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**MAD** Remedial Investigation  
Documentation and  
Feasibility Study: Final  
Radiological Survey Work

**ADMINISTRATIVE RECORD  
FOR THE MADISON SITE  
MADISON, ILLINOIS**

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**Remedial Investigation Documentation and  
Feasibility Study-**

Radiological Survey Work Plan - Addendum  
Spectrulite Consortium, Inc. Facility

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**US Army Corps  
of Engineers**  
St. Louis District®

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**FINAL**  
**USACE/OR/DACA62-1048**

**RADIOLOGICAL SURVEY WORK PLAN-  
ADDENDUM**

**SPECTRULITE CONSORTIUM, INC. FACILITY**

**MADISON, ILLINOIS**

**NOVEMBER 1998**

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prepared by  
U.S. Army Corps of Engineers, St. Louis District Office, Formerly Utilized Sites Remedial Action Program

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GTS Duratek

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## 1.0 PURPOSE AND SCOPE

The purpose of this Work Plan Addendum is to provide a framework for guiding survey activities at the Spectrulite facility. The survey described here is to evaluate the current radiological conditions of the Spectrulite Consortium, Inc. facility in Madison, IL. Evaluation will be limited to Buildings 4 and 6 for radiological contaminants of concern (natural uranium). The survey will also include measurements in non-impacted site buildings to establish reference areas for the survey data analyses. The scope of the survey will include the following.

- A gamma dose rate survey of the twenty-three (23) door openings leading from Buildings 4 and 6.
- Investigate total beta survey measurements at five (5) locations in Class II areas.
- Investigate total beta survey measurements at two (2) locations in Class III areas.
- Collect total beta measurements in reference areas.
- Collect gamma dose rate measurements in reference areas.

The survey will, combined with data from the original survey, determine whether there is residual uranium in the facility from previous AEC operations. Levels and extent of uranium contamination, if any, will be determined and compared with decontamination guidelines of the State of Illinois, Department of Nuclear Safety.

*Note: This Work Plan Addendum describes the radiological survey activities; associated health and safety requirements are addressed in Appendix A of the original Work Plan. Quality assurance aspects of the survey (beyond those, which are integral with the certain survey methodologies) are not addressed in this Addendum.*

## 2.0 ORGANIZATION AND RESPONSIBILITIES

Science Application International Corporation (SAIC) is responsible for implementation of the survey work plan. The Project Manager for this survey is Mr. J. R. Moos. GTS Duratek has been contracted by SAIC to provide the personnel, instrumentation, and supporting procedures to perform the survey. Mr. D. M. Hall of GTS Duratek will be the Site Survey Supervisor, Site Safety and Health Officer and Project Health Physicist for this survey.

## 3.0 RADIOLOGICAL CONTAMINANT

The radiological contaminant of concern is processed natural uranium.

## 4.0 SURVEY OBJECTIVES

### 4.1 GENERAL

The primary purpose of this survey is to investigate areas where elevated measurements were recorded during the initial survey in July 1998, and establish and take measurements in appropriate reference areas. The elevated measurements identified during the initial survey need to be validated before remedial action decisions are made using the

data. The reference areas need to be established and measurements taken to allow a statistical comparison to be made with the equivalent survey measurements taken from impacted survey areas.

## 4.2 STATE OF ILLINOIS RADIOLOGICAL GUIDELINES

The State of Illinois' surface contamination guideline (total activity) for alpha emitter is 1000 dpm/100 cm<sup>2</sup>, averaged over any one surface, and 5000 dpm/100 cm<sup>2</sup>, maximum (32 Illinois Administrative Code: Chapter II, Section 340, Appendix A, June 1995). The guideline for removable activity is 33 dpm/100 cm<sup>2</sup>, averaged over any one surface, and 100 dpm/100 cm<sup>2</sup>, maximum. Although uranium is an alpha emitter, it also emits beta radiation at an equivalent rate to the alpha emissions. Beta radiation measurements will be used in this survey to determine surface activity.

