS exterior land area surface within remediated areas will therefore consist of the slag monolith surface, rather than soil.

4.1.2 Class 2 and 3 Land Area Survey Units

Class 2 and 3 land areas received high density gamma surface scans during the characterization survey. The overall gamma radiation scan coverage was virtually 100% of all accessible land areas. These data were discussed in the characterization survey report and will also satisfy the FSS requirements (ORISE 2006b). Additional FSS gamma surface scans will be performed in those Class 2 or 3 survey units that are contiguous with remediated Class 1 survey units.

4.1.3 Class 1 Building Survey Units

All Class 1 building surfaces were 100% scanned during characterization. These areas will be subdivided into survey units and scanned 100% for alpha plus beta or beta radiation following the completion of the remediation and satisfactory remedial action support surveys. Class 1 areas include portions of the floor, lower walls, and overhead surfaces of Bays 1 through 10 of Building 200E, the floor and lower wall of the northwest closet area of Building 200E, and two areas of the floor of Bays 15 through 20 of Building 100E. Building 100E was initially a Class 3 survey area. However, the identification of the contaminated pallets stored in the northern-most Bays 19 and 20 of the building resulted in reclassifying these bays and the contiguous Bays 15 through 18 used in the pallet segregation and disposal project. Additionally, the floor of the center sections of Bays 8 through 18 in Building 100W has been surveyed as a Class 1 area. The characterization survey of this portion of Building 100W satisfied the Class 1 FSS requirements and because no contamination was present, no additional surveys are required. The results were provided in the characterization report and will be further detailed in the FSS report.

4.1.4 Class 2 and 3 Building Survey Units

Building floors and lower walls were scanned for alpha plus beta, or beta, and gamma radiation during the scoping surveys. Additionally, the floor of Building 100W was rescanned during the characterization survey. The rescanning was necessary due to identified ambient gamma radiation background interference that resulted from the drums of tungsten that were present during the scoping survey but removed during the characterization phase. These scoping/chararacterization scans were conducted such that FSS scanning requirements were satisfied in all cases.

Twenty-five to 50% of accessible surfaces were systematically scanned during scoping surveys. Results of these scans as the survey progressed also resulted in the identification of additional areas for judgmental scanning. Upper walls, ceilings, and overhead structures were scanned with emphasis on horizontal surfaces where residual contamination may have settled and accumulated.

Characterization surface scans were performed over 100% of floor surfaces where anomalies were identified during the scoping surveys. Class 2 areas subject to expanded scan coverage included the eastern-most section of Bays 7 through 17 of Building 100W and Bays 15 through 20 of Building 100E. The remaining Class 2 survey units that will be addressed during the FSS include uncontaminated floor, wall, and overhead surfaces in Building 200E south, Bays 1 through 10.

Class 3 floors and lower walls were judgmentally scanned for alpha plus beta and gamma radiation during the scoping survey. Up to 25% of the accessible floor surfaces were scanned for direct gamma and alpha plus beta radiation. The remaining Class 3 area to be assessed during the FSS is the lower walls of Building 200E north, Bays 11 through 20.

The remaining site buildings consist of a Guard House, Pump House, Office Building, Garage Building, and a Contractor Maintenance Building that are considered as non-impacted structures. However, the interior lower surfaces of these structures will be surveyed as individual Class 3 survey units.

4.2 Soil Sampling and Surface Activity Measurements

FSS surface soil samples (0 to 0.15 m) will be collected from random-start/systematic or random locations dependent upon the survey unit classification. Additionally, judgmental samples have been or will be collected from locations where elevated direct gamma radiation is detected by surface scans. Soil samples are maintained under formal chain-of-custody procedures then analyzed in the IEAV laboratory by gamma spectroscopy and results reported in units of pCi/g.

FSS direct measurements to quantify total beta activity levels have been or will be performed at pre-determined random start/systematic or random locations as applicable. Additional judgmental measurements have been or will be made within any areas of residual contamination identified by surface scans and at contiguous locations to delineate contamination boundaries. Measurements will be made using gas proportional detectors coupled to ratemeter-scalers. Surface activity data will be converted to units of dpm/100 cm^2.

4.2.1 Class 1 Land Area Survey Units

The number of and specific locations for FSS surface activity measurements on outdoor slag surfaces or soil samples, as applicable, in Class 1 land area survey units will be determined in accordance with Sections 3.6.1 and 3.6.2. The specific DQO inputs will be derived from the remedial action support survey sample results. It is anticipated that a minimum of five surface activity measurements or soil samples will be collected from within each survey unit during remediation from which the mean concentration and variability will be determined. The seven Class 1 survey units are shown on Figure A-3.

4.2.2 Class 2 Land Area Survey Units

The number of FSS soil samples required for each Class 2 survey unit is provided in Table B-5. As previously discussed, the scoping survey sample results were used for generating the DQO inputs for Class 2 survey units. The number of samples required and locations is generated in accordance with Sections 3.6.1 and 3.6.2. Survey units are shown on Figure A-3.

4.2.3 Class 3 Land Area Survey Units

The number of FSS soil samples required for each of the five Class 3 survey units is provided in Table B-5. The same DQO inputs were used for the Class 3 survey units as used for the Class 2s. Survey units are shown on Figure A-3.

4.2.4 Class 1 Building Survey Units

Class 1 structural survey units are associated with Buildings 200E and 100E. The DQO inputs will be derived from the remedial action support survey measurement results for Building 200E and characterization results for the Class 1 area of Building 100E.

4.2.5 Class 2 Building Survey Units

FSS direct measurements of most Class 2 structural survey units were completed during the scoping survey phase. The DQO mean concentration and variability inputs for determining the number of direct measurements to satisfy FSS requirements were prospectively estimated. The actual data results were retrospectively reviewed to determine the adequacy of the estimated surface activity concentration. This planning followed the procedure described in Sections 3.6.1 and 3.6.2. The planning and retrospective values are provided in Tables B-6 and B-8. The results of the Sign test for these survey units will be provided in the FSS report. For those Class 2 survey units that are co-located with Class 1 areas requiring remediation and therefore have not had an FSS completed, the characterization data will provide the required mean concentration and variability inputs for the FSS design, provided these survey units are not impacted by remedial activities. Should the potential for cross-contamination occur, five to 10 ten post-remedial measurements will be collected from any impacted Class 2 survey unit and these data used to develop the DQO parameters. The original prospective parameters may be used in the event that their use results in a more rigorous FSS requirement.

