CHARACTERIZATION OF OBJECTS CONTAMINATED BY TECHNOLOGICALLY ENHANCED NATURALLY OCCURRING RADIOACTIVE MATERIALS (TENORM) WITHIN THE PHOSPHATE INDUSTRY

FINAL REPORT

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PERSPECTIVE

Brian K. Birky, Ph.D., Public Health Research Director

The Florida Institute of Phosphate Research (FIPR) established a framework to conduct research that will meet the needs of the people of Florida, which was published as *1998-2003 Strategic Research, Programmatic & Management Priorities*. Under the strategic research area of public health, the objective is to define the magnitude of public and occupational health aspects of radiation, hazardous or toxic materials, and air and water pollutants.

Radioactivity is a natural part of the environment in which we live. Over the millennia, radioactivity has accumulated deep underground where phosphate ore is found. The radioactivity is more concentrated near the ore deposits than in surface soil, but the concentration varies such that there is less in North Florida ore than Central Florida ore. There are many radioactive elements from uranium to lead, and many different forms (isotopes) of those elements. When the ore is handled during beneficiation, the process in which phosphate rock is separated from clay and sand, the radioactivity concentrations in the rock concentrate that goes on for further processing is very similar to the concentrations in the original ore that was mined. At the chemical processing plant, that rock is reacted with acids and filtered. It is here, during the production of phosphoric acid and granulated fertilizers, that the different radioactive elements may be separated and concentrated, especially uranium and radium. Like many non-radioactive elements, radioactivity may become imbedded in equipment or form scale precipitates on pipes or other objects. Radium scale in particular can build up to where radiation levels on site are of concern.

The radioactivity on and within objects can determine how waste is classified and stored, shipping and labeling requirements for transport over public roads, and receipt of materials for recycling. This study was conducted to provide an estimate of the quantity of radioactivity from phosphate-processing operations that follows the waste and recycling pathways, and the concentrations associated with the various objects that bear that radioactivity. The acid and fertilizer products of the phosphate industry have been determined to be radiologically safe, and are not part of this study.

Over the course of a year, about 130 tons of waste and scrap were surveyed, comprised of materials such as cardboard, wood, cloth, rubber, metals and much more. Almost three-fourths of the material headed for salvage yards, and over three-fourths of the objects destined for municipal landfills had higher uranium than radium concentrations. Uranium would be hard to detect using the portal monitors in place at most salvage and landfill facilities. The majority of materials surveyed had uranium activity concentrations between 15 and 100 picocuries per gram (pCi/g). A little less than one-third had radium activity concentrations between 15 and 100 pCi/g. Radium emits gamma radiation that is easily detected, but only about one-fourth of the objects with radium activity concentrations above 100 pCi/g had detectable exposure rates above background. The majority of materials with uranium to radium ratios above 10 were

destined for off-site salvage or municipal disposal. The mass of these materials compared to the mass of other materials added into these off-site waste and salvage streams, i.e., dilution, should be considered during any subsequent pathway risk analysis.

The amounts of radioactive materials present in the phosphate industry objects examined in this study are actually quite small. As a basis for comparison, at the lower end of the scale the uranium contents in common cement and granite are about 1.2 and 1.7 pCi/g, respectively. Some smoke detectors use radium as an emission source (although Am-241 is more common). The quantity of radium in such a detector ranges from 500,000 to 1,000,000 pCi. It would take 500 to 1,000 grams (roughly one to two pounds) of material at the 100 pCi/g level to supply that amount of radium. Old luminous wrist and pocket watches frequently used radium paint on dials and hands ranging from 1,000,000 to 4,500,000 pCi. At 100 pCi/g Ra-226, it would take from 22 to 99 pounds of material to extract enough radium to paint the dial and hands of one watch. Finally, coal-fired electric generating plants liberate naturally occurring radioactive materials via the combustion process. Even with air cleaning equipment that provides 99.5% total ash retention, a power plant still releases 20 billion pCi of uranium-238 and radium-226 per 1,000 MWe generated. That radioactivity is released to the atmosphere and surrounding environment. That is equivalent to over 220 tons of 100 pCi/g U-238 or Ra-226 bearing material.

ABSTRACT

The purpose of this study is to provide information as to the characterization of objects contaminated with TENORM within the industry. Technical enhancement is the separation of the principal radionuclides, namely uranium and radium-226, with the resultant material not in equilibrium. TENORM is currently not officially defined by the regulatory agency nor are compliance criteria established. Seven facilities participated in the study that lasted twelve months. Current practices at each site were reviewed with results being anonymous. Each site maintained a "lay-down" area where items were collected, segregated and surveyed prior to determining the disposition. Samples were taken from debris, metals, and other items destined for landfills, salvers and phosphogypsum stacks. Collective sample analyses indicated the enhancement being 72% favoring uranium and 25% favoring radium. Thirty-five percent of the uranium samples had activity 10 times greater than the radium activity. Over 50% of the discarded items went to salvers, of which 66% had background radiation levels. One hundred tons of debris destined for off-site disposition consisted of approximately 4.5 millicuries of uranium and 8 millicuries of radium. One hundred thirty-six total samples were taken with detailed descriptions delineating identification, radiation levels, estimated mass and whether having fixed or removable contamination.

ACKNOWLEDGMENTS

Applied Environmental Consulting, Inc. would like to thank the management of all the companies that generously granted us access to their facilities during the course of this project. A special thanks goes to the site personnel who took time out of their busy schedules to show us around their facilities, provide escort, and answer questions. We feel that the contribution of these people were the key to the success of this project. AEC also appreciates the smooth transition from Dr. Brian Birky to Dr. George Harder as the principal investigator, immediately after commencing the study.

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EXECUTIVE SUMMARY

The overall objective of this investigation was to provide information to the phosphate industry as it pertains to the characterization of TENORM. This study could provide information to assist industry and regulatory agencies in understanding the issues regarding handling, packaging, loading and transportation of TENORM. The characterization information in the data collected in this study could provide a basis for the standardization of procedures that can be used by the industry and a characterization base to regulatory personnel in the development of realistic standards.

TENORM has been handled for years by the phosphate industry. It has been in the form of physical and chemical changes from the original ore that was mined. These changes create a ratio of uranium to its daughter, radium, as being no longer in unity (1 to 1). The processes making fertilizer enhanced the concentrations of the naturally occurring radioactive materials, rendering the ancillary equipment and debris as having surface by-product material that is difficult to remove. Items with these adhering by-products have been taken to the phosphogypsum stacks for on-site disposition or removed to landfills, salvers or service repair companies.

There is a large variability in the makeup of the radiological by-products. These include physical differences of the types of items having the adhering contaminants to the actual concentrations of the radionuclides that make up the contaminants. The physical items include unwanted debris, filter cloths, trash and waste materials that have no further value, metallic items that have recycling value and items with inherent value that can be repaired.

The practice for handling discarded materials varied across the industry. Some sites had an active survey program to check material before it left the sites. Others relied on portal monitors to survey loaded trucks as they left. This project showed that TENORM contaminated material had left the site as a contaminant on debris and salvageable metal in a very limited fashion.

The characterization of objects contaminated by TENORM within the phosphate industry was hampered by the general slowdown in the industry with the subsequent closure of some plants. This study did not evaluate the decommissioning of a phosphate facility but simply revealed information on the types of material that routinely were placed on the phosphogypsum stack or left a facility for repair, salvage or landfill.

This study was conducted over a twelve-month period. The methodology included making contact with several phosphate companies. Meetings were conducted to understand how the companies implemented screening, surveying, handling and disposition of items potentially contaminated with TENORM. Results indicated that each site had designated “lay-down” areas for collecting, segregating and surveying the items. The types of samples were taken from items that were categorized as destined for: repair

(service company), salvage (metal salver), off-site disposal (landfill) or on-site disposition (phosphogypsum stack).

Sample collection included identifying the sample, surveying the item with a microR meter, estimating the mass and determining the type of contamination (fixed/removable/imbedded). The samples were sealed in vials, held for two weeks to allow ingrowth of daughters and counted for sufficient time to improve the lower limit of detectability (LLD). One hundred thirty-six samples representing 130 tons of material with a total of 2.3 millicuries of uranium (predominantly uranium-238) and 8.0 millicuries of radium (predominantly radium-226) were taken. There were 27 different types of material sampled that were categorized into three basic categories. Material from the fourth category, repair, was not sampled.

The primary purpose was to determine the uranium-to-radium ratio (U/Ra), which indicated a degree of enhancement of the process, thus the creation of TENORM. The concentrations of uranium ranged from > 100 pCi/g to < 5 pCi/g. The radiological constituents indicated mixtures of uranium-to-radium ratios. The U/Ra ratios for the respective categories were diverse. Those samples with a U/Ra ratio of less than (<) unity (more radium) were 28% and those being greater than (>) unity were 72%. Of those with ratios > unity, 32% had ratios of ten times greater of those items discarded, 57% went to salvers and 14% remained for on-site disposition. Of the material shipped off-site as industrial waste (landfill), 16.5 tons were sampled having a total uranium content of approximately 1.2 millicuries and radium content of 0.1 millicuries. Two thirds of those items destined off-site for disposition or salvage had no external exposure rates above background. Material sent to the phosphogypsum stack was predominantly unwanted process equipment having little value for salvage. Approximately 20 tons were sampled having uranium content of 0.5 millicuries and radium of 6.8 millicuries.

As a result of the study, there are a few recommendations of follow-up studies that could be beneficial to the industry:

- Of those items destined for off-site disposition having greater than background levels, a follow up MOP (members of the public dose) study could be readily accomplished;

- A review of the portal monitors of the salvers could create consistency in the acceptance of items destined for unrestricted release; and

- When the phosphate industry becomes rejuvenated and increases production, a follow up study of the effect on the characterization of the radionuclide enhancement to the discarded materials could be meaningful to confirm that current practices are realistic.

INTRODUCTION

BACKGROUND OF THE PROBLEM AND WHY THE WORK NEEDED TO BE DONE

The characterization of TENORM contaminated objects is a generic problem shared by the chemical plants producing phosphoric acid and ammoniated phosphates. An industry-wide effort to characterize the TENORM contaminated objects would eliminate the inefficiency associated with companies attempting to address the issue on an individual basis. TENORM is an industry acronym describing the technical enhancement of naturally occurring radioactive materials. Removing ores from the ground and combining with chemicals creates changes in the chemical makeup of the uranium and "daughters" that were previously in equilibrium in the ground. One example is the generation of radium sulfate from the addition of sulfuric acid in the fertilizer extraction process. This compound is insoluble and tends to concentrate in hard-to-clean places such as pumps, bends in pipes and filter cloths. This radioactive material is not generated at the phosphate site, but simply concentrated as an unwelcomed by-product. The concentrations of uranium and radium become different as the radium is inadvertently separated from the fertilizer mixture. Other than general categories of radiation protection and waste disposal, there is no regulatory definition that officially characterizes the radioactivity concentrations or action levels expected by the industry for handling and disposing of TENORM. So far, the concepts of good health physics practices and proper stewardship of resources have been the principal industry guides to the handling of TENORM contaminated items.

As the industry is asked more and more by the regulators to develop procedures for handling, transporting, salvaging and disposing of items contaminated with TENORM, this document provides the quantitative assessment of these materials being generated at the phosphate plants. Also, since there is the need to assure as much efficiency and cost savings as possible, salvaging as much metallic items as possible can be problematic if the salver's perceived liability risks are not consistent with standardized regulatory release limits.

HISTORICAL PERSPECTIVE

Phosphate facilities have handled TENORM contaminated materials in their plant for many years. This includes the replacing of pipes, repair of filter pans, disposal of debris and the salvaging of metal components contaminated by the TENORM. Some companies transport TENORM across public roads to phosphogypsum stacks, to service companies and to metal salvers, while others do not travel beyond company property.

As the handling, disposal and salvaging of items contaminated with TENORM comes under more scrutiny by the regulators and the public, it is important to have the proper characterization of the TENORM. Also, as regulations become more restrictive in

the release of radioactive materials for unrestricted use, such as salvage or landfilling, the need for understanding the TENORM composition is imperative. It is difficult developing procedures for handling TENORM, standardizing regulations, and providing assistance to salvers when the nomenclature of the item of concern is not clearly defined and accepted by the regulatory agencies or the regulated community. It is important to understand the characteristics of TENORM and the large variability in radioactivity from the phosphate processes.

The practice of depositing contaminated TENORM items in the respective gypsum stacks has provided immediate financial relief from commercial waste disposal. The characterization information in this study could provide a tool to the industry in projecting future depositions. The information could be used to estimate radioactivity of contaminated TENORM items in existing gypsum stacks. This information could be coupled with previous studies of gypsum stack activities to show the additions represent a small fraction of the total stack activity that is passed through from the normal fertilizer production process from ores.