The State of Illinois guideline for gamma radiation is that the gamma dose rate shall not exceed background at 100 cm (1 meter) from the surface.

## 4.3 DATA QUALITY OBJECTIVES

The data collected from this and the original survey will be used to determine to what extent the surfaces and soils in and around the buildings were impacted by AEC operations (classify areas) and, subsequently, to plan the remedial actions for the site. To provide data, which can be used, reliably for these decisions, the data should meet the following quality objectives.

### Total Beta Measurements

- The detection level for the measurements, when both instrument and source efficiencies are considered, should be as low as possible, but always less than the average guideline value (1000 dpm/100 cm<sup>2</sup>). Because the actual field source efficiency is unknown, the detection level, considering only the instrument efficiency, should be set at a level of not more than twenty-five (25) percent of the average guideline value, or 250 dpm/100 cm<sup>2</sup> for the total beta measurements on this survey. This value should ensure that even with the source efficiency as low as twenty-five (25) percent, the overall detection level should not exceed the guideline value.
- Reference area measurements should be collected for all equivalent survey unit measurements. Reference areas and measurements should be taken for floor materials, wall materials, and structures, which are equivalent to construction materials in the survey unit.
- Reference area measurements should be taken in a manner equivalent to the survey area. The measurement locations should be selected based upon a grid system similar to the survey unit, with randomly selected grids measured. The measurement count times and method of measurement should be equivalent to measurements in the survey unit.
- The number of reference areas and measurements in the areas should be adequate to allow statistical testing of the data. The NRC recommendation for reference area statistical comparisons using the Kruskal-Wallis test is a minimum of four (4) reference areas and fifteen (15) measurements in each area.

### Gamma Dose Rate Measurements

- The survey instrument used should provide adequate sensitivity to detect variations in the gamma fluence rates.
- Reference area measurements should be collected for all equivalent survey unit measurements. Reference areas and measurements should be taken for substrate materials (e.g., concrete, stone, and dirt) which are equivalent to the materials in the survey unit.
- Reference area measurements should be taken in a manner equivalent to the survey area. The measurement locations should be selected based upon a grid system similar to the survey unit, with randomly selected grids measured. The measurement count time, instrument stabilization time, and positioning should be equivalent to measurements in the survey unit.
- The number of reference areas and measurements in the areas should be adequate to allow statistical testing of the data. The NRC recommendation for reference area statistical comparisons using the Kruskal-Wallis test is a minimum of four (4) reference areas and fifteen (15) measurements in each area.

### Material Samples

- Material samples should be of sufficient size to allow sample analysis to be performed with detection limits at approximately fifty (50) percent of environmental background levels. The average concentration for uranium-238 in soil is 37 Bq/kg (1 pCi/g)(NUREG-1501, Table 2.2). Sample size and analysis methods should be adequate to give a detection limit of 0.5 pCi/g.

In addition to the data quality objectives noted, the instrumentation, procedures and survey methods used for this survey shall meet the requirements of the Quality Assurance Project Plan and the Quality Control section of this Addendum.

## **5.0 STATISTICAL TESTING FOR COMPLIANCE WITH GUIDELINES**

The only statistical testing that is anticipated under the guidelines of this Addendum is the possible testing of the various reference area measurements using the Kruskal-Wallis test. Regulatory Position 2.3.4, Differences in Backgrounds Between Areas, in Draft Regulatory Guide, DG-4006, allows for the use of this test when there may be a significant difference in backgrounds between different (reference) areas. The NRC recommends at least fifteen (15) measurements from at least four (4) reference areas and a Type I error rate of  $\alpha_{KW} = 0.2$  to provide an adequate number of measurements for the determination of whether there is a significant difference in the background values.

## **6.0 DETERMINATION OF DATA REQUIREMENTS**

### **6.1 INVESTIGATION OF ELEVATED MEASUREMENTS**

The data requirements to investigate the elevated measurements taken during the original survey are specified by the original Survey Plan. The specific survey locations and measurements to be investigated and taken are as follows.