4.2.6 Class 3 Building Survey Units

FSS direct measurements for most Class 3 structural survey units were completed during the scoping survey phase. The DQO mean concentration and variability inputs for determining the number of direct measurements to satisfy FSS requirements were prospectively estimated. These same parameters will be used in the DQO process for the remaining Class 3 units. The actual data results for the completed Class 3 survey units were retrospectively reviewed to determine the adequacy of the estimated surface activity concentration. This planning followed the procedure described in Sections 3.6.1 and 3.6.2. The planning and retrospective values are provided in Tables B-7 and B-9. The Sign test results for these survey units will be provided in the FSS report.

5.0 INSTRUMENTATION AND CALIBRATION

Calibration of all field and laboratory instrumentation will be based on standards/sources, traceable to NIST. Specific field and laboratory instrumentation parameters are discussed below.

5.1 FIELD INSTRUMENTATION

The following, or similar, survey instrumentation will be used during the FSS.

5.1.2 Scanning Instrument/Detector Combinations

Alpha plus Beta

Ludlum Floor Monitor Model 239-1 combined with Ludlum Ratemeter-Scaler Model 2221 coupled to Ludlum Gas Proportional Detector Model 43-37, Physical Area: 550 cm^2 (Ludlum Measurements, Inc., Sweetwater, TX), Minimum Detectable Concentration (MDC) = 300 dpm/100 cm^2 Th-232, based on a scanning total efficiency for the Th-232 decay series of approximately 1.50.

Beta

Ludlum Ratemeter-Scaler Model 2221 coupled to Ludlum Gas Proportional Detector Model 43-68, Physical Area: 126 cm^2 equipped with a 3.8 mg/cm^2 Mylar window (Ludlum Measurements, Inc., Sweetwater, TX) MDC = 800 dpm/100 cm^2 Th-232, based on a scanning total efficiency for the beta-only component of the Th-232 decay series of approximately 0.40.

The actual scanning MDC for the instrumentation will be compared with required scanning MDC determined at the time of final status survey plan development. Sample spacing will be adjusted if necessary to ensure that the actual scan MDC is less than the required scan MDC for each Class 1 survey unit.

Gamma

Ludlum Ratemeter Model 12 or Ludlum Ratemeter-Scaler Model 2221 (Ludlum Measurements, Inc., Sweetwater, TX) coupled to Victoreen sodium iodide (NaI) Scintillation Detector Model 489-55, Crystal: 3.2 cm x 3.8 cm (Victoreen, Cleveland, OH). MDC = 2.8 pCi/g Th-232 (assumes secular equilibrium with progeny in the decay series) and MDC = 4.5 pCi/g for U-238 (assumes secular equilibrium with the decay series).

Gamma Scan Data Capture

Ludlum Ratemeter-Scaler Model 2221 (Ludlum Measurements, Inc., Sweetwater, TX) coupled to Victoreen sodium iodide (NaI) Scintillation Detector Model 489-55, coupled to Trimble Navigation Pro-XRS Receiver and Data Logger (Trimble Navigation Limited, Sunnyvale, CA). The Trimble Navigation Receiver is also used to locate exterior sampling coordinates with an expected positional accuracy of ± <1 to 5 meters.

Based on characterization data demonstrating that U-238 concentrations from licensed material contamination exist as a mixture dominated by Th-232, a combined scan MDC for the mixture may be calculated from the observed fractional amounts. The observed Th-232:U-238 ratio averaged 11:1. The calculated scan MDC for the 11:1 activity ratio is calculated to be 2.89 pCi/g total activity and can be compared with the similarly calculated total activity DCGL of 2.77 pCi/g. The actual scanning MDC for the instrumentation will be compared with required scanning MDC for Class 1 survey units. Sample spacing will be adjusted if necessary to ensure that the actual scan MDC is less than the required scan MDC for each Class 1 survey unit.

5.1.3 Direct Measurement Instrument/Detector Combinations

Beta

Ludlum Ratemeter-Scaler Model 2221 coupled to Ludlum Gas Proportional Detector Model 43-68, Physical Area: 126 cm^2 (Ludlum Measurements, Inc., Sweetwater, TX). MDC = 200 dpm/100 cm^2 Th-232, based on the beta-only efficiency of approximately 0.42.

Use of only the more restrictive Th-232 surface activity $DCGL_W$, rather than modifying the $DCGL_W$ to also account for any small percentage of natural uranium activity that may be present, will allow for simplification of the survey process yet provide an overall more conservative approach for assessing surface activity levels. Therefore, the calibration of detectors used for assessing surface activity will be calibrated only for the Th-232 decay series. The calibration procedure will be in accordance with ISO-7503[1] recommendations. Total beta efficiencies (ε_{total}) will be determined for each instrument/detector combination and consist of the product of the 2π instrument efficiency (ε_i) and surface efficiency (ε_s): $\varepsilon_{total} = \varepsilon_i \times \varepsilon_s$. Beta total efficiencies will be determined based on a beta energy multi-point calibration, development of instrument efficiency to beta energy calibration curves, and the calculation of the weighted efficiency representing the Th-232 decay series. Included in the weighted efficiency will be an empirically determined correction for disequilibrium in the decay series that results from Rn-220 loss. A 3.8 mg/cm^2 density thickness Mylar window will be used on the beta detectors to block detector response contributions from alpha radiation.

ISO-7503 recommends an ε_s of 0.25 for beta emitters with a maximum energy of less than 0.4 MeV and an ε_s of 0.5 for maximum beta energies greater than 0.4 MeV. Figure A-4 illustrates an example multi-point calibration efficiency determination.

Direct measurement results will be reported in units of dpm/100 cm^2.

5.2 Laboratory Instrumentation

FSS samples will be analyzed in accordance with the ORISE Laboratory Procedures Manual (ORISE 2007b). Smear samples will be analyzed using a low-background proportional counter and results reported in units of dpm/100 cm^2. Soil samples will be analyzed by gamma spectroscopy and results reported in units of picocuries per gram (pCi/g).

5.2.1 Gross Alpha/Beta (Removable Activity)

Smear samples will be analyzed using the following equipment:

Low Background Gas Proportional Counter Model LB-5100-W (Tennelec/Canberra, Meriden, CT). MDCs = 9 dpm/100 cm^2 for alpha and 15 dpm/100 cm^2 for beta with a two-minute count time.

[1]International Standard. ISO 7503-1, Evaluation of Surface Contamination - Part 1: Beta-emitters (maximum beta energy greater than 0.15 MeV) and alpha-emitters. August 1, 1988.

5.2.2 Gamma Spectroscopy

Soil samples will be analyzed by gamma spectroscopy using the following equipment:

High Purity Extended Range Intrinsic Detector CANBERRA/Tennelec Model No: ERVDS30-25195 (Canberra, Meriden, CT) used in conjunction with Lead Shield Model G-11 (Nuclear Lead, Oak Ridge, TN) and Multichannel Analyzer DEC ALPHA Workstation (Canberra, Meriden, CT).