LITERATURE REVIEW OF PREVIOUS RELATED RESEARCH

There is no related work currently in progress. References to TENORM in waste streams in published literature are generally concerned with large waste streams such as sands, clays and phosphogypsum (Roessler and others 1979; Ryan and Cotter 1980). Descriptions of activity concentrations in scale are often nonspecific and highly variable. For example, TENORM scale generated as a by-product of the wet phosphoric acid process can have radium concentrations ranging from 10 to 100,000 pCi/g (Lardinoye and others 1982). This large variability in radium concentration is characteristic of the process (Birky and others 1998). Since the waste stream includes tank sludge, filter cloths and pipes, it is expected that activity concentrations will vary widely. In the repair stream, it is less likely, but still possible that imbedded radioactivity can present higher activity concentrations. The salvage stream is expected to have consistently low activity concentrations. However, salvage loads are sometimes rejected at the salver and are commonly returned for disposition on the gypsum stack without further analysis. Those rejected loads are likely to contain the higher activity concentrations for this stream.

TIME FRAME

This study was conducted over a 12-month period. This time period was necessary to coordinate with the staffs of the respective phosphate plants as to the best times to go on-site and gain information about the debris contaminated with TENORM.

The work proceeded with the on-site survey sample collection and nomenclature accumulation of information of the samples. Samples were transported off-site to a radiological laboratory for analysis. Data was collected and compiled with results provided to enable conclusions to be drafted as to the results.

METHODOLOGY

ORGANIZATION OF THE PROJECT

A letter was sent to facilities in the production and service sectors explaining the TENORM study project (Appendix A). Project members interviewed interested site personnel. A point of contact was established at each of the participating facilities and visits were scheduled.

Participating Facilities

Seven phosphoric acid processing facilities supported the project by providing sampling access. Anonymity has been maintained to avoid misinterpretation of data.

Meetings with the seven facility points of contact were conducted during initial site visits to discuss the specific procedures and the common practices used for surveying, releasing and shipping of materials from their site. Inquiries were also made as to the total number of shipments that routinely were sent off-site, where materials were going and any problems that had been encountered during prior shipments. Access to materials that were to be shipped was requested so team members could collect samples.

For reasons discussed above, information and sample data obtained for this report are presented in a manner that preserves the source facility anonymity. An alphabetical character (A-G) was randomly assigned to identify each of the participants. For subsequent information in this report that specifically references a particular site, only the assigned alphabetical character for identification was used.

Review of Industry Practices and Procedures

Site representatives were questioned about the measures taken for checking and screening materials prior to shipments, the release criteria employed, the disposition locations and other issues dealing with the segregation, survey and release of materials. All facilities used “lay-down” areas for pre-staging material before disposal. This pre-staging allowed for easier segregation of materials.

Sample Classification

The overall objective of this investigation was to characterize TENORM contaminated materials and equipment from the phosphate industry in terms of activity concentration. Four categories of objects were studied:

- repair stream
- salvage stream
- off-site disposal waste stream
- on-site disposal waste stream

Repair stream objects include filter pans, valves, pipes and other equipment that are routinely repaired off-site. Such process components may have fixed and/or removable TENORM scale present on exterior and/or interior surfaces. While these objects were screened prior to release, hidden TENORM contamination may have been shielded from detection by structural components.

Salvage stream objects contain recyclable metals to be fashioned into a wide variety of materials for use outside of the phosphate industry. Salvage companies screen incoming shipments using large radiation detector arrays positioned on either side of the truck's path. While vendors claim a high sensitivity for detection of radiation sources in the interior of a shipment, the activity concentrations of TENORM that typically pass, or are rejected by such detector configurations are not known. The salvage facilities are not regulated and are not required to follow any guidelines concerning monitor calibration or alarm levels. Therefore, acceptance of TENORM contaminated items is inconsistent.

Off-site disposal waste stream objects include primarily general trash and waste materials that are sent to public landfills or burners, but also include waste products of specific constituents that are sent to industrial landfills. Examples of materials that may be sent to industrial landfills include, but are not limited to, treated wood, asphalt, concrete, rubber products, fiberglass and plastics.

On-site disposal waste stream objects include virtually all possible components of the operating facility. The content of this waste stream can be complex and variable; e.g., diffuse TENORM waste (scale particulates, sludges, etc.) that may also contain discrete sources of TENORM (filter cloths, scale-contaminated piping, etc.) mixed in the volume. These objects are normally buried within an on-site phosphogypsum stack.

In spite of the fact that phosphogypsum contains radium, there is question as to whether it is considered TENORM because it is *depleted* in overall uranium activity, not *enhanced*. The addition of TENORM contaminated objects places TENORM in a place where the ratio or the concentrations of the radionuclides is different than the U/Ra concentrations in the phosphogypsum. A characterization of the objects placed in the stack yielded estimates of the TENORM activity typically added.

A thorough characterization of the samples was defined for this study as a compilation of data in the following classes:

- Description of materials
- Mass of materials
- Uranium-235, uranium-238 and radium-226 activity concentrations in picocuries per gram.

Sample Collection

Field characterization of collected samples included an estimate of the mass or volume of the material. The material was checked for:

- diffuse TENORM materials, e.g., loose scale particulates, sludges, etc.;
- surface contamination, e.g., scale, loose residues, etc.;
- fixed contamination on objects, e.g., filter cloths, piping, etc.; and
- imbedded TENORM, e.g., within pans, valves, pumps, etc.

Representative samples were collected and analyzed for uranium and radium activity concentrations. Perma-Fix Environmental Services in Gainesville, Florida, provided laboratory services for this project.

The primary targeted materials were from the repair, salvage and waste streams of phosphoric acid, dry products (MAP, DAP, GTSP) and animal feeds. This did not include product MAP, DAP, GTSP or animal feeds. Final products have been radiologically characterized in other studies. It was difficult to identify the point of origin within the facility of material needing disposition. Facilities accumulated materials from all areas within the facility to one selected area.

Sample Analysis

The major analytical technique used was gamma spectroscopy, as is the standard practice for TENORM contaminated materials. The procedure called for sealing the material in a 20 milliliter vial, holding for a minimum of two weeks to allow ingrowth of radon-222 and its daughters and counting for long periods of time to improve the sample lower limit of detection (LLD). Some radionuclides in the NORM series were counted directly by their gamma energy peaks, while others like radium-226 were estimated using equilibrium and emanation assumptions. Radioactivity concentrations were recorded in picocuries per gram as found, since the moisture content is a component of the shipping condition.

RESULTS

INDUSTRY PRACTICES AND PROCEDURES FOR THE RELEASE OF MATERIALS

Keeping the sample data obtained for this report anonymous was a priority. Information was compiled with the alphabetical characters (A-G) randomly assigned to identify each of the participants.

The following information from the site representatives questioned is a summary of how they screened materials prior to shipments, the release criteria employed and the disposition locations:

- A common practice at all of the participating facilities was to segregate materials based on the likelihood that a particular item could be contaminated with TENORM. This segregation was based on the type of materials, the source of the material and the presence of visible scale. Using these visual determinations, many items were automatically routed for disposal on the phosphogypsum stack. Examples of these types of materials were filter cloths from the phosphoric acid plant, piping with large amounts of scale buildup and rubber lined materials. The rubber lined materials appeared to have an affinity for the deposition of radium sulfate.

- Surveying of shipments leaving the facilities varied. One was very thorough in surveying each item and every shipment that exits the premises. Another surveys only materials destined for landfills, while not surveying materials that are sent to salvers. Two depend on gate monitors to check materials leaving their sites. Three have no formal program to perform surveys of shipments.

- Release limits for items at the different sites varied. Two of the sites rejected materials if the exposure rate was twice the background. Four of the sites used a value of 25 μR/hr above background as a release limit. One site had a release limit of 250 μR/hr including background.

- All of the sites had qualified personnel who spot-checked items that were in temporary "lay-down" areas and would check questionable items that were brought to their attention.

- In the event that items shipped from a site set off the alarms at the salver, the salver either rejected the load and returned it to the site for segregation or sorted the load himself and returned the materials with elevated readings. Most of the sites have acknowledged that materials were occasionally rejected and returned by the salver, but that this was not a frequent occurrence.

SAMPLES

Early in this project it became apparent that being at a particular site when a shipment was actually leaving would be by coincidence only. There were no set schedules for material shipments at any of the participating facilities. Therefore, it became necessary to obtain samples from partially filled containers and from materials stored in temporary "lay-down" areas (Figure 1). Since actual shipments were not checked and characterized, contents were not recorded.

Figure 1. Typical Lay-Down Area.

Additionally, collecting items that would be considered a part of the repair stream category would be unlikely. Very few items were sent off-site for repair. Items that were sent off-site for repair were thoroughly cleaned of any external scale and debris prior to shipment. Sandblasting or power washing the item often accomplished this cleaning. Radiation safety departments and Radiation Safety Officer (RSO) participation is generally limited to assisting with the shipment of large items that require special handling and transportation arrangements. During this project there was no notification of items for repair; therefore, no repair items were sampled.

Sample Collection

As samples were collected, an effort was made to select a variety of items that were representative of the materials that would usually be part of a shipment. A sample identification number was assigned to each sample. The design of the numbering used incorporated the alphabetical character representation for the facility, a numerical identification of the type of waste stream the sample fell under, the incremental number of the samples collected within that waste stream and the date the sample was collected.

All of the sampled items were checked for gamma radiation exposure rate using a calibrated Ludlum Model 19 "micro-R" scintillation detector. Dimensional measurements were made, and when possible, weights were obtained to assist with the determination of the item's mass. Finally, a sample of the item or loose material adhering to the item was collected in a twenty-milliliter vial for weighing and analysis.

Sampling of materials predominantly occurred within "lay-down" areas. Often the origin of the material was not readily available and was not commented upon here. Some origins of material were identified by facility personnel and recorded by contractor.

The total number of samples collected on this project was one hundred thirty-six (136). Descriptions of the collected samples are provided in Appendix B.

Sample Analysis

Estimation of the total mass of each item was accomplished by measuring or estimating the area and/or volume of an item. A small volume of material was weighed and analyzed using the gamma spectroscopy system. The activity concentration, in picocuries per gram, was then multiplied by the estimated weight of the item to obtain the total activity.

This project inspected 136 different items or collections of items and provided samples for radiological analysis. A total of 260,034 pounds (130 tons) of material, with a total uranium activity of 2.3 mCi and radium activity of 8.0 mCi, was surveyed. There were twenty-seven (27) different types of materials (Table 1) falling into the three categories examined. Appendix B contains a more detailed description of each sample.

Table 1. Sampled Material by Type.

Type Material	Qty	Type Material	Qty
Cardboard	4	Paper	2
Cloth	1	Pipe	12
Concrete	1	Plastic	8
Dirt	1	Railroad Rails	1
Fiberglass	4	Rubber	14
Filter Cloth	9	Sandblast Media	1
Glove	2	Scrubber Media	2
Grating	6	Slag	1
I-beam	4	Sludge	3
Ladder	1	Stainless Steel	9
Metal	37	Tyvex	3
Mud	1	Wire	3
Nylon	2	Wood	1
Oil Filter	1		

Uranium-to-Radium Activity Ratio

This project was directed at characterizing TENORM in phosphoric acid processing materials. However, with no regulations or formal policies from the Florida Department of Health, defining TENORM in this report was an assertion only. Whatever the future regulatory definition, the definition of TENORM will be founded on the changes done by man on the materials. Currently, the only aspect of TENORM that can be discussed is the ratio of uranium to radium.

The ratio of uranium to radium, in a natural and undisturbed area, is one to one. The processing of phosphate ore changes the ratio. The processes where this occurs have been discussed in other reports and are outside the scope of this project. All material that demonstrates a ratio of uranium to radium not equal to one, no matter the resultant concentration of either radionuclide, may be subject to some future definition of TENORM.

Uranium Activity Concentration

Uranium activity concentration was determined by combining the activities for uranium-235 and uranium-238. Measurements and calculations for uranium activity concentrations for samples are provided in Appendix C. The activity concentration results are also provided in Appendix B as part of the sample description. Figure 2 summarizes the number of samples with differing uranium activity concentrations.