- Class II, Unit 1, Floor, Locations BB-45 and CC-50: The original survey had total beta measurements of 2058 and 1632 dpm/100 cm<sup>2</sup> for these locations. The average value for the Class II floor total beta measurements is 557 and 718 dpm/100 cm<sup>2</sup> for direct and scan measurements, respectively. These locations will be scanned to identify the size of the elevated area and total beta measurements will be taken at 30 locations within the location grids (25 feet by 25 feet, or approximately 60 square meters).
- Class II, Unit 3, Wall, Locations S-46, S-47 and S-48: The original survey had total beta measurements of 1130, 1031 and 1055 dpm/100 cm<sup>2</sup> for these locations. The average value for the Class II wall total beta measurements is 509 and 572 dpm/100 cm<sup>2</sup> for direct and scan measurements, respectively. This section of wall is composed of red brick vs. poured concrete for other wall sections. Reference measurements (minimum of 15) will be taken on the exterior (non-impacted) side of these wall grids and compared to the survey data. If the survey data shows elevated values compared to the reference values, these locations will be scanned and total beta measurements taken at 30 locations within all three grids (the grids are contiguous).
- Class III, Building 4 and 6 Exit Points: Gamma dose rate measurements and soil samples were taken outside of the twenty-three (23) exit points from Building 6 and adjacent areas in Building 4. The soil samples did not identify natural uranium above background at these locations. The gamma dose rate measurements were, on average, higher than the measurements taken inside the buildings in Class III areas. Three exit point surveys did not document the types of substrate material (e.g., soil, gravel, and concrete) in the survey area. The exit point gamma dose rate surveys will be repeated using the NaI detector. Additionally, NaI isotopic spectrums will be collected at locations with elevated gamma levels to identify if the elevated measurements are due to the presence of thorium-232.
- Class III, Building 6 Roof: The original survey had a total beta measurement of 1601 dpm/100 cm<sup>2</sup> on the roof of Building 6. The average total beta value for the other roof measurements was 496 dpm/100 cm<sup>2</sup>. The roof was installed after the suspension of AEC activities. It is believed the elevated measurement represents natural radioactivity in the roof material or radioactive material under the newer roof. The area will be scanned for total beta to confirm the original measurement. The area will also be scanned for gamma using a NaI detector to identify if radioactive material is present under the newer roof. A sample of the new roof will be taken at the highest measurement location. If there is an older roof present, a sample of that material will be taken also. These samples will be analyzed using alpha spectrometry.
- Class III, Floor and Equipment, Location K-44: The original survey showed slightly elevated gamma measurements in this area. The survey will be repeated with the NaI detector. If the elevated levels are confirmed, NaI isotopic spectrums will be collected to identify if the elevated measurements are due to the presence of thorium-232.

## 6.2 REFERENCE AREA MEASUREMENTS

The original Survey Work Plan specified a limited number of measurements to be taken in reference areas at the facility. The Addendum provides for a larger number of measurements to be taken from material samples, which represent the range of materials in

the survey areas. The specific reference area locations and measurements to be taken are as follows.

- **Floor Reference Areas:** The floor of the survey area is concrete construction with a heavy residue on the surface. There is evidence of concrete repairs and overpours. Buildings 9 and 10 are of similar construction and age as the survey unit. These areas are also unaffected by past or current operations involving radioactive materials. These are the only areas of the facility that meet these criteria. Therefore, thirty (30) total beta and thirty (30) gamma (1-meter) measurements (NaI detector) will be taken in each of these areas (Buildings 9 and 10). The reduced number of reference areas does not meet the NRC recommendation stated in the DQOs and provides a lower power statistical test (81.7% for 2 areas of 30 samples vs. 96% for 4 areas of 15 samples). If additional reference areas are identified during the survey, the number of reference areas will be increased accordingly.
- **Wall Reference Areas:** The wall material in the survey area is predominantly constructed of poured concrete. The exception is at grid locations S-46 to S-48, which is being investigated as an elevated measurement area. Thirty (30) total beta measurements will be taken in Building 9 and Building 10 on the concrete walls. Fifteen (15) total beta measurements will be taken on the outside of the brick wall at grid locations S-46 to S-48.
- **Building Exits:** Fifteen (15) exit points from Buildings 9 and 10 will be measured for gamma dose rate using a NaI detector.
- **Equipment:** The equipment and machinery in the survey area is unique in construction, so reference measurements may not be representative of the materials. However, for comparison purposes, fifteen (15) total beta measurements will be collected from equipment in Buildings 9 and 10 of similar construction, if available.