High Purity Extended Range Intrinsic Detector Model No. GMX-45200-5 (AMETEK/ORTEC, Oak Ridge, TN) used in conjunction with Lead Shield Model SPG-16-K8 (Nuclear Data) Multichannel Analyzer DEC ALPHA Workstation (Canberra, Meriden, CT).

High-Purity Germanium Detector Model GMX-30-P4, 30% Eff. (AMETEK/ORTEC, Oak Ridge, TN) used in conjunction with Lead Shield Model G-16 (Gamma Products, Palos Hills, IL) and Multichannel Analyzer DEC ALPHA Workstation (Canberra, Meriden, CT).

Gamma Spectroscopy MDC = 0.11 pCi/g for Th-232 (based on the 0.911 MeV photopeak from Ac-228) and 0.70 pCi/g for U-238 (based on the 0.063 MeV photopeak from Th-234) based on a 60-minute count time.

6.0 DATA REVIEW AND INVESTIGATION THRESHOLDS

Data will be reviewed to assure that the type, quantity, and quality are consistent with the survey plan and design assumptions. Data standard deviations will be compared with the assumptions made in establishing the number of data points. Individual and average data values will be compared with guideline values and proper survey area classifications will be confirmed. Individual measurements in excess of the guideline level for Class 1 and 2 areas have been or will be investigated. For Class 3 survey units, although less conservative than the recommendation provided in MARSSIM, measurements in excess of 75 percent of the guideline for Class 3 areas have or will prompt investigation. The requirement for increasing the investigation threshold is due to the low DCGLs relative to background. Should a survey unit require investigation, reclassification, remediation, and/or resurvey, a determination of the cause will be initiated and the data conversion and assessment process repeated for new data sets. Additional information regarding the evaluation of measurement results in excess of the DCGLs is provided in Section 7.3.

7.0 DETERMINING COMPLIANCE WITH DCGLs

As discussed in Section 3.1 both soil concentration and surface activity DCGLs have been developed with which FSS data will be compared. These DCGLs include both the mean concentrations ($DCGL_W$) and also provide for small areas of elevated contamination in excess of the $DCGL_W$, the $DCGL_{EMC}$. Compliance demonstration with both requirements for each survey unit is discussed below.

7.1 LAND AREA SURVEY UNITS

Land area survey units will be evaluated using the Wilcoxon Rank Sum test. Survey unit and background reference area soil sample results collected from the random or random-start/systematic locations will be converted to unity in accordance with the equation in Section 3.1. The DCGL in this case is also established as 1. The reference area results will then be adjusted by adding the DCGL to the unity concentration value. The results for both data sets are then ranked as follows:

- Rank all (survey unit and reference area) measurements in order of increasing size from 1 to N, where N is the total number of pooled measurements.

- If several measurements have the same value, assign them the average ranking of the group of tied measurements.

- Sum the ranks of the adjusted reference area measurements; this value is the test statistic, W_R.

- Compare the value of W_R to the critical value in MARSSIM Table I.4 for the appropriate sample size and decision level.

Prior to applying the test, if the difference between the largest survey unit result and the smallest reference area result is less than the DCGL, the survey unit will always pass a complete application of the WRS test. No further evaluation is necessary as the survey unit will always pass the WRS test and the null hypothesis rejected. Otherwise, W_R must be calculated. If W_R is greater than the critical value, H_0 is rejected, and the survey unit meets the established criteria. If W_R is less than or equal to the critical value, H_0 is not rejected, and the survey unit does not meet the established criteria; investigation, remediation, reclassification, and/or resurvey should be performed as appropriate.

7.2 BUILDING SURVEY UNITS

Structural survey units will be evaluated using the Sign test. Individual activity values and the average activity value will be calculated.

If all values from the random or random-start/systematic locations for a survey unit are less than the guideline level, the survey unit satisfies the criterion and no further evaluation is necessary.

If the average activity value is greater than the guideline, the survey unit does not satisfy the criterion, and further investigation, possible reclassification, remediation, and/or resurvey is required.

If the average activity value is less than the guideline level, but some individual values are greater than the guideline, data evaluation by the Sign test proceeds, as follows:

- List each of the survey unit measurements.
- Subtract each measurement from the guideline level.
- Discard all differences which are "0"; determine a revised sample size.
- Count the number of positive differences; this value is the test statistic, S+.
- Compare the value of S+ to the critical value in MARSSIM Table I.3 for the appropriate sample size and decision level.

If S+ is greater than the critical value, H_0 is rejected, and the survey unit meets the established criteria. If S+ is less than or equal to the critical value, H_0 is not rejected, and the survey unit does not meet the established criteria; investigation, remediation, reclassification, and/or resurvey should be performed, as appropriate.

7.3 ELEVATED MEASUREMENT COMPARISON

Soil samples or direct measurement results that exceed the $DCGL_W$ must also be evaluated for compliance with a $DCGL_{EMC}$. The remediation scope of work requires that contamination be reduced to levels that are below the $DCGL_W$ and remedial action support surveys will be performed as assurance that this requirement is met (ORNL 2006). However because contamination is present prior to remediation in a Class 1 survey unit, the potential also exists that isolated locations of residual soil concentrations or surface activity may be identified during the FSS that exceed the $DCGL_W$. The statistical tests for demonstrating compliance are such that some samples/measurements may exceed the $DCGL_W$, yet still reject the null hypothesis. Therefore, both the statistically-based and judgmental samples exceeding the $DCGL_W$ by a predetermined threshold must be compared with a $DCGL_{EMC}$ that corresponds with the size of a given area of elevated activity—defined as the $DCGL_W \times$ Area Factor. The concentration threshold for soil samples from Class 1 survey units that would require an EMC comparison will be when the summed net concentration of Th-232 and U-238 exceeds the unity rule $DCGL_W$ of 1. For Class 1 surfaces, the corresponding threshold would be the surface activity $DCGL_W$, in terms of counts per minute, plus the sum of the mean construction material-specific background count rate and two standard deviations. Tables B-10 and B-11 provide area factors for both soil concentrations and surface activity. Area factors were developed using the identical inputs used in generating the site-specific $DCGL_W$s with only the size of the area of contamination changed and for soil, the length parallel to the aquifer flow. When individual samples/measurements with elevated concentrations are less than the respective $DCGL_{EMC}$ the impact of multiple hot spots on the mean concentration in a survey unit must also be evaluated. This will be performed using equation 8-2 in MARSSIM. Any measurement that exceeds the $DCGL_W$ within a Class 2 or 3 survey unit will be investigated as discussed in Section 6.0 and may require reclassification of the survey unit.