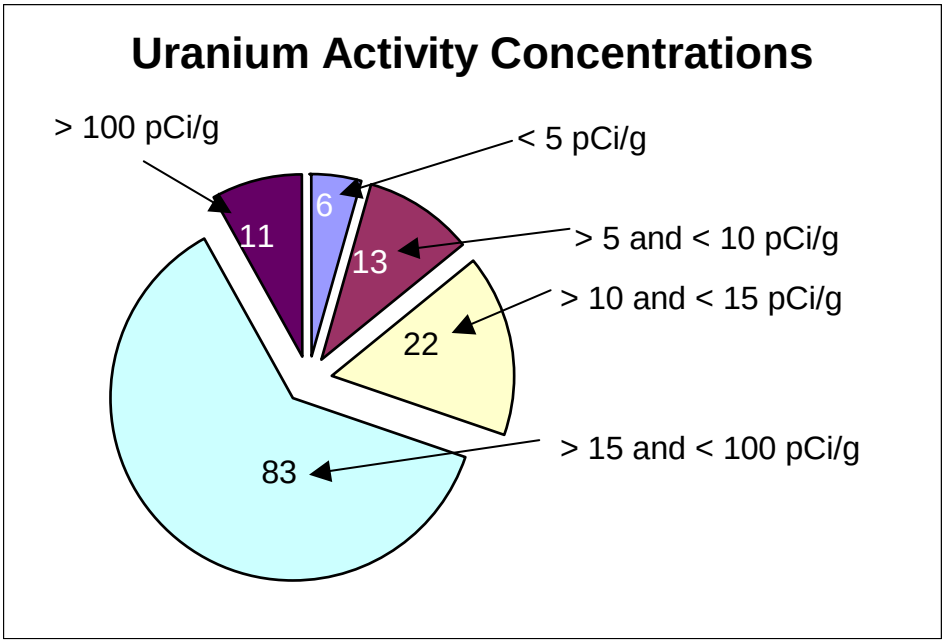


Figure 2. Uranium Activity Concentrations.

Eleven items had a uranium activity concentration greater than 100 pCi/g and all of those items were destined for off-site disposal or salvage (Table 2). None of those items had an exposure rate above background, thus making them impossible to isolate with handheld exposure rate detectors.

Table 2. Uranium Activity Concentration Greater Than 100 pCi/g.

Disposition	Material Type	Exposure Rate μ/R/hr	Uranium (pCi/g)
Salvage	metal	BKG	378.6
On-Site Disposal	fiberglass	BKG	330.1
On-Site Disposal	fiberglass	BKG	170.2
On-Site Disposal	wood	BKG	127.7
On-Site Disposal	cardboard	BKG	126.1
Off-Site Disposal	tyvex	BKG	124.4
Off-Site Disposal	paper	BKG	123.5
Off-Site Disposal	tyvex	BKG	105.8
Salvage	Metal	BKG	104.3
Off-Site Disposal	tyvex	BKG	103.5
Off-Site Disposal	cardboard	BKG	100.6

Radium activity concentration was determined by measuring the lead-214 and bismuth-214 activity concentrations after allowing sufficient time for radon-222 and daughter build-up. Measurements and calculations for radium activity concentration for samples are provided in Appendix C. The activity concentration results are also provided in Appendix B as part of the sample description. Figure 3 summarizes the number of samples with differing radium activity concentrations.

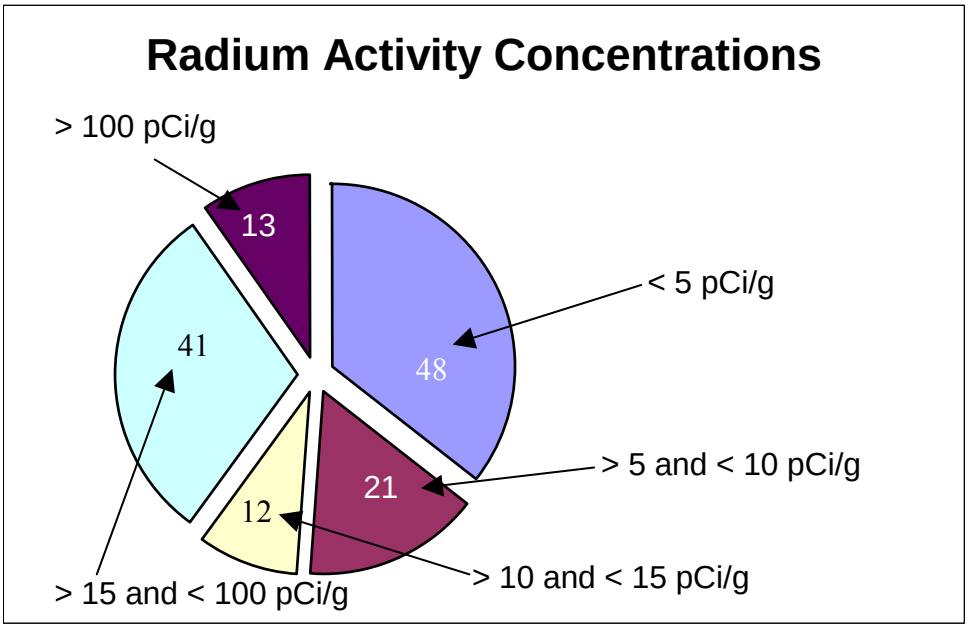


Figure 3. Radium Activity Concentrations.

Thirteen items had a radium activity concentration greater than 100 pCi/g and three of those items were destined for off-site disposal (Table 3). Only one of those items displayed an exposure rate above background. Four of the thirteen items were destined for salvage. Two of those items had exposure rates at background, making them impossible to isolate with handheld exposure rate detectors.

Table 3. Radium Activity Concentration Greater Than 100 Picocuries/Gram.

Disposition	Material Type	Exposure Rate (μR/hr)	Radium (pCi/g)
On-Site Disposal	rubber	1200	14190.3
On-Site Disposal	filter cloth	280	7822.7
On-Site Disposal	filter cloth	1200	7367.6
On-Site Disposal	filter cloth	200	2549.8
On-Site Disposal	filter cloth	3800	392.4
Off-Site Disposal	rubber	100	363.3
On-Site Disposal	rubber	600	298.5
Off-Site Disposal	concrete	BKG	202.6
Salvage	metal	BKG	167.5
Salvage	metal	160	163.3
Salvage	stainless steel	BKG	143.1
Salvage	pipe	100	121.8
Off-Site Disposal	fiberglass	BKG	114.2

Uranium-to-Radium Activity Ratio Results

Material with uranium-to-radium activity ratios less than unity was found in 38 items (28%). Material with ratios greater than unity was found in 97 items (72%). Figure 4 displays these results.

From the materials with ratios greater than unity, 31 items (32%) had ratios greater than 10, indicating the uranium activity was ten times that of the radium activity.

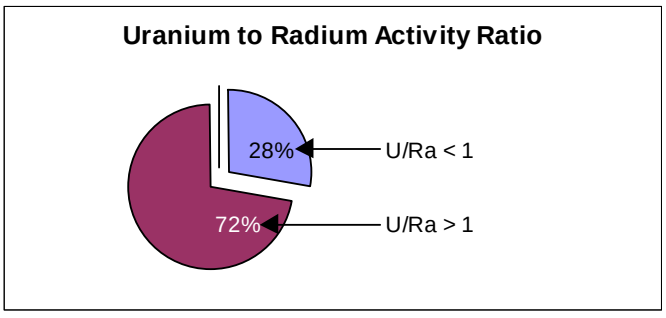


Figure 4. Uranium-to-Radium Activity Ratio.

The highest ratio of uranium-to-radium activity was 370.5 found on 70 pounds of paper destined for an industrial landfill (see Sample #79). The second highest ratio of uranium-to-radium activity was 91.0 found on 12 pounds of wire destined for metal recycling (see Sample #73). Only 2 of the 31 items (6%) were destined for the gypsum stack for disposal. Fourteen items (45%) were destined for an industrial landfill and 15 items (48%) were destined for metal recycling (Figure 5). Table 4 lists the material that had uranium-to-radium activity ratios greater than 10.

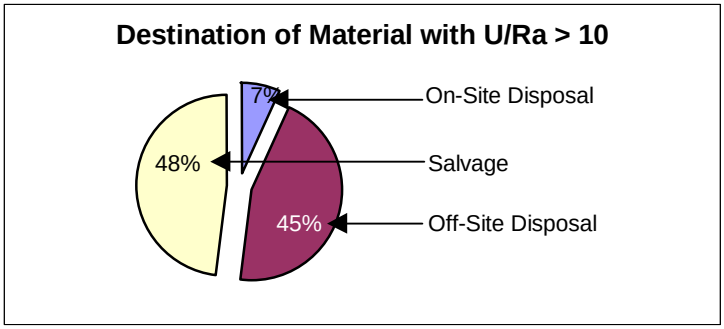


Figure 5. Destination of Material with U/Ra > 10.

Table 4. Uranium-to-Radium Ratio Greater Than 10.

Disposition	Type Material	U/Ra
Salvage	pipe	10.1
Salvage	stainless steel	10.2
Salvage	metal	10.2
Salvage	metal	10.8
Off-Site Disposal	fiberglass	11.6
Off-Site Disposal	plastic	11.9
Off-Site Disposal	rubber	12.2
Salvage	metal	12.3
Off-Site Disposal	paper	13.0
Salvage	metal	13.2
Off-Site Disposal	cloth	13.9
Off-Site Disposal	glove	14.3
Salvage	metal	14.3
Off-Site Disposal	cardboard	14.5
Salvage	metal	14.5
Off-Site Disposal	fiberglass	14.8
Off-Site Disposal	cardboard	15.2
Salvage	pipe	15.4

Table 4. Uranium-to-Radium Ratio Greater Than 10 (Cont.).

Disposition	Type Material	U/Ra
Salvage	stainless steel	16.4
Salvage	wire	17.4
Salvage	metal	18.3
On-Site Disposal	plastic	18.4
Off-Site Disposal	tyvex	20.4
Salvage	metal	20.4
Off-Site Disposal	rubber	25.5
Salvage	metal	28.7
Salvage	metal	36.7
On-Site Disposal	rubber	43.9
Off-Site Disposal	cardboard	50.0
Salvage	nylon	51.6
Salvage	metal	52.1
Off-Site Disposal	fiberglass	64.0
Salvage	wire	93.5
Off-Site Disposal	paper	380.5

Uranium-to-Radium Activity Ratio by Category

A composite of the uranium-to-radium activity ratios is provided by category.

Category – Salvage Stream. The majority of metal was destined for recycling (Figure 6). Metal that was rejected by a salver was surveyed subsequently disposed of on-site. There were seventy-eight (78) samples taken of material destined for salvage with a total weight of 57,443 pounds (29 tons). This group included pipes, grating, ladders, I-beams and other metallic items. From this study, material for salvage had a total uranium activity of 0.88 mCi and radium activity of 0.76 mCi (Figure 2). These respective activities suggest a uranium-to-radium ratio near unity, however, 57 of the salvage material samples (73%) had a ratio greater than unity, and 18 (32%) of the 57 samples exhibited uranium activities greater than ten times the radium activities.

Figure 6. Salvage Metal.

Category - Off-Site Disposal Waste Stream. Non-processing related material, such as paper, cardboard and plastic was sent off-site as industrial waste (Figure 7). Thirty-three (33) items weighing 48,465 pounds (24 tons) were sampled. Off-site disposal accounted for a total uranium activity of 1.48 mCi and radium activity of 1.15 mCi (Figure 2). While these numbers indicated off-site disposal had a uranium-to-radium ratio near unity, 5 of the samples (15%) had ratios less than unity and 28 samples (85%) had ratios greater than unity. Fourteen samples (50%) of the 28 samples with a ratio greater than unity had a uranium-to-radium ratio greater than 10.

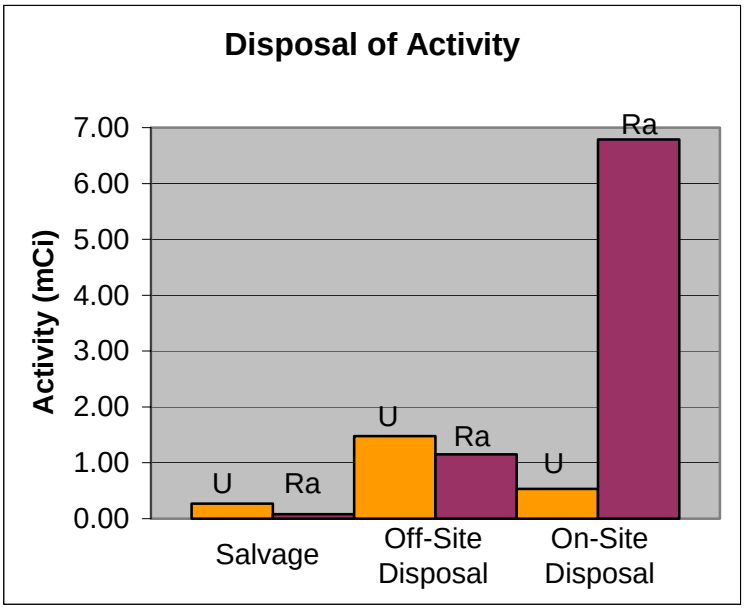
Figure 7. Off-Site Disposal.