## **7.0 DETERMINATION OF DATA POINT LOCATIONS**

The original Work Plan dictates measurement locations for the investigative surveys. Measurement locations for reference areas will be selected in the same manner, if possible, as the original survey points were selected. The reference areas will be defined using a series of grids and measurements will be taken from randomly selected grids. Many areas of Building 9 and 10 are filled with materials and equipment, so the selection will be biased irrespective of the selection technique.

## **8.0 INSTRUMENTATION**

### **8.1 INSTRUMENT SELECTION**

The following radiological survey instruments will be used. Detection sensitivities have been determined following the guidance of NUREG-1507, using nominal literature values for background, response, and site conditions.



Description	Application	Approximate Detection Sensitivity
Ludlum Model 2350-1 w/ Model 43-68 Gas Proportional Detector (126 cm <sup>2</sup> )	Alpha and beta scans and direct measurements	30-950 dpm/100 cm <sup>2</sup> , alpha; 450-850 dpm/100 cm <sup>2</sup> , beta; depending upon dust loading
Ludlum Model 2350-1 w/ Model 44-2 NaI Scintillation Detector (1"x1")	Gamma scans and direct measurements	115 pCi/g uranium
Bubble Tech MicroSpec NaI Portable Spectrometer	Gamma energy peak measurements	~5 pCi/g thorium-232 for soil* * Not based upon NUREG-1507

## 8.2 INSTRUMENT DETECTION LIMITS

The measurement count times should be based upon matching the counting times used during the original survey.

- Measurements for investigation of the original survey data should be taken with identical counting times to try to duplicate the detection limits as closely as possible. If detector efficiencies or background is substantially different, the Survey Supervisor can modify the counting times to try to match the detection limits in the original survey.
- The counting times for reference areas should generally match the original survey. The counting times for total beta were 60 seconds for a direct measurement and a 0.5 m/s travel speed for scanning the floor. Prior to taking measurements the instrument detection limit will be determined. If the detection limit is significantly different from the DQO, the Survey Supervisor may adjust counting times.

## 8.3 SAMPLE ANALYSIS

Samples will be transferred to a radio-analytical laboratory where they will be processed and analyzed by gamma or alpha spectroscopy. Chain of custody will be maintained by procedure throughout the sampling and analysis process.

## 8.4 QUALITY CONTROL

The following processes and actions will insure quality control of the measurement data.

- Instruments will be calibrated to NIST standards using approved written procedures.
- Instruments shall be response checked before and after use, generally at the start and end of the workday. Instruments should respond to within  $\pm 20\%$  of the established reference value, unless otherwise specified in the instrument procedures.

- Replicate measurements will be taken on a minimum of five (5) percent of the measurements.
- Chain of custody will be maintained on all physical samples taken for analysis.

Additional quality control measures are specified in the Quality Assurance Project Plan (Appendix B of the Radiological Survey Work Plan) and will not be duplicated in the Addendum.

## 9.0 DATA INTERPRETATION

Measurements taken to define reference areas or verify or complete the original Survey Work Plan will be reviewed and tested in accordance with the Plan. Generally, this involves testing the survey unit data and the reference area data using the Wilcoxon Rank Sum test. If needed, the Kruskal-Wallis test may be used to test the data from reference areas.

## 10.0 REPORT OF SURVEY FINDINGS

The survey measurements and data taken under this Addendum will be documented in the report with the original Radiological Survey Work Plan data.