8.0 REPORTING

The results of the FSS will be compiled into a detailed report that will be submitted to the NRC for review. The contents of the report will provide all applicable data and documentation necessary to support the request for removal of the Hammond Depot from the DNSC's NRC license

9.0 TENTATIVE SCHEDULE

The FSS schedule will be dependent upon the progress and schedule of the remediation contractor. The current anticipated schedule is as follows:

Measurement and Sampling	August through October 2007
Sample Analysis	August through October 2007
Draft Report	Within six weeks of completing the sample analyses

APPENDIX A:

FIGURES

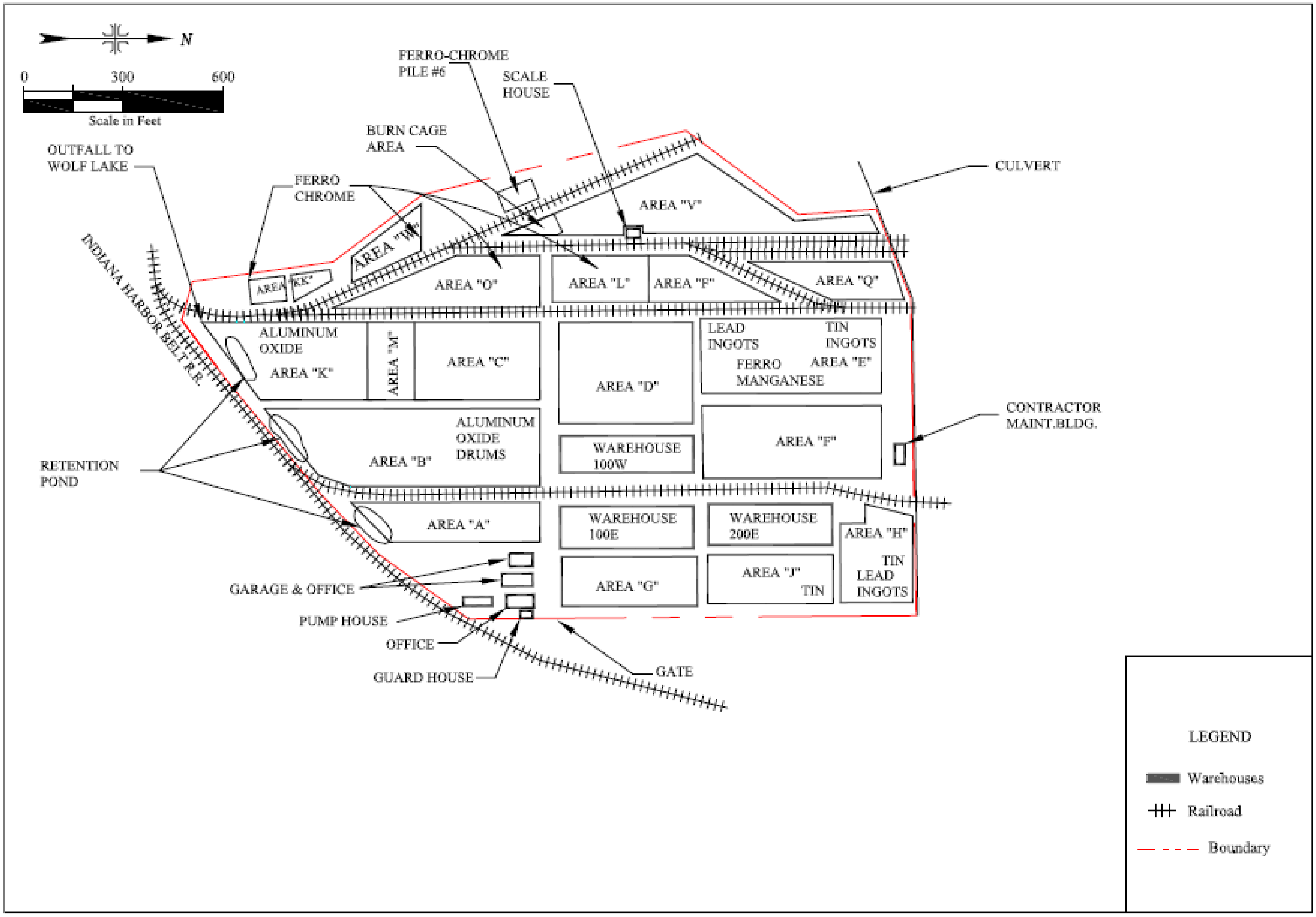


Figure A-1: Hammond Depot, Hammond, Indiana—Plot Plan

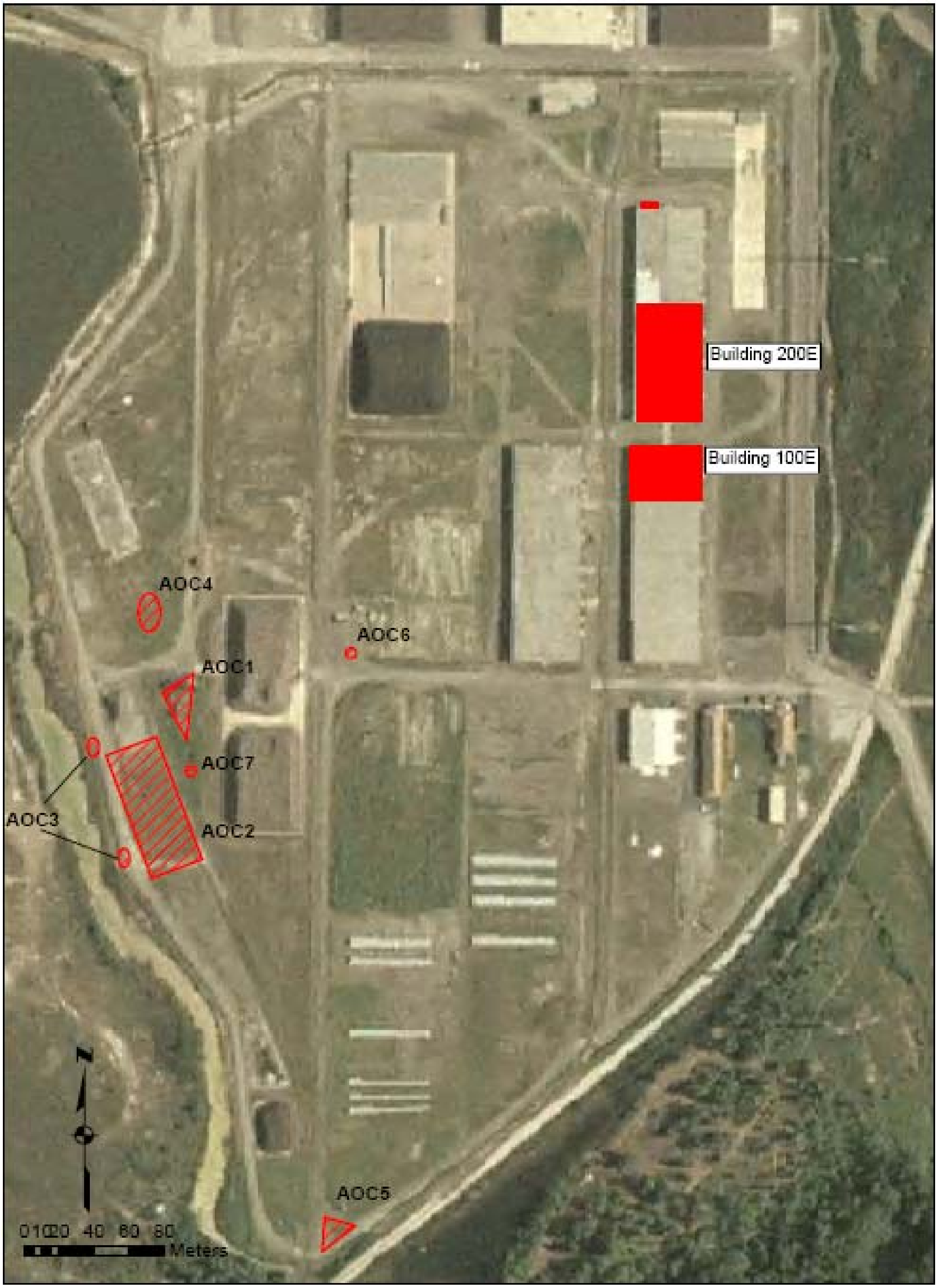


Figure A-2: Hammond Depot—Contaminated Buildings and Soil AOCs

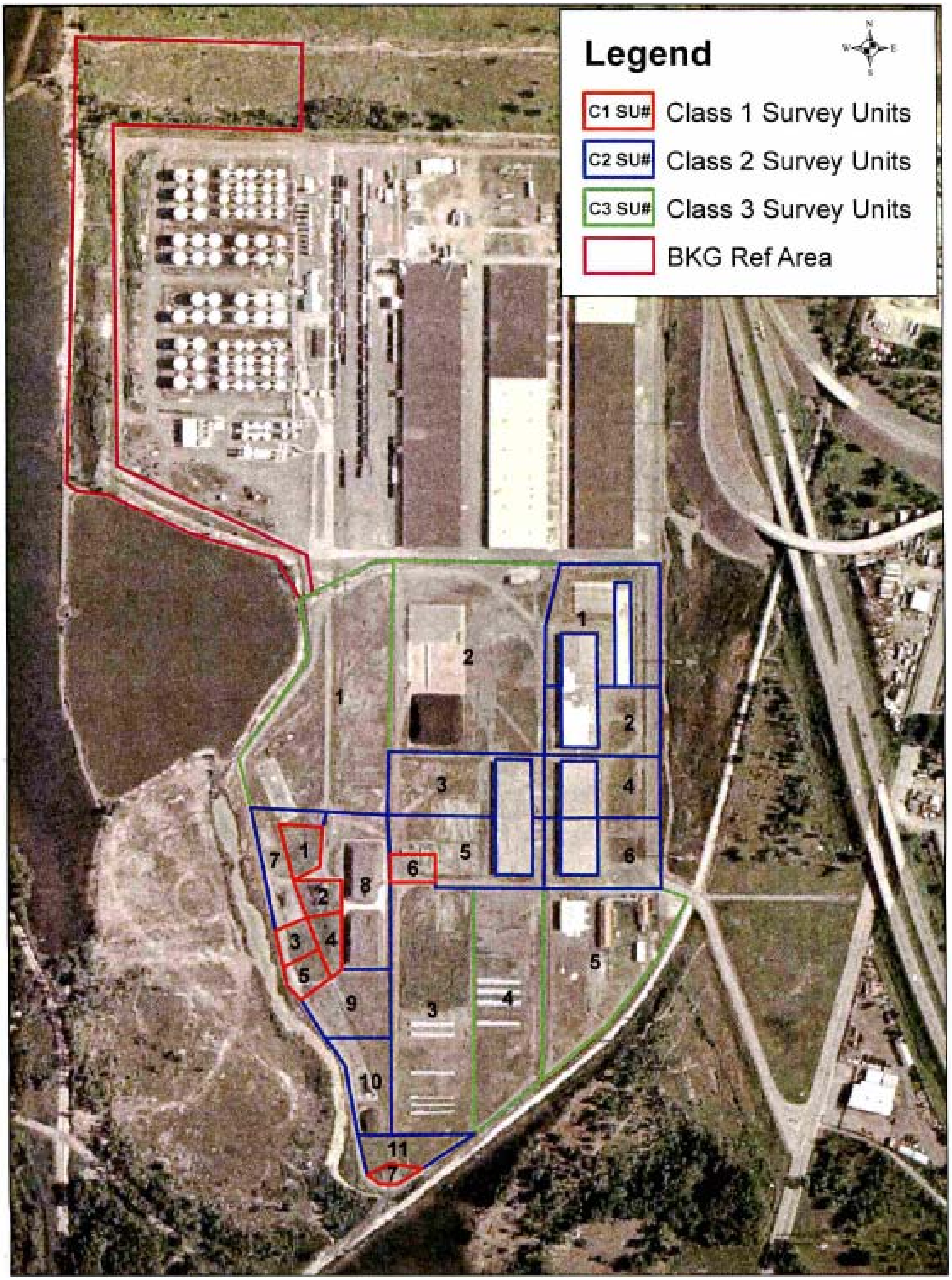


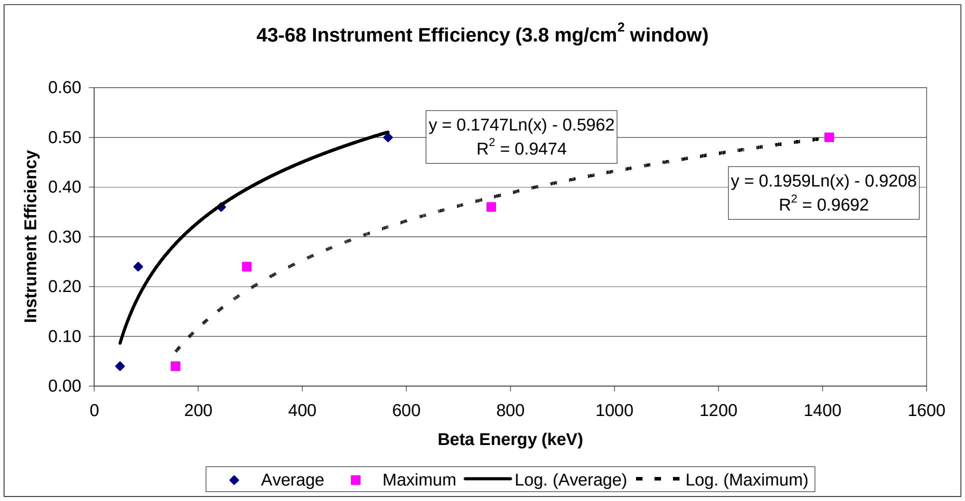
Figure A-3: Hammond Depot—Land Area FSS Survey Units (#Survey Unit ID)