Category - On-Site Disposal Waste Stream. Processing equipment contaminated with scale and having no potential value for salvage is sent to the gypsum stack (Figure 8). Twenty-four (24) samples with a total weight of 38,862 pounds (19 tons) included filter cloth, fiberglass and mud. From this study, on-site disposal accounted for a total uranium activity of 0.53 mCi and radium activity of 6.79 mCi (Figure 2). Ten of the 24 samples (42%) had a uranium-to-radium ratio less than unity and 14 samples (58%) had a ratio greater than unity. Only 2 (14%) of the 14 samples with a ratio greater than unity had a uranium-to-radium ratio greater than 10.

Figure 8. On-Site Disposal.

Figure 9 is a graphical representation of the uranium and radium disposition activities as discussed in the three categories in this section.

Figure 9. Graphical Representation of Uranium and Radium Disposition Activities.



Salvage
U: 0.27
Ra: 0.08
Off-Site Disposal
U: 1.48
Ra: 1.15
On-Site Disposal
U: 0.53
Ra: 6.79

CONCLUSIONS AND RECOMMENDATIONS

This study of TENORM contaminated material revealed that screening procedures generally exist across the industry; however, with the variable radiological content and lack of regulatory definition, off-site disposal also varied. All sites had informal protocols for screening that depended on identifying potentially contaminated material and diverting it to the gypsum stack for disposal. This practice alone ensured that 19 tons (33%) of discarded material was destined for a gypsum stack. This material contained 33% of the uranium-contaminated material and 85% of the radium contaminated material. Apart from visual screening, each site maintained a protocol for surveying off-site destined shipments. Regardless of the protocol, this study has shown that TENORM contaminated material does leave the sites. Protocols defined pass/fail as 25 μR/hr including background or double background exposure rates. But with no clear definition for TENORM, other than the unofficial definition used by the industry, a standardized protocol cannot be evaluated properly. For example, it can be argued the uranium and radium concentrations up to 100 pCi/g were derived from raw material, but this can only be true if the ratio of activities is near unity and received from a licensed uranium production facility. Beyond that, uranium and radium has been either depleted or enhanced from ore materials.

Most material sampled that was destined for off-site disposal or salvage did have TENORM contamination. Contamination was quantified only after performing a detailed radiological analysis. This study showed that 88% of material did not have radiation exposure rates above background, but 9% had levels of radioactivity greater than 100 pCi/g of uranium and 4 % of material had radium exposure rates above 100 pCi/g.

This study revealed landfilled materials had an increased activity concentration of either uranium or radium and these parent/daughter radioisotopes were not in equilibrium. However, in most cases, exposure rates were at background. Fortunately, the eventual destination of the material is to be returned into the ground and covered by topsoil and vegetation. Exposure rates from certain levels of TENORM will be indistinguishable from background. Therefore, TENORM contaminated general refuse, which accounts for over ten percent of discarded material, should be safely added to industrial landfills. A follow-up study of dose to Members of the Public (MOP) to quantify the extent of dose to which the public may be exposed from this source is recommended.

This project provided a cross-section of the discarded materials that were generated on a phosphate site. However, a limitation in this project resulted from a slowdown in the phosphate industry over the last year which could have affected the estimates of materials that were placed on the piles available for sampling, the gypsum stack, sent to salvers or disposed in landfills. The number of samples taken during this study would have had a larger population to choose from if taken during stronger phosphate production. The size of each type of material sampled could have changed, but it is unknown as to how this was affected by the slowdown in production that would have created a higher reliability in the sampling results as being more representative of the site. This study cannot provide a conclusion as to estimating the amount of radiation that leaves a site during different stages of production; however, in the future, it could be performed again in a modified form when phosphate production increases to see if there is a corollary to current production levels.

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Appendix A

SAMPLE INTRODUCTION LETTER

POC
XYZ Phosphate Co.
Phosphate City, FL 55555

Subject: TENORM Contaminated Object Study

Dear Mr. POC:

Applied Environmental Consulting, Inc. (AEC) recently received funding by the Florida Institute of Phosphate Research (FIPR) for the project entitled *Characterization of Objects Contaminated by Technologically Enhanced Naturally Occurring Radioactive Materials (TENORM) Within the Phosphate Industry*. The intent of this study is to generate an overview of the radioactivity concentrations (in picocuries per gram) within materials transported both on and off site for chemical plants. The study is concerned with the *repair stream*, *salvage stream* and *waste stream.* This does not include product MAP, DAP, GTSP or animal feeds by definition. Those products have been radiologically characterized in other studies.

Repair stream objects include filter pans, valves, pipes and other materials that are routinely repaired on and off site. Such process components may have fixed and/or removable TENORM scale present on exterior and/or interior surfaces. While these objects are screened prior to release, hidden TENORM contamination may be shielded from detection by structural components.

Salvage stream objects contain reusable metals to be fashioned into a wide variety of materials for use outside of the phosphate industry. Salvage companies screen incoming shipments using large radiation detector arrays positioned on either side of the truck's path. While vendors claim a high sensitivity for detection of radiation sources in the interior of a shipment, the activity concentrations of TENORM that typically pass, or are rejected by, such detector configurations are not known.

Waste stream objects include virtually all possible components of the operating facility. The content of the waste stream could be complex and variable; e.g., diffuse TENORM waste (scale particulates, sludges, etc.) which may also have some discrete sources of TENORM (filter cloths, scale-contaminated piping, etc.) mixed in the volume. These objects are normally buried within an on-site phosphogypsum stack.

In order to successfully meet the project goals, we request your permission to:

- visit your chemical plant sites;
- be notified of shipping schedules for the three material streams;
- review any data you would like to provide concerning shipping frequencies, descriptions and masses for the three streams;
- collect small samples (no greater than 500 milliliters per sample) of various materials from truck loads at repeated times over the next nine months;
- weigh small portions of constituents of each truck load and
- photograph sampled materials.

Samples and photographs will be coded so that no specific company can be identified in the final report. Results will be combined for all sites that participate in the study. If you would like to have radioactivity concentration results for a particular sampled item from your site only, those specific results can be provided to you confidentially.

The principal investigator will be Dr. George Harder and the field work will be performed by an AEC technician, Kent Brakefield, who has been assigned full-time duties on phosphate chemical plant site for the past year.

Dr. Harder can be reached by phone during business hours at 352-395-1360 or by email at gharder@perma-fix.com. AEC appreciates your attention in this matter and looks forward to hearing from you.

Sincerely,

George Harder, Ph.D., P.E.
Senior Health Physicist
2825 B N.W. 104th Ct
Gainesville, FL 32606

Appendix B

SAMPLE DESCRIPTIONS

Sample	Date	Sample ID	Category
1	03/22/00	A-2-7-032200	Salvage

Description: Two “mag meters” that were once in the acid line were rejected at the salvers and returned to the plant. The interior of each meter was coated with a thin scale.

Sample: A 1.02 gram sample of scale was chipped off.

Survey Data: 1.2 mR/hr on contact

Sample Analysis:

Nuclide	pCi/g
U-natural	0.0
Ra-226	146095

Calculations: Total mass or area was not calculated on this piece of equipment. No uranium-238 was indicated by the lack of thorium-234 in the scale.

Sample	Date	Sample ID	Category
2	07/06/00	D-2-1-070600	Salvage

Description: Material was located in a "20-yard" Recyclable Metals container in a metals lay-down area. The twenty cubic yard container was 70% full of metal. Approximately 0.1% of the total volume was scale and dirt.

Sample: A 0.458 cu. in.. sample weighing 9.38 grams was collected from the container.

Survey Data: No exposure rates above background were detected on the sample.

Sample Analysis:

Nuclide	pCi/g
U-natural	39.7
Ra-226	50.9

Calculations: Uranium: 39.7 (pCi/g) x (9.38 (g) / 0.458 (cu. in..))

x 20 (cu. yd.) x 46656 (cu. in../cu. yd.)

x 0.70 x 0.001 = 530.7 nCi

Radium: 50.9 (pCi/g) x (9.38 (g) / 0.458 (cu. in..))

x 20 (cu. yd.) x 46656 (cu. in../cu. yd.)

x 0.70 x 0.001 = 680.9 nCi

Sample	Date	Sample ID	Category
3	07/06/00	D-2-1-070600	Salvage

Description: Metal shavings were located in a "20-yard" Recyclable Metals container in a metals lay-down area. There was estimated to be 1.0 cubic feet of metal shavings in the container.

Sample: Approximately 0.5 cu. in.. weighing 3.27 grams was collected.

Survey Data: No exposure rates above background were detected on this sample.

Sample Analysis:

Nuclide	pCi/g
U-natural	81.0
Ra-226	12.5

Calculations: Uranium: 81.0 (pCi/g) x (3.27 (g) / 0.5 (cu. in..)) x 1 (cu. ft.)

x ((1728 cu. in..) / 1 (cu. ft.)) = 915.4 nCi

Radium: 12.5 (pCi/g) x (3.27 (g) / 0.5 (cu. in..)) x 1 (cu. ft.)

x ((1728 cu. in..) / 1 (cu. ft.)) = 141.3 nCi

Sample	Date	Sample ID	Category
4	07/06/00	D-4-1-070600	On-Site Disposal

Description: A 24-inch diameter rubber lined pipe was located in the gypsum stack lay-down area. The pipe was 20 feet long and had a 1/8" layer of scale throughout the pipe..

Sample: A 1.22 cu. in.. sample that weighed 10.75 grams was collected.

Survey Data: Exposure rates of up to 1200 μR/hr above background were detected on the inside of this pipe.

Sample Analysis:

Nuclide	pCi/g
U-natural	43.9
Ra-226	14190.3

Calculations: Uranium: 43.9 (pCi/g) x 20 (ft.) x 12 (in. / ft.)

x π x ((12 (in.))^2 - (11.875 (in.))^2)

x (10.75 (g) / 1.22 (cu. in.)) = 870.4 nCi

Radium: 14190.3 (pCi/g) x 20 (ft.) x 12 (in. / ft.)

x π x ((12 (in.))^2 - (11.875 (in.))^2)

x (10.75 (g) / 1.22 (cu. in.)) = 281.4 μCi

Sample	Date	Sample ID	Category
5	07/18/00	C-4-1-071800	Salvage

Description: A 12-inch diameter valve housing was located in a metals lay-down area. The valve housing had a spherical interior with a layer of scale throughout its inside walls. A sample of scale was collected by scraping the inside of the valve.

Sample: A 0.915 cu. in.. sample weighing 13.33 grams was collected.

Survey Data: Exposure rates of up to 160 μR/hr above background were detected on the inside of this item.

Sample Analysis:

Nuclide	pCi/g
U-natural	20.7
Ra-226	163.3

Calculations: Uranium: 20.7 (pCi/g) x (π x (12 (in.)^2))

x (13.33 (g) / 0.915 (cu. in.)) = 136.6 nCi

Radium: 163.3 (pCi/g) x (π x (12 (in.)^2))

x (13.33 (g) / 0.915 (cu. in.)) = 1076.2 nCi

Sample	Date	Sample ID	Category
6	07/18/00	C-3-1-071800	Off-Site Disposal

Description: A 48-inch rubber fan belt was located in a "20-yard" container of general area trash that was being taken off site to an industrial landfill.

Note: Site personnel identified a hot spot (as defined by their site survey procedures and/or practices) on the outside of this container as it was being surveyed. The load was not permitted to leave site. It was to be dumped in a lay-down area to allow segregation and identification of the source of the elevated Exposure rates.

Sample: A one-inch section weighing 9.22 grams was collected.

Survey Data: No exposure rates above background were detected on this sample.

Sample Analysis:

Nuclide	PCi/g
U-natural	35.4
Ra-226	3.8

Calculations: Uranium: 35.4 (pCi/g) x 48 (in.) x (9.22 (g) / 1 (in.))

= 15.7 nCi

Radium: 3.8 (pCi/g) x 48 (in.) x (9.22 (g) / 1 (in.))

= 1.7 nCi

Sample	Date	Sample ID	Category
7	07/18/00	C-3-2-071800	Off-Site Disposal

Description: Fiberglass insulation was located in a "20-yard" container of general area trash that was being taken off site to an industrial landfill. Estimated volume of insulation in the container was 20 cubic feet.

Note: Site personnel identified a hot spot (as defined by their site survey procedures and/or practices) on the outside of this container as it was being surveyed. The load was not permitted to leave site. It was to be dumped in a lay-down area to allow segregation and identification of the source of the elevated Exposure rates.

Sample: A 2.0 cu. in.. sample weighing 1.55 grams was collected.

Survey Data: No exposure rates above background were detected on this sample.

Sample Analysis:

Nuclide	pCi/g
U-natural	170.2
Ra-226	15.3

Calculations: Uranium: 170.2 (pCi/g) x 20 (cu. ft.) x 1728 (cu. in./cu. ft.)

x (1.55 (g) / 2.0 (cu. in.)) = 4558.9 nCi

Radium: 15.3 (pCi/g) x 20 (cu. ft.) x 1728 (cu. in./ cu. ft.)

x (1.55 (g) / 2.0 (cu. in.)) = 409.8 nCi

Sample	Date	Sample ID	Category
8	07/18/00	C-4-2-071800	On-Site Disposal

Description: Approximately 2.0 cubic yards of used filter cloth was located in a filter cloth lay-down area. Collected a 1" X 6" piece of material from a pile of approximately 2.0 cubic yards. A 2 gallon sample of this material weighs 8 pounds.

Sample: A 1.0 cu. in. sample weighing 2.61 grams was collected.

Survey Data: Exposure rates of up to 3800 μR/hr above background were detected on the filter cloth.

Sample Analysis:

Nuclide	pCi/g
U-natural	92.2
Ra-226	392.4

Calculations: Uranium: 92.2 (pCi/g) x 2.0 (cu. yd.) x (46656 (cu. in..)

/ (cu. yd.)) x (2.61 (g) / 1.0 (cu. in.)) = 22.5 μCi

Radium: 392.4 (pCi/g) x 2.0 (cu. yd.) x (46656 (cu. in.)

/ (cu. yd.)) x (2.61 (g) / 1.0 (cu. in.)) = 95.6 μCi

Sample	Date	Sample ID	Category
9	07/19/00	E-2-1-071900	Salvage

Description: A large metal flange attached to a base for mounting a pump was located in a "20-yard" Recyclable Metals container in a metals lay-down area. The flange was covered with a thin layer of scale. The flange portion of this item had a 30-inch outside diameter and a 24-inch inside diameter. The pump mount portion was 20" X 10" X 10" and there was a rear plate that was 20" X 24". Scale was collected from a 2 square inch area. The volume of the collected sample is 0.61 cu. in. and the weight is 6.64 grams.

Sample: A 2.0 square inch area of scale weighed 6.64 grams.

Survey Data: No exposure rates above background were detected on the flange.

Sample Analysis:

Nuclide	pCi/g
U-natural	60.9
Ra-226	21.8

Calculations: The total area covered with scale on this item was determined by calculating the surface areas for flange portion (front and back), the base portions (the exposed surfaces of the front, top, and both sides) and the rear plate (front and back less the area covered by the base). These values were then added together to get the total surface area for the assembly.

Surface Areas:

Flange: (((π x (15 (in.))^2) - (π x (12 (in.))^2)) x 2)
= 509 (sq. in.)
Base Front: (20 (in.) x 10 (in.)) = 200 (sq. in.)
Base Top: (10 (in.) x 20 (in.)) = 200 (sq. in.)
Base Sides: ((10 (in.) x 10 (in.)) x 2) = 200 (sq. in.)
Rear Plate: (((20 (in.) x 24 (in.)) x 2) – 200 (sq. in.))
= 760 (sq. in.)

Uranium: 60.9 (pCi/g) x 1869 (sq. in.)

x (6.64 (g) / 2.0 (sq. in.)) = 378.0 nCi

Radium: 21.8 (pCi/g) x 1869 (sq. in.)

x (6.64 (g) / 2.0 (sq. in.)) = 135.3 nCi

Sample	Date	Sample ID	Category
10	07/19/00	E-4-1-071900	On-Site Disposal

Description: Approximately 1.0 cubic yard of used filter cloth was located on the ground next to the phosphoric acid plant. A 1 inch by 6 inch sample was collected.

Sample: Approximately 1.0 cu. in. sample of filter cloth weighing 2.47 grams was collected.

Survey Data: Exposure rates up to 200 μR/hr above background were detected on the filter cloth.

Sample Analysis:

Nuclide	pCi/g
U-natural	84.6
Ra-226	2549.8

Calculations: Uranium: 84.6 (pCi/g) x 1.0 (cu. yd.) x (46656 (cu. in..)

/ (cu. yd.)) x (2.47 (g) / 1.0 (cu. in.)) = 9.7 μCi

Radium: 2549.8 (pCi/g) x 1.0 (cu. yd.) x (46656 (cu. in.)

/ (cu. yd.)) x (2.47 (g) / 1.0 (cu. in.)) = 293.8 μCi

Sample	Date	Sample ID	Category
11	07/19/00	E-4-2-071900	On-Site Disposal

Description: Approximately 1.0 cubic yard of used filter cloth was located on the ground next to the phosphoric acid plant (See Sample #10). Scale from 1 square foot of the filter cloth was collected.

Sample: Scale weighing 3.91 grams was scraped from a one square foot section of the filter cloth.

Survey Data: Exposure rates of up to 200 μR/hr above background were detected on this item.

Sample Analysis:

Nuclide	pCi/g
U-natural	77.9
Ra-226	34.3

Calculations: A 1 inch by 6 inch piece of filter cloth is approximately 1 cubic inch in volume when folded (See sample #10).

Surface Area of filter cloth:

(46656 (cu. in./cu. yd.)) x (6 (sq. in.) / 1 (cu. in.))

/ (144 (sq. in./sq. ft.)) = 1944 (sq. ft. / cu. yd.)

Uranium: 77.9 (pCi/g) x 1.0 (cu. yd.)

x 1944 (sq. ft./ cu. yd.)

x (3.91 (g) / 1.0 (sq. ft.)) = 591.9 nCi

Radium: 34.3 (pCi/g) x 1.0 (cu. yd.)

x 1944 (sq. ft./cu. yd.)

x (3.91 (g) / 1.0 (sq. ft.)) = 260.7 nCi

Sample	Date	Sample ID	Category
12	07/19/00	F-2-1-071900	Salvage

Description: A motor shroud was located in a recyclable metals lay-down area. The shroud was 20 inches in diameter and was 8 inches deep. One end was enclosed while the other end was open. The shroud had a layer of scale on all portions of the inside and outside surfaces.

Sample: Scale was removed from a 1 square inch area of the shroud which resulted in a sample weighing 6.87 grams.

Survey Data: No exposure rates above background were detected on the shroud.

Sample Analysis:

Nuclide	pCi/g
U-natural	52.0
Ra-226	28.4

Calculations: The surface area for this item was determined by calculating the inside and outside of a 20-inch diameter by 8-inch long cylinder with one end open.

Uranium: 52.0 (pCi/g) x ((2π x 10 (in.) x 8 (in.)) x 2

+ (π x (10 (in.))^2) x 2) x 6.87 (g/sq. in.) = 583.9 nCi

Radium: 28.4 (pCi/g) x ((2π x 10 (in.) x 8 (in.)) x 2

+ (π x (10 (in.))^2) x 2) x 6.87 (g/sq. in.) = 318.7 nCi

Sample	Date	Sample ID	Category
13	07/19/00	F-2-2-071900	Salvage

Description: Approximately 50 square feet of grating was located in a recyclable metals lay-down area. The estimated surface area of the grating in the pile was 100 square feet (front and back of grating).

Sample: Scale was collected from a 4 square inch area. The scale sample weighed 9.79 grams.

Survey Data: No exposure rates above background were detected on this sample.

Sample Analysis:

Nuclide	pCi/g
U-natural	56.7
Ra-226	91.9

Calculations: Uranium: 56.7 (pCi/g) x 100 (sq. ft.) x 144 (sq. in./sq. ft.)

x (9.79 (g) / 4 (sq. in.)) = 2.0 μCi

Radium: 91.9 (pCi/g) x 100 (sq. ft.) x 144 (sq. in./sq. ft.)

x (9.79 (g) / 4 (sq. in.)) = 3.2 μCi

Sample	Date	Sample ID	Category
14	07/19/00	F-4-1-071900	On-Site Disposal

Description: Sludge, approximately 15 feet by 20 feet and ½ inch deep, was located on the ground at a Phosphoric Acid plant.

Sample: A 0.915 cu. in. sample of the sludge weighed 19.00 grams.

Survey Data: Exposure rates of up to 150 μR/hr above background were detected over the sludge.

Sample Analysis:

Nuclide	pCi/g
U-natural	13.6
Ra-226	11.3

Calculations: Uranium: 13.6 (pCi/g) x 15 (ft) x 20 (ft) x 0.5 (in.)

x 144 (sq. in./sq. ft.) x (19.00 (g) / 0.915 (cu. in.))

= 6.1 μCi

Radium: 11.3 (pCi/g) x 15 (ft) x 20 (ft) x 0.5 (in.)

x 144 (sq. in./sq. ft.) x (19.00 (g) / 0.915 (cu. in.))

= 5.1 μCi

Sample	Date	Sample ID	Category
15	08/16/00	A-2-1-081600	Salvage

Description: Scale was affixed to an 18-inch by 30-inch metal plate located in a "20-yard" recyclable metal's container. The plate had an isolated area of scale, approximately 10 inches by 8 inches by 2 inches thick, while the remainder was free from scale buildup.

Sample: A 0.915 cu. in. sample weighing is 7.61 grams was collected.

Survey Data: No exposure rates above background were detected from the sample.

Sample Analysis:

Nuclide	pCi/g
U-natural	46.6
Ra-226	8.1

Calculations: Uranium: 46.6 (pCi/g) x 10 (in.) x 8 (in.) x 2 (in.)

x (7.61 (g) / 0.915 (cu. in.)) = 62.0 nCi

Radium: 8.1 (pCi/g) x 10 (in.) x 8 (in.) x 2 (in.)

x (7.61 (g) / 0.915 (cu. in.)) = 10.8 nCi

Sample	Date	Sample ID	Category
16	08/16/00	A-2-2-081600	Salvage

Description: A tapered pipe located in a "20-yard" recyclable metals container. Pipe had a thin layer of scale on the inside. The pipe had a 28-inch diameter at one end and tapered to a 16-inch diameter at the other end. Total length of the pipe was 58 inches. Scale was thinly distributed on the inside of the pipe.

Sample: A two square inch section of pipe was scraped and removed 12.16 grams of scale.

Survey Data: No exposure rates above background were detected on this sample.

Sample Analysis:

Nuclide	pCi/g
U-natural	59.8
Ra-226	6.1

Calculations: Surface area for the inside of this tapered pipe was calculated using the equation for a smaller cone subtracted from a larger cone.

Uranium: 59.8 (pCi/g) x 4043.6 (sq. in.)

x (12.16 (g) / 2 (sq. in.) = 1469.5 nCi

Radium: 6.1 (pCi/g) x 4043.6 (sq. in.)

x (12.16 (g) / 2 (sq. in.) =145.0 nCi

Sample	Date	Sample ID	Category
17	08/16/00	A-2-3-081600	Salvage

Description: A large metal hopper used in the pond water system was located on the ground in a recyclable metals lay-down area. It was in the process of being cut up for disposal. The funnel was 14 feet in diameter and 6 feet deep and tapered to a 12 inch opening at the bottom. A 3 foot wall extended from the top of the funnel around 80% of its circumference. A 3 foot lip extended 40% around the funnel circumference. A thin layer of scale was located on approximately 5 % of the surface area.

Sample: A 4 square inch area was scraped. The scale weighed 13.66 grams.

Survey Data: No exposure rates above background were detected on this sample.

Sample Analysis:

Nuclide	pCi/g
U-natural	87.2
Ra-226	3.1

Calculations: Surface area for the inside of the funnel was calculated using the equation for a smaller cone subtracted from a larger cone.

Funnel: 208.5 (sq. ft.)

Wall: 2π x 7 (ft.) x 3 (ft.) x 0.80 = 105.6 (sq. ft.)

Lip: π x ((13 (ft.))^2 – (10 (ft.))^2) x 0.40 = 86.7 (sq. ft.)

Uranium: 87.2 (pCi/g) x 400.8 (sq. ft.) x (13.66 (g) / 4 (sq. in.)

x 144 (sq. in./sq. ft.) = 17186.6 nCi

Radium: 3.1 (pCi/g) x 400.8 (sq. ft.) x (13.66 (g) / 4 (sq. in.)

x 144 (sq. in./sq. ft.) = 611.0 nCi

Sample	Date	Sample ID	Category
18	08/25/00	B-2-1-082500	Salvage

Description: A 40-foot by 40-inch metal plate with a protruding flange was located in a "20-yard" recyclable metal's container. The flange was 14 inches in diameter and protruded 4 inches from the plate. Scale was ½-inch thick and was only located on the upper half of the flange protrusion.

Sample: A 1.22 cu. in. sample that weighed 20.65 grams was collected.

Survey Data: No exposure rates above background were detected on this sample.