Th-232 Decay Series Gas Proportional Detector Calibration Worksheet

Task Number:	0432	Hammond Depot	Characterization	Data Entry

Instrument:	2221 #30	
Detector:	43-68 #30	(3.8 mg/cm^2 window)
Cal. BKG Avg (cpm):	374	

Calibration Data			
Radionuclide	**Average Beta Energy (keV)[1]**	**Maximum Beta Energy (keV)[1]**	**Instrument Efficiency**
C-14	49.74	156.5	0.04
Tc-99	84.6	293.5	0.24
Tl-204	244.03	763.4	0.36
Sr/Y-90	564.75	1413.05	0.50



Th-232 Decay Series Calculation[2]					
Radionuclide	**Average Beta Energy (keV)[1]**	**Fraction**	**Instrument Efficiency[3]**	**Surface Efficiency**	**Weighted Efficiency**
Th-232	alpha	1	0.00	0.25	0.00
Ra-228	7.2	1	0.00	0.00	0.00
Ac-228	377	0.93	0.44	0.50	0.20
Th-228	alpha	1	0.00	0.25	0.00
Ra-224	alpha	1	0.00	0.25	0.00
Rn-220	alpha	0.75	0.00	0.25	0.00
Po-216	alpha	0.75	0.00	0.25	0.00
Pb-212	102	0.751	0.21	0.25	0.04
Bi-212	770	0.307	0.56	0.50	0.09
Bi-212	alpha	0.27	0.00	0.25	0.00
Po-212	alpha	0.48	0.00	0.25	0.00
Tl-208	557	0.268	0.51	0.50	0.07
			Total Efficiency:		0.40
			Static MDC (dpm/100 cm^2):		185

[1] http://atom.kaeri.re.kr/ton/
[2] Refer to Table 14.2 of *Decommissioning Health Physics: A Handbook for MARSSIM Users*. E W Abelquist, 2001. Fractions adjusted to account for Rn-220 loss.
[3] Calculated using exponential curve shown above for average beta energy

Figure A-4: Example Instrument Calibration Efficiency Determination

APPENDIX B:

TABLES

Table B-1: Building Information Hammond Depot, Hammond, Indiana		
Building ID/Area	**History of Radioactive Material Use**	**HSA/Scoping Survey Classification**
Building 100E, Bays 1 through 15/F & LW[a]	None	Class 3
Building 100E/US[b]	None	Class 3/Non-impacted
Building 200E, Bays 1 through 10/F & LW	ThN[c], monazite, sodium sulfate	Class 1
Building 200E, Bays 1 through 10/US	ThN[c], monazite, sodium sulfate	Class 1
Building 200E, Bays 11 through 20/F & LW	None	Class 2
Building 200E, Bays 11 through 20/US	None	Class 3/Non-impacted
Building 100W, Bays 8 through 18/F & LW	ThN, columbium tantalum, Ta_2O_5[d], sodium sulfate, monazite	Class 1
Building 100W Bays 8 through 18/US	None	Class 3
Building 100W, Bays 1 through 7, 19, 20/F & LW	None	Class 2
Building 100W, Bays 1 through 7, 19, 20/US	None	Class 3/ Non-impacted

[a]F & LW = Floors and Lower Walls
[b]US = Upper Surfaces
[c]ThN = Thorium Nitrate
[d] Ta_2O_5 = Tantalum Pentoxide

Table B-2: Hammond Depot Land Area Survey Unit Identification			
SURVEY UNIT	**CLASS**	**AREA**	**REMARKS**
Class 1 Survey Units (C1 SU#)			
C1 SU 1	1	2,271 m^2	AOC 4
C1 SU 2	1	2,671 m^2	AOC 1
C1 SU 3	1	1,743 m^2	AOC 2 and 3
C1 SU 4	1	2,115 m^2	AOC 7
C1 SU 5	1	2,601 m^2	AOC 2 and 3
C1 SU 6	1	2,513 m^2	AOC 6
C1 SU 7	1	1,575 m^2	AOC 5
Class 2 Survey Units (C2 SU#)			
C2 SU 1	2	11,489 m^2	---
C2 SU 2	2	6,476 m^2	---
C2 SU 3	2	8,947 m^2	---
C2 SU 4	2	5,864 m^2	---
C2 SU 5	2	8,522 m^2	---
C2 SU 6	2	6,970 m^2	---
C2 SU 7	2	4,559 m^2	---
C2 SU 8	2	10,301 m^2	---
C2 SU 9	2	5,893 m^2	---
C2 SU 10	2	4,974 m^2	---
C2 SU 11	2	3,289 m^2	---
C2 SU 12	2	TBD	Burn Cage Area Debris Pile
Class 3 Survey Units (C3 SU#)			
C3 SU 1	3	30,338 m^2	---
C3 SU 2	3	34,296 m^2	---
C3 SU 3	3	23,844 m^2	---
C3 SU 4	3	17,561 m^2	---
C3 SU 5	3	19,216 m^2	---

Table B-3: Hammond Depot Building Survey Unit Identification			
Building/Survey Unit	**CLASS**	**AREA**	**REMARKS**
Building 200E South (Bays 1 through 10)			
C1 SU 1	1	100 m^2	Floor
C1 SU 2	1	100 m^2	Floor
C1 SU 3	1	100 m^2	Floor
C1 SU 4	1	100 m^2	Floor
C1 SU 5	1	100 m^2	Floor
C1 SU 6	1	100 m^2	Floor
C1 SU 7	1	100 m^2	Floor
C1 SU 8	1	100 m^2	Floor
C1 SU 9	1	100 m^2	Floor
C1 SU 10	1	100 m^2	Floor
C1 SU 11	1	100 m^2	Floor
C1 SU 12	1	100 m^2	Floor
C1 SU 13	1	100 m^2	Floor
C1 SU 14	1	100 m^2	Floor
C1 SU 15	1	33 m^2	Bay 10, Sect. 5 N. Wall
C1 SU 16	1	50 m^2	Bays 4, 5 W. Wall
C1 SU 17	1	100 m^2	Overheads
C1 SU 18	1	100 m^2	Overheads
C2 SU 19	1	100 m^2	Overheads
C1 SU 20	1	100 m^2	Overheads
C1 SU 21	1	100 m^2	Overheads
C1 SU 22	1	100 m^2	Overheads
C1 SU 23	1	100 m^2	Overheads
C1 SU 24	1	100 m^2	Overheads
C1 SU 25	1	100 m^2	Overheads
C1 SU 26	1	100 m^2	Overheads
C1 SU 27	1	100 m^2	Overheads
C1 SU 28	1	100 m^2	Overheads
C1 SU 29	1	100 m^2	Overheads
C2 SU 30	2	450 m^2	Floor, Bays 1-6
C2 SU 31	2	375 m^2	Floor, Bays 7-10
C2 SU 32	2	251 m^2	S. Wall and W. Wall Bays 1-3
C2 SU 33	2	266 m^2	W. Wall Bay 6-10 and N. Wall Sections 1-4
C2 SU 34	2	281 m^2	East Wall
C2 SU 35	2	545 m^2	Overheads, Bays 1-2.5
C2 SU 36	2	545 m^2	Overheads, Bays 2.5-5