Sample Analysis:

Nuclide	pCi/g
U-natural	11.3
Ra-226	167.5

Calculations: Uranium: 11.3 (pCi/g) x 4 (in.) x π

x ((7.5 (in.))^2 - (7 (in.))^2) x 0.50

x (20.65 (g) / 1.22 (cu. in.)) = 8.7 nCi

Radium: 167.5 (pCi/g) x 4 (in.) x π

x ((7.5 (in.))^2 - (7 (in.))^2) x 0.50

x (20.65 (g) / 1.22 (cu. in.)) = 129.2 nCi

Sample	Date	Sample ID	Category
19	08/25/00	B-4-1-082500	On-Site Disposal

Description: Two flange couplings on an 8-inch diameter plastic pipe was located in a "20-yard" scrap materials container in a metals lay-down area. The two flanges had a 10-inch diameter. Scale was an average of 1/8 inches thick on all exposed portions of the flange coupling.

Sample: Scale was collected from a 2 square inch area and weighed 11.69 grams.

Survey Data: No exposure rates above background were detected on this sample.

Sample Analysis:

Nuclide	pCi/g
U-natural	36.2
Ra-226	19.7

Calculations: Uranium: 36.2 (pCi/g) x π x ((5 (in.))^2 – (4 (in.))^2)

x 4 x (11.69 (g) / 2 (sq. in.)) = 23.9 nCi

Radium: 19.7 (pCi/g) x π x ((5 (in.))^2 – (4 (in.))^2)

x 4 x (11.69 (g) / 2 (sq. in.)) = 13.0 nCi

Sample	Date	Sample ID	Category
20	08/25/00	B-4-2-082500	On-Site Disposal

Description: A filter pan roller wheel was located in a "20-yard" scrap materials container in a metals lay-down area. The wheel hub was 8 inches in diameter with a 2 inch diameter axle opening. Scale was an average of approximately ¼ inch thick on all exposed portions of the roller wheel.

Sample: A 0.915 cu. in. scale sample weighing 9.92 grams was collected.

Survey Data: No exposure rates above background were detected on this sample.

Sample Analysis:

Nuclide	pCi/g
U-natural	44.7
Ra-226	28.2

Calculations:

Uranium: 44.7 (pCi/g) x π x ((4 (in.))^2 – (1 (in.))^2)

x 2 x 0.25 (in.) x (9.92 (g) / 0.915 (sq. in.))

= 11.4 nCi

Radium: 28.2 (pCi/g) x π x ((4 (in.))^2 – (1 (in.))^2)

x 2 x 0.25 (in.) x (9.92 (g) / 0.915 (sq. in.))

= 7.2 nCi

Sample	Date	Sample ID	Category
21	08/25/00	B-4-3-082500	On-Site Disposal

Description: Approximately 0.5 cubic yards of used filter cloth was located in a lay-down area at a Phosphoric Acid plant.

Sample: A 1.0 cu. in. sample of filter cloth weighing 3.58 grams was collected

Survey Data: Exposure rates of up to 15 μR/hr above background were detected on this item.

Sample Analysis:

Nuclide	pCi/g
U-natural	82.2
Ra-226	32.4

Calculations: Uranium: 82.2 (pCi/g) x 0.5 (cu. yd.) x 46656 (cu. in../cu. yd.)

x (3.58 (g) / 1.0 (cu. in.)) = 6.9 μCi

Radium: 32.4 (pCi/g) x 0.5 (cu. yd.) x 46656 (cu. in./cu. yd.)

x (3.58 (g) / 1.0 (cu. in.)) = 2.7 μCi

Sample	Date	Sample ID	Category
22	08/30/00	G-4-1-083000	On-Site Disposal

Description: A 14 foot long pipe with an 8 inch diameter was located in a gypsum stack lay-down area. A one-inch layer of scale was present throughout the pipe.

Sample: A 0.763 cu. in. sample of scaled weighed 10.83 grams.

Survey Data: No exposure rates above background were detected on this sample.

Sample Analysis:

Nuclide	pCi/g
U-natural	30.4
Ra-226	15.6

Calculations: Uranium: 30.4 (pCi/g) x 14 (ft.) x 12 (in./ft.) x π

x ((4 (in.))^2 – (3.0 (in.))^2)

x (10.83 (g) / 0.763 (sq. in.))

= 1592.0 nCi

Radium: 15.6 (pCi/g) x 14 (ft.) x 12 (in./ft.) x π

x ((4 (in.))^2 – (3.0 (in.))^2)

x (10.83 (g) / 0.763 (sq. in.))

= 818.1 nCi

Sample	Date	Sample ID	Category
23	08/30/00	G-4-2-083000	On-Site Disposal

Description: Muddy sediment from a 20 foot long pipe with a 4 inch was located in the gypsum stack lay-down area. A layer of sediment that had settled on the bottom along the length of the pipe. It was estimated that approximately 10% of the pipe volume was filled with this sediment.

Sample: A 1.22 cu. in. sample of sediment weighing 31.39 grams was collected.

Survey Data: No exposure rates above background were detected on this sample.

Sample Analysis:

Nuclide	pCi/g
U-natural	16.9
Ra-226	5.5

Calculations: Uranium: 16.9 (pCi/g) x 20 (ft.) x 12 (in./ft.) x π

x (4 (in.))^2 x 0.10 x (31.39 (g) / 1.22 (sq. in.))

= 523.1 nCi

Radium: 5.5 (pCi/g) x 20 (ft.) x 12 (in./ft.) x π

x (4 (in.))^2 x 0.10 x (31.39 (g) / 1.22 (sq. in.))

= 170.7 nCi

Sample	Date	Sample ID	Category
24	08/30/00	G-2-1-083000	Salvage

Description: A 41-inch by 28-inch by 1-inch grating was located in a recyclable metals lay-down area. Scale covered approximately 10% of its recesses.

Sample: A 0.915 cu. in. sample of the scale weighed 13.48 grams.

Survey Data: No exposure rates above background were detected on this sample.

Sample Analysis:

Nuclide	pCi/g
U-natural	26.5
Ra-226	37.3

Calculations: Uranium: 26.5 (pCi/g) x 41 (in.) x 28 (in.) x 1 (in.)

x 0.10 x (13.48 (g) / 0.915 (cu. in.)) = 44.8 nCi

Radium: 37.3 (pCi/g) x 41 (in.) x 28 (in.) x 1 (in.)

x 0.10 x (13.48 (g) / 0.915 (cu. in.)) = 63.1 nCi

Sample	Date	Sample ID	Category
25	08/30/00	G-2-2-083000	Salvage

Description: An estimated 1 cubic foot of metal shavings was located in a recyclable metals lay-down area.

Sample: A 1.0 cu. in. sample of the metal shavings weighed 12.16 grams.

Survey Data: No exposure rates above background were detected on this sample.

Sample Analysis:

Nuclide	pCi/g
U-natural	22.2
Ra-226	1.6

Calculations: Uranium: 22.2 (pCi/g) x 1 (cu. ft.) x 1728 (cu. in./cu. ft.)

x (12.16 (g) / 1.0 (cu. in.)) = 466.3 nCi

Radium: 1.6 (pCi/g) x 1 (cu. ft.) x 1728 (cu. in./cu. ft.)

x (12.16 (g) / 1.0 (cu. in.)) = 33.6 nCi

Sample	Date	Sample ID	Category
26	08/30/00	G-2-3-083000	Salvage

Description: A 10 foot long I-beam was located in a recyclable metals lay-down area. The cross member of the I-beam was 8 inches wide and the side plates were 6 inches wide. Approximately 50% of the surfaces were covered with a thin layer of scale.

Sample: A 4 sq. in. sample of scale weighing 10.43 grams was collected.

Survey Data: No exposure rates above background were detected on this sample.

Sample Analysis:

Nuclide	pCi/g
U-natural	21.4
Ra-226	3.9

Calculations:

Uranium: 21.4 (pCi/g) x 10 (ft.) x 12 (in./ft.)

x (2 x 8 (in.) + 4 x 6 (in.)) x 0.50

x (10.43 (g) / 4 (sq. in.)) = 133.6 nCi

Radium: 3.9 (pCi/g) x 10 (ft.) x 12 (in./ft.)

x (2 x 8 (in.) + 4 x 6 (in.)) x 0.50

x (10.43 (g) / 4 (sq. in.)) = 24.4 nCi

Sample	Date	Sample ID	Category
27	09/27/00	A-3-1-092700	Off-Site Disposal

Description: A fiberglass flange was located in a "20-yard" scrap materials container in a metals lay-down area. The flange had a 24 inch diameter at the opening and a 36 inch diameter at the outer rim. A short length of pipe connected to the flange was 24 inches in diameter and 4 inches long. Scale covered approximately 20% of the flange.

Sample: A 1 sq. in. sample of scale weighed 6.33 grams.

Survey Data: No exposure rates above background were detected on this sample.

Sample Analysis:

Nuclide	pCi/g
U-natural	330.1
Ra-226	23.1

Calculations: Uranium: 330.1 (pCi/g) x (π x ((18 (in.))^2 – (12 (in.))^2)

x 2 + 2 x 2π x 12 (in.) x 4 (in.)) x 0.20

x (6.33 (g) / 1 (sq. in.)) = 724.7 nCi

Radium: 23.1 (pCi/g) x (π x ((18 (in.))^2 – (12 (in.))^2)

x 2 + 2 x 2π x 12 (in.) x 4 (in.)) x 0.20

x (6.33 (g) / 1 (sq. in.)) = 50.7 nCi

Sample	Date	Sample ID	Category
28	09/27/00	A-3-2-092700	Off-Site Disposal

Description: Fiberglass was located in a "20-yard" container in a metals lay-down area. The container was approximately 70% filled with fiberglass.

Sample: A 1.0 cu. in.. sample of fiberglass weighed 8.41 grams.

Survey Data: No exposure rates above background were detected on this sample.

Sample Analysis:

Nuclide	pCi/g
U-natural	31.1
Ra-226	0.5

Calculations: Uranium: 31.1 (pCi/g) x 20 (cu. yd.) x 46656 (cu. in../cu. yd.)

x 0.70 x (8.41 (g) / 1.0 (cu. in..)) = 170.8 μCi

Radium: 0.5 (pCi/g) x 20 (cu. yd.) x 46656 (cu. in../cu. yd.)

x 0.70 x (8.41 (g) / 1.0 (cu. in..)) = 2.8 μCi

Sample	Date	Sample ID	Category
29	09/27/00	A-3-3-092700	Off-Site Disposal

Description: A Tyvex suit, with an estimated volume of 0.1 cubic feet, was located in a "30-yard" container of scrap wood and waste in the metals lay-down area.

Sample: A 1.0 cu. in.. sample of tyvex weighed 3.31 grams.

Survey Data: No exposure rates above background were detected on this sample.

Sample Analysis:

Nuclide	pCi/g
U-natural	103.5
Ra-226	29.8

Calculations: Uranium: 103.5 (pCi/g) x 0.1 (cu. ft.) x 1728 (cu. in../cu. ft.)

x (3.31 (g) / 1.0 (cu. in..)) = 59.2 nCi

Radium: 29.8 (pCi/g) x 0.1 (cu. ft.) x 1728 (cu. in../cu. ft.)

x (3.31 (g) / 1.0 (cu. in..)) = 17.0 nCi

Sample	Date	Sample ID	Category
30	09/27/00	A-3-4-092700	Off-Site Disposal

Description: Concrete scraps were located in a "20-yard" container of Off-Site Disposal located in a metals lay-down area. This container was 40% full.

Sample: A 0.5 cu. in.. sample of the concrete scraps weighed 6.31 grams.

Survey Data: No exposure rates above background were detected on this sample.

Sample Analysis:

Nuclide	pCi/g
U-natural	45.6
Ra-226	202.6

Calculations: Uranium: 45.6 (pCi/g) x 20 (cu. yd.) x 46656 (cu. in../cu. yd.)

x 0.40 x (6.31 (g) / 0.5 (cu. in..)) = 215.0 μCi

Radium: 202.6 (pCi/g) x 20 (cu. yd.) x 46656 (cu. in../cu. yd.)

x 0.40 x (6.31 (g) / 0.5 (cu. in..)) = 954.3 μCi

Sample	Date	Sample ID	Category
31	09/27/00	A-2-1-092700	Salvage

Description: A 2 foot by 3 foot by 3 foot pile of metal shavings was located in a 30-yard container of recyclable metals in a metals lay-down area.

Sample: A 1.0 cu. in.. sample of the metal shavings weighed 20.66 grams.

Survey Data: No exposure rates above background were detected on this sample.