Table B-3 (cont.): Hammond Depot Building Survey Unit Identification			
Building/Survey Unit	**CLASS**	**AREA**	**REMARKS**
Building 200E North (Bays 11 through 20)			
C2 SU 37	2	1,173 m^2	Floor/FSS Complete
C2 SU 38	2	1,173 m^2	Floor/FSS Complete
C3 SU 39	3	901 m^2	Walls
C3 SU 40	3	2,350 m^2	Ceiling/FSS Complete
Building 200E Locker Room/Closet			
C1 SU41	1	12 m^2	Closet
C2 SU42	2	64 m^2	Locker Room F/LW/ FSS Complete
Building 100E			
C1 SU43	1	94 m^2	Floor, Bay 16
C1 SU44	1	94 m^2	Floor, Bay 17
C2 SU45	2	1,090 m^2	Floor, Bays 15-20
C2 SU46	2	663 m^2	Walls, Bays 15-20
C3 SU47	3	1,278 m^2	Ceiling, Bays 15-20
C3 SU48	3	7,400 m^2	All Surfaces, Bays 1-14/FSS Complete
Building 100W			
C2 SU 49	2	1,750 m^2	Floor, Bays 7-17/FSS Complete
C2 SU 50	2	2,100 m^2	Floor and Wall, Bays 1-10/ FSS Complete
C2 SU 51	2	2,100 m^2	Floor and Wall, Bay 11-20/ FSS Complete
C3 SU 52	3	4,514 m^2	Ceiling/FSS Complete

Table B-4: Hammond Depot
Estimated Background

Background Data		
Sample ID	Th-232	U-238
0432S0118	0.99	2.41
0432S0119	0.81	2.08
0432S0120	1.00	3.17
0432S0121	0.58	0.75
0432S0122	0.44	1.23
0432S0123	0.82	2.26
0432S0124	0.77	2.29
0432S0125	1.02	1.96
0432S0126	0.94	2.55
Mean	0.82	2.08
Sigma	0.20	0.72

Unity Sigma=0.37

Table B-5: Hammond Depot
Class 2 and 3 Land Area Planning Inputs

Class 2 and 3 FSS Planning					
Sample ID	Th-232	Est Net	U-238	Est Net	Unity
0432S0001	0.96	0.14	1.95	-0.13	0.00
0432S0002	0.89	0.07	2.24	0.16	0.09
0432S0003	1.20	0.38	2.89	0.81	0.46
0432S0004	0.84	0.02	2.03	-0.05	-0.01
0432S0005	0.88	0.06	1.34	-0.74	-0.28
0432S0006	2.05	1.23	4.00	1.92	1.19
0432S0007	2.47	1.65	3.92	1.84	1.30
0432S0008	1.35	0.53	2.35	0.27	0.29
0432S0009	1.41	0.59	2.48	0.40	0.36
0432S0010	1.56	0.74	1.44	-0.64	0.00
0432S0011	1.34	0.52	2.77	0.69	0.46
0432S0012	1.09	0.27	4.20	2.12	0.94
0432S0013	1.10	0.28	2.90	0.82	0.42
0432S0014	0.96	0.14	2.61	0.53	0.26
DCGLs	2.90		2.50		
Mean	1.29	0.47	2.65	0.57	0.39
Sigma	0.47	0.47	0.89	0.89	0.39
$\Delta/\sigma = 1.56$	$\alpha = 0.05$ $\beta = 0.05$		$N/2 = 18$		

Table B-6: Class 2 Building Prospective Survey Unit Planning

Class 2 Structural Survey Units		
Th-232		
DCGL	400 dpm/100^2	210 cpm
Mean		120 cpm
Sigma		63 cpm
$\Delta/\sigma = 1.4$	$\alpha = 0.05$ $\beta = 0.05$	N = 20

Table B-7: Class 3 Building Prospective Survey Unit Planning

Class 3 Structural Survey Units		
Th-232		
DCGLs	400 dpm/100^2	210 cpm
Mean		120 cpm
Sigma		42 cpm
$\Delta/\sigma = 3$	$\alpha = 0.05$ $\beta = 0.05$	N = 15

Table B-8: Class 2 Building Retrospective Survey Unit Planning

Class 2 Structural Survey Units		
Th-232		
DCGL	400 dpm/100^2	210 cpm
Mean		56 cpm[a]
Sigma		62 cpm[a]
$\Delta/\sigma = 2.5$	$\alpha = 0.05$ $\beta = 0.05$	N = 15

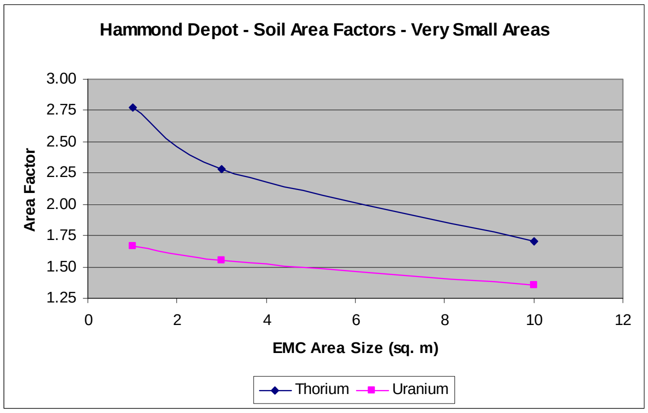
Table B-9: Class 3 Building Retrospective Survey Unit Planning