Sample Analysis:

Nuclide	pCi/g
U-natural	16.3
Ra-226	2.1

Calculations: Uranium: 16.3 (pCi/g) x 18 (cu. ft.) x 1728 (cu. in../cu. ft.)

x (20.66 (g) / 1.0 (cu. in..)) = 10.5 μCi

Radium: 2.1 (pCi/g) x 18 (cu. ft.) x 1728 (cu. in../cu. ft.)

x (20.66 (g) / 1.0 (cu. in..)) = 1.4 μCi

Sample	Date	Sample ID	Category
32	09/27/00	A-2-2-092700	Salvage

Description: A 55 gallon drum lid, 24 inches in diameter, was 50% covered by scale on one side. Material was located in a 30-yard container of recyclable metals in a metals lay-down area.

Sample: A one square inch of area was scraped and the scale weighed 15.6 grams.

Survey Data: No exposure rates above background were detected on this sample.

Sample Analysis:

Nuclide	pCi/g
U-natural	56.8
Ra-226	8.6

Calculations: Uranium: 56.8 (pCi/g) x π x (12 (in.))^2 x 0.50

x (15.6 (g) / 1.0 (sq. in.)) = 200.6 nCi

Radium: 8.6 (pCi/g) x π x (12 (in.))^2 x 0.50

x (15.6 (g) / 1.0 (sq. in.)) = 30.4 nCi

Sample	Date	Sample ID	Category
33	09/27/00	A-2-3-092700	Salvage

Description: Approximately two square feet of stainless steel insulation wrapping was located in a "30-yard" container of recyclable metals in a metals lay-down area.

Sample: A four square inch sample weighing 10.04 grams was collected.

Survey Data: No exposure rates above background were detected on this sample.

Sample Analysis:

Nuclide	pCi/g
U-natural	26.6
Ra-226	3.3

Calculations: Uranium: 26.6 (pCi/g) x 2 (sq. ft.) x 144 (sq. in./sq. ft.)

x (10.04 (g) / 4 (sq. in.)) = 19.2 nCi

Radium: 3.3 (pCi/g) x 4 (sq. ft.) x 144 (sq. in./sq. ft.)

x (10.04 (g) / 4 (sq. in.)) = 2.4 nCi

Sample	Date	Sample ID	Category
34	09/27/00	A-4-1-092700	On-Site Disposal

Description: An estimated 10 cubic yards of sludge from a phosphoric acid plant was located in a lay-down area.

Sample: A 0.763 cu. in.. sample of sludge weighing 20.32 grams was collected.

Survey Data: Exposure rates of up to 1500 μR/hr above background were detected on this item.

Sample Analysis:

Nuclide	pCi/g
U-natural	32.7
Ra-226	26.0

Calculations: Uranium: 32.7 (pCi/g) x 10 (cu. yd.) x 46656 (cu. in../cu. yd.)

x (20.32 (g) / 0.763 (cu. in..)) = 405.9 μCi

Radium: 26.0 (pCi/g) x 10 (cu. yd.) x 46656 (cu. in../cu. yd.)

x (20.32 (g) / 0.763 (cu. in..)) = 323.1 μCi

Sample	Date	Sample ID	Category
35	09/27/00	C-2-1-092700	Salvage

Description: A metal hopper, with a 30-inch diameter opening, was located in a "20-yard" recyclable metals container in a metals lay-down area.

Sample: Scale from a 5-inch section along the hopper rim, weighing 15.36 grams, was collected.

Survey Data: No exposure rates above background were detected on this sample.

Sample Analysis:

Nuclide	pCi/g
U-natural	58.9
Ra-226	39.6

Calculations: Uranium: 58.9 (pCi/g) x 2 x π x 15 (in.)

x (15.36 (g) / 5 (in.)) = 17.1 nCi

Radium: 39.6 (pCi/g) x 2 x π x 15 (in.)

x (15.36 (g) / 5 (in.)) = 11.5 nCi

Sample	Date	Sample ID	Category
36	09/27/00	C-2-2-092700	Salvage

Description: A 12 foot long pipe with a diameter of 4 inches has approximately ¼ inches of scale throughout the inside. The pipe was located in a "20-yard" recyclable metals container in a metals lay-down area.

Sample: A 1.22 cu. in.. sample of scale weighed 19.99 grams.

Survey Data: No exposure rates above background were detected on this sample.

Sample Analysis:

Nuclide	pCi/g
U-natural	7.6
Ra-226	18.2

Calculations: Uranium: 7.6 (pCi/g) x 12 (ft.) x 12 (in./ft.) x π

x ((2 (in.))^2 – (1.75 (in.))^2)

x (19.99 (g) / 1.22 (cu. in..)) = 53.1 nCi

Radium: 18.2 (pCi/g) x 12 (ft.) x 12 (in./ft.) x π

x ((2 (in.))^2 – (1.75 (in.))^2)

x (19.99 (g) / 1.22 (cu. in..)) = 126.5 nCi

Sample	Date	Sample ID	Category
37	09/27/00	C-2-3-092700	Salvage

Description: Seven DAP filter cage assemblies were located in a "10-yard" recyclable metals container outside of the DAP plant. Scale was located on the 4-inch diameter end caps of each assembly.

Sample: Scale was scraped from a 1 square inch area on each end cap. The scale weighed 2.08 grams.

Survey Data: No exposure rates above background were detected on this sample.

Sample Analysis:

Nuclide	pCi/g
U-natural	378.6
Ra-226	20.9

Calculations: Uranium: 378.6 (pCi/g) x π x (2 (in.))^2 x 7

x (2.08 (g) / 1 (sq. in.)) = 69.3 nCi

Radium: 20.9 (pCi/g) x π x (2 (in.))^2 x 7

x (2.08 (g) / 1 (sq. in.)) = 3.8 nCi

Sample	Date	Sample ID	Category
38	09/27/00	C-2-4-092700	Salvage

Description: Filter cloth from the seven DAP filter cage assemblies was located in a "10-yard" recyclable metals container outside of a DAP plant. The filter cloth from each assembly was 4 inches in diameter and 8 feet long.

Sample: A 3 square inch section of the cloth, weighing 2.19 grams, was collected.

Survey Data: No exposure rates above background were detected on this sample.

Sample Analysis:

Nuclide	pCi/g
U-natural	87.8
Ra-226	17.1

Calculations:

Uranium: 87.8 (pCi/g) x 7 x 2 x π x 2 (in.) x 8 (ft.)

x 12 (in./ft.) x (2.19 (g) / 3 (sq. in.)) = 541.4 nCi

Radium: 17.1 (pCi/g) x 7 x 2 x π x 2 (in.) x 8 (ft.)

x 12 (in./ft.) x (2.19 (g) / 3 (sq. in.)) = 105.4 nCi

Sample	Date	Sample ID	Category
39	09/27/00	C-3-1-092700	Off-Site Disposal

Description: Cardboard trash was located in a "20-yard" container of general trash outside of a maintenance shop. The constituents of this container were cardboard (50%), paper trash (45%), and plastic (5%). The container was 50% full.

Sample: A 0.5 cu. in.. sample of cardboard weighed 2.07 grams.

Survey Data: No exposure rates above background were detected on this sample.

Sample Analysis:

Nuclide	pCi/g
U-natural	126.1
Ra-226	13.3

Calculations: Uranium: 126.1 (pCi/g) x 20 (cu. yd.) x 46656 (cu. in../cu. yd.)

x 0.50 x 0.50 x (2.07 (g) / 0.5 (cu. in..)) = 121.8 μCi

Radium: 13.3 (pCi/g) x 20 (cu. yd.) x 46656 (cu. in../cu. yd.)

x 0.50 x 0.50 x (2.07 (g) / 0.5 (cu. in..)) = 12.9 μCi

Sample	Date	Sample ID	Category
40	09/27/00	C-3-2-092700	Off-Site Disposal

Description: Paper trash was located in a "20-yard" container of general trash outside of a maintenance shop. The constituents of this container were cardboard (50%), paper trash (45%), and plastic (5%). The container was 50% full.

Sample: A 0.5 cu. in.. sample of paper weighed 2.17 grams.

Survey Data: No exposure rates above background were detected on this sample.

Sample Analysis:

Nuclide	pCi/g
U-natural	123.5
Ra-226	9.7

Calculations: Uranium: 123.5 (pCi/g) x 20 (cu. yd.) x 46656 (cu. in../cu. yd.)

x 0.45 x 0.50 x (2.17 (g) / 0.5 (cu. in..)) = 112.6 μCi

Radium: 9.7 (pCi/g) x 20 (cu. yd.) x 46656 (cu. in../cu. yd.)

x 0.45 x 0.50 x (2.17 (g) / 0.5 (cu. in..)) = 8.8 μCi

Sample	Date	Sample ID	Category
41	09/27/00	C-3-3-092700	Off-Site Disposal

Description: Plastic trash was located in a "20-yard" container of general trash outside of a maintenance shop. The constituents of this container were cardboard (50%), paper trash (45%), and plastic (5%). The container was 50% full.

Sample: A 0.5 cu. in.. sample of plastic weighed 5.90 grams.

Survey Data: No exposure rates above background were detected on this sample.

Sample Analysis:

Nuclide	pCi/g
U-natural	44.9
Ra-226	4.7

Calculations: Uranium: 44.9 (pCi/g) x 20 (cu. yd.) x 46656 (cu. in../cu. yd.)

x 0.05 x 0.50 x (5.90 (g) / 0.5 (cu. in..)) = 12.3 μCi

Radium: 4.7 (pCi/g) x 20 (cu. yd.) x 46656 (cu. in../cu. yd.)

x 0.05 x 0.50 x (5.90 (g) / 0.5 (cu. in..)) = 1.3 μCi

Sample	Date	Sample ID	Category
42	09/28/00	F-3-1-092800	Off-Site Disposal

Description: Fifty 3-inch diameter rubber washers were located in a "20-yard" container of rubber/plastic waste in the lay-down area.

Sample: One quarter of a washer, weighing 9.24 grams, was collected.

Survey Data: No exposure rates above background were detected on this sample.

Sample Analysis:

Nuclide	pCi/g
U-natural	35.1
Ra-226	5.8

Calculations: Uranium: 35.1 (pCi/g) x 50 x π x (1.5 (in.))^2

x (9.24 (g) / (0.25 x π x (1.5 (in.))^2)) = 64.8 nCi

Radium: 5.8 (pCi/g) x 50 x π x (1.5 (in.))^2

x (9.24 (g) / (0.25 x π x (1.5 (in.))^2)) = 10.7 nCi

Sample	Date	Sample ID	Category
43	09/28/00	F-3-2-092800	Off-Site Disposal

Description: A 48-inch rubber fan belt was located in a "20-yard" container of rubber/plastic waste in a lay-down area.

Sample: A 2-inch section, weighing 8.8 grams, was collected.

Survey Data: No exposure rates above background were detected on this sample.

Sample Analysis:

Nuclide	pCi/g
U-natural	26.0
Ra-226	4.3

Calculations: Uranium: 26.0 (pCi/g) x 48 (in.) x (8.8 (g) / 2 (in.))

= 5482.9 pCi

Radium: 4.3 (pCi/g) x 48 (in.) x (8.8 (g) / 2 (in.))

= 908.2 pCi

Sample	Date	Sample ID	Category
44	09/28/00	F-3-3-092800	Off-Site Disposal

Description: Wood pieces were located in a "20-yard" container of scrap wood products in a lay-down area. The container was 100% full.

Sample: A 0.5 cu. in.. sample weighed 2.05 grams.

Survey Data: No exposure rates above background were detected on this sample.

Sample Analysis:

Nuclide	pCi/g
U-natural	127.7
Ra-226	19.1

Calculations: yd.)

Uranium: 127.7 (pCi/g) x 20 (cu. yd.) x 46656 (cu. in../cu.

x (2.05 (g) / 0.5 (cu. in..)) = 488.6 μCi

Radium: 19.1 (pCi/g) x 20 (cu. yd.) x 46656 (cu. in../cu. yd.)

x (2.05 (g) / 0.5 (cu. in..)) = 731.7 μCi

Sample	Date	Sample ID	Category
45	09/28/00	F-2-1-092800	Salvage

Description: A 9 foot by 5 foot by 3 foot pile of metal shavings was located in a recyclable metals lay-down area.

Sample: A 0.5 cu. in.. sample of the shaving weighed 5.64 grams.

Survey Data: No exposure rates above background were detected on this sample.

Sample Analysis:

Nuclide	pCi/g
U-natural	47.3
Ra-226	3.7

Calculations: Uranium: 47.3 (pCi/g) x 135 (cu. ft.) x 1728 (cu. in../cu. ft.)

x (5.64 (g) / 0.5 (cu. in..)) = 124.5 μCi

Radium: 3.7 (pCi/g) x 135 (cu. ft.) x 1728 (cu. in../cu. ft.)

x (5.64 (g) / 0.5 (cu. in..)) = 9.7 μCi

Sample	Date	Sample ID	Category
46	09/28/00	F-2-2-092800	Salvage

Description: A 6-foot long stainless steel pipe with a 24-inch diameter was located in a recyclable metals lay-down area. The pipe had a ½ inch layer of scale on approximately 40% of the interior.