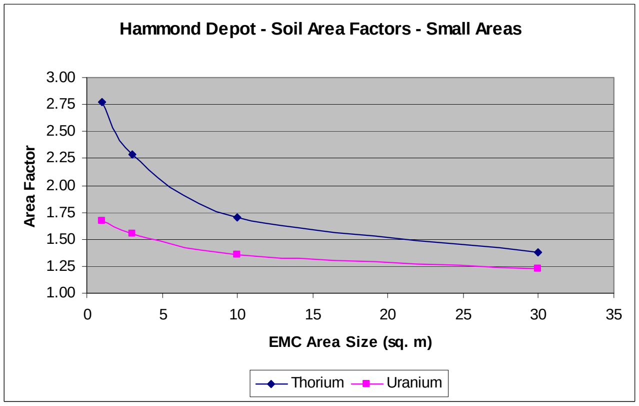
Class 3 Structural Survey Units		
Th-232		
DCGLs	400 dpm/100^2	210 cpm
Mean		20 cpm[a]
Sigma		56 cpm[a]
$\Delta/\sigma = 3.4$	$\alpha = 0.05$ $\beta = 0.05$	N = 14

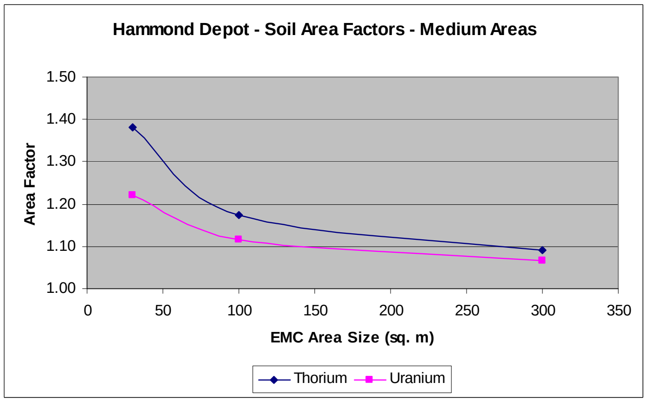
[a]Mean and sigma values shown are the maximum retrospective values from scoping survey results for the respective building classification.

Table B-10: Hammond Depot
Soil Area Factors

Soil Area Factors	Area Size (square meters)								
	10000	3000	1000	300	100	30	10	3	1
Thorium	1.00	1.02	1.03	1.09	1.17	1.38	1.70	2.28	2.77
Uranium	1.00	1.01	1.02	1.07	1.11	1.22	1.36	1.55	1.67







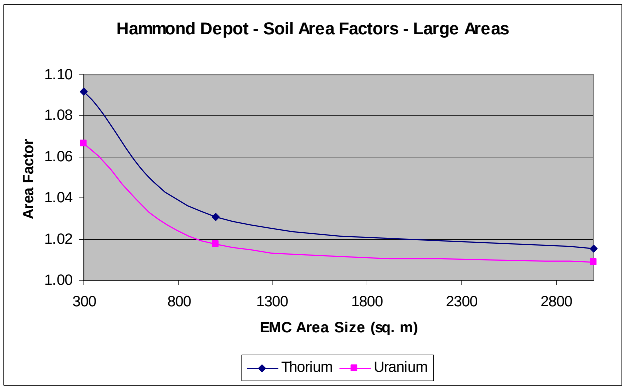
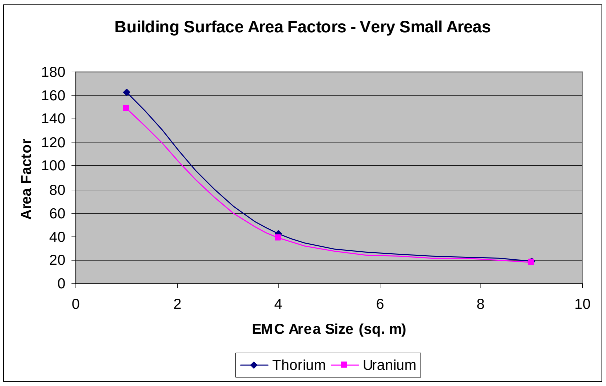
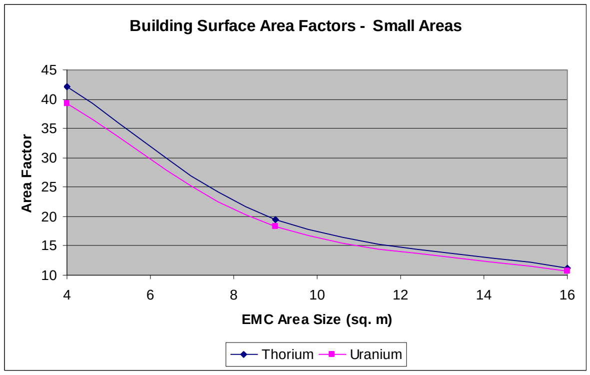
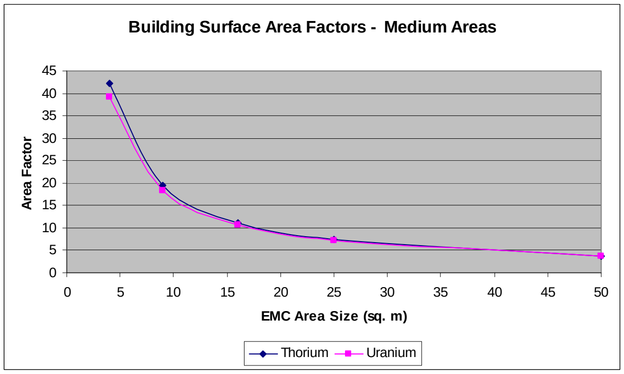


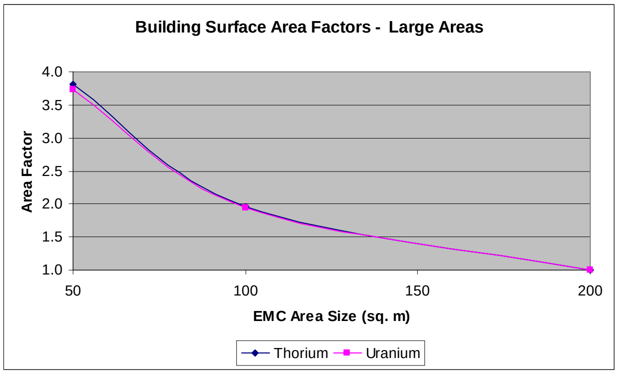
Table B-11: Hammond Depot
Structural Surface Area Factors

Building Area Factors	Area Size (square meters)							
	200	100	50	25	16	9	4	1
Thorium	1.00	1.96	3.82	7.40	11.24	19.41	42.15	162.56
Uranium	1.00	1.94	3.74	7.15	10.75	18.32	39.19	149.08









APPENDIX C:
REFERENCES

REFERENCES

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