Sample: A 1.068 cu. in.. sample of scale weighed 10.32 grams.

Survey Data: No exposure rates above background were detected on this sample.

Sample Analysis:

Nuclide	pCi/g
U-natural	24.2
Ra-226	31.7

Calculations: Uranium: 24.2 (pCi/g) x 6 (ft.) x 12 (in./ft.) x π

x ((12 (in.))^2 – (11.5 (in.))^2) x 0.40

x (10.32 (g) / 1.068 (sq. in.)) = 248.4 nCi

Radium: 31.7 (pCi/g) x 6 (ft.) x 12 (in./ft.) x π

x ((12 (in.))^2 – (11.5 (in.))^2) x 0.40

x (10.32 (g) / 1.068 (sq. in.)) = 325.6 nCi

Sample	Date	Sample ID	Category
47	09/28/00	F-2-3-092800	Salvage

Description: A 3 foot by 15 foot by 1 inch metal grating was located in a recyclable metals lay-down area. Scale was embedded in approximately 75% of the recesses.

Sample: A 1.068 cu. in.. sample of scale weighed 9.65 grams.

Survey Data: No exposure rates above background were detected on this sample.

Sample Analysis:

Nuclide	pCi/g
U-natural	32.0
Ra-226	24.6

Calculations: Uranium: 32.0 (pCi/g) x 45 (sq. ft.) x 0.75 x 144 (sq. in./sq. ft.)

x 1 (in.) x (9.65 (g) / 1.068 (cu. in..)) = 1.4 μCi

Radium: 24.6 (pCi/g) x 45 (sq. ft.) x 0.75 x 144 (sq. in./sq. ft.)

x 1 (in.) x (9.65 (g) / 1.068 (cu. in..)) = 1.1 μCi

Sample	Date	Sample ID	Category
48	09/28/00	F-2-4-092800	Salvage

Description: Metal insulation wrapping the elbow of a 6-inch diameter pipe was located on the ground in a metals lay-down area. The length of the insulation was 10 inches.

Sample: A 4 square inch sample of insulation was collected that weighed 2.89 grams.

Survey Data: No exposure rates above background were detected on this sample.

Sample Analysis:

Nuclide	pCi/g
U-natural	104.3
Ra-226	9.9

Calculations: Uranium: 104.3 (pCi/g) x 2 x π x 3 (in.) x 10 (in.)

x (2.89 (g) / 4 (sq. in)) = 14.2 nCi

Radium: 9.9 (pCi/g) x 2 x π x 3 (in.) x 10 (in.)

x (2.89 (g) / 4 (sq. in)) = 1.3 nCi

Sample	Date	Sample ID	Category
49	09/28/00	F-3-4-092800	Off-Site Disposal

Description: A "20-yard" container was completely filled with cardboard trash outside of a maintenance shop.

Sample: A 1.0 cu. in.. sample of the cardboard weighed 3.01 grams.

Survey Data: No exposure rates above background were detected on this sample.

Sample Analysis:

Nuclide	pCi/g
U-natural	100.6
Ra-226	7.1

Calculations: Uranium: 100.6 (pCi/g) x 20 (cu. yd.) x 46656 (cu. in../cu. yd.)

x (3.01 (g) / 1.0 (cu. in..)) = 282.5 μCi

Radium: 7.1 (pCi/g) x 20 (cu. yd.) x 46656 (cu. in../cu. yd.)

x (3.01 (g) / 1.0 (cu. in..)) = 19.9 μCi

Sample	Date	Sample ID	Category
50	09/28/00	E-3-1-092800	Off-Site Disposal

Description: A rubber hose, approximately 75 feet long, was located in a "2-yard" trash container at a phosphoric acid plant.

Sample: A 0.5-inch section weighing 3.18 grams was collected.

Survey data: No exposure rates above background were detected on this sample.

Sample Analysis:

Nuclide	pCi/g
U-natural	67.5
Ra-226	10.5

Calculations: Uranium: 67.5 (pCi/g) x 900 (in.)

x (3.18 (g) / 0.5 (in.)) = 386.5 nCi

Radium: 10.5 (pCi/g) x 900 (in.)

x (3.18 (g) / 0.5 (in.)) = 60.1 nCi

Sample	Date	Sample ID	Category
51	09/28/00	E-3-2-092800	Off-Site Disposal

Description: A rubber fan belt, approximately 25 feet long, was located in a "2-yard" trash container at a Phosphoric Acid plant.

Sample: A 1 inch section weighing 9.66 grams was collected.

Survey data: No exposure rates above background were detected on this sample.

Sample Analysis:

Nuclide	pCi/g
U-natural	29.1
Ra-226	2.4

Calculations: Uranium: 29.1 (pCi/g) x 300 (in.)

x (9.66 (g) / 1 (in.)) = 84.3 nCi

Radium: 2.4 (pCi/g) x 300 (in.)

x (9.66 (g) / 1 (in.)) = 7.0 nCi

Sample	Date	Sample ID	Category
52	09/28/00	E-3-3-092800	Off-Site Disposal

Description: Cardboard trash was located in a "2-yard" trash container at a maintenance shop. There was estimated to be 1 cubic yard of cardboard in the container.

Sample: Approximately 0.5 cu. in.. weighing 3.80 grams was collected.

Survey data: No exposure rates above background were detected on this sample.

Sample Analysis:

Nuclide	pCi/g
U-natural	79.0
Ra-226	5.3

Calculations: Uranium: 79.0 (pCi/g) x (3.80 (g) / 0.5 (cu. in..)) x 1 (cu. yd.)

x 46656 (cu. in../cu. yd.) = 28.0 μCi

Radium: 5.3 (pCi/g) x (3.80 (g) / 0.5 (cu. in..)) x 1 (cu. yd.)

x 46656 (cu. in../cu. yd.) = 1.9 μCi.

Sample	Date	Sample ID	Category
53	09/28/00	E-3-4-092800	Off-Site Disposal

Description: Cloth coveralls were located in a "2-yard" trash container at a maintenance shop. There was estimated to be 2 cubic feet of cloth materials in the container.

Sample: Approximately 1.0 cu. in.. weighing 5.21 grams was collected.

Survey data: No exposure rates above background were detected on this sample.

Sample Analysis:

Nuclide	pCi/g
U-natural	49.2
Ra-226	3.7

Calculations: Uranium: 49.2 (pCi/g) x (5.21 (g) / 1 (cu. in..)) x 2 (cu. ft.)

x (1728 (cu. in.. / cu. ft.)) = 885.9 nCi

Radium: 3.7 (pCi/g) x (5.21 (g) / 1.0 (cu. in..)) x 2 (cu. ft.)

x (1728 (cu. in.. / cu. ft.)) = 66.6 nCi.

Sample	Date	Sample ID	Category
54	09/28/00	E-3-5-092800	Off-Site Disposal

Description: Plastic chemical suit and other miscellaneous plastics were located in a "2-yard" trash container at a maintenance shop. There was estimated to be 2 cubic feet of plastic materials in the container.

Sample: Approximately 0.5 cu. in.. weighing 2.28 grams was collected.

Survey data: No exposure rates above background were detected on this sample.

Sample Analysis:

Nuclide	pCi/g
U-natural	97.7
Ra-226	8.6

Calculations: Uranium: 97.7 (pCi/g) x (2.28 (g) / 0.5 (cu. in..)) x 2 (cu. ft.)

x (1728 (cu. in../cu. ft.)) = 1539.2 nCi

Radium: 8.6 (pCi/g) x (2.28 (g) / 0.5 (cu. in..)) x 2 (cu. ft.)

x (1728 (cu. in../cu. ft.)) = 135.5 nCi

Sample	Date	Sample ID	Category
55	09/28/00	E-2-1-092800	Salvage

Description: A pipe with a 9-inch outside diameter was located in a "20-yard" Recyclable Metals container in a metals lay-down area. The pipe was 20 feet long and had a thin layer of scale on approximately 50% of its outside surface.

Sample: Scale was removed from a 2 square inch area of the pipe exterior, which resulted in a sample weighing 14.57 grams.

Survey data: No exposure rates above background were detected on this sample.

Sample Analysis:

Nuclide	pCi/g
U-natural	23.9
Ra-226	1.6

Calculations: Uranium: 23.9 (pCi/g) x (π x 9 (in.)) x 240(in.) x 0.50

x (14.57 (g) / 2 (sq. in.)) = 589.9 nCi

Radium: 1.6 (pCi/g) x (π x 9 (in.)) x 240(in.) x 0.50

x (14.57 (g) / 2 (sq. in.)) = 39.5 nCi

Sample	Date	Sample ID	Category
56	09/28/00	E-2-2-092800	Salvage

Description: A pipe coupling junction with an 18-inch diameter that was located in a "20-yard" Recyclable Metals container in a metals lay-down area. The pipe junction was 18 inches long and had a 1.5 inch layer of scale throughout the pipe.

Sample: A 0.763 cu. in.. sample that weighed is 6.84 grams was collected.

Survey data: No exposure rates above background were detected on this sample.

Sample Analysis:

Nuclide	pCi/g
U-natural	47.4
Ra-226	2.3

Calculations:

Uranium: 47.4 (pCi/g) x (π x (9 (in.))^2) - (π x (7.5 (in.))^2)

x 18 (in.) x (6.84 (g) / 0.763 (cu. in..)) = 594.9 nCi

Radium: 2.3 (pCi/g) x (π x (9 (in.))^2) - (π x (7.5 (in.))^2)

x 18 (in.) x (6.84 (g) / 0.763 (cu. in..)) = 28.9 nCi

Sample	Date	Sample ID	Category
57	09/28/00	E-2-3-092800	Salvage

Description: A pipe with a 9-inch outside diameter was located in a "20-yard" Recyclable Metals container in a metals lay-down area. The pipe has a 90-degree elbow at one end and has a total length of approximately 10 feet. There was a thin layer of scale on approximately 50% of its outside surface.

Sample: Scale was removed from a 2 square inch area of the pipe exterior, which resulted in a sample weighing 19.14 grams.

Survey data: No exposure rates above background were detected on this sample.

Sample Analysis:

Nuclide	pCi/g
U-natural	22.2
Ra-226	5.0

Calculations: Uranium: 22.2 (pCi/g) x π x 9 (in.) x 120 (in.) x 0.50

x (19.14 (g) / 2 (sq. in.)) = 360.3 nCi

Radium: 5.0 (pCi/g) x π x 9 (in.) x 120 (in.) x 0.50

x (19.14 (g) / 2 (sq. in.)) = 81.2 nCi

Sample	Date	Sample ID	Category
58	09/29/00	G-4-1-092900	On-Site Disposal

Description: Approximately 2.0 cubic yards of used filter cloth was located on the phosphogypsum stack where it had recently been dumped.

Sample: A 1.0 cu. in.. sample weighing 3.18 grams was collected.

Survey Data: Exposure rates of up to 280 μR/hr above background were detected on the filter cloth.

Sample Analysis:

Nuclide	pCi/g
U-natural	67.1
Ra-226	7822.7

Calculations: Uranium: 67.1 (pCi/g) x 0.25 (cu. yd.)

x 46656 (cu. in../cu. yd.) x (3.18 (g) / 1.0 (cu. in..))

= 2.5 μCi

Radium: 7822.7 (pCi/g) x 0.25 (cu. yd.)

x 46656 (cu. in../cu. yd.) x (3.18 (g) / 1.0 (cu. in..))

= 290.2 μCi

Sample	Date	Sample ID	Category
59	09/29/00	G-4-2-092900	On-Site Disposal

Description: A valve that has a 1-inch diameter and 5 inches long was located in a "2-yard" container at a Phosphoric Acid plant. The outside of the valve is covered with a layer of scale.

Sample: Scale was removed from a 2 square inch area of the pipe exterior, which resulted in a sample weighing 4.63 grams.

Note: This container was for temporary disposal. These items were to be segregated prior to determination of final disposition. Site personnel noted that based on the appearance of this item, it would automatically be set in the gypsum stack laydown area.

Survey Data: No exposure rates above background were detected on this sample.

Sample Analysis:

Nuclide	pCi/g
U-natural	91.6
Ra-226	5.1

Calculations: Uranium: 91.6 (pCi/g) x π x 1 (in.) x 5 (in.)

x (4.63 (g) / 2 (sq. in.)) = 3330.7 pCi

Radium: 5.1 (pCi/g) x π x 1 (in.) x 5 (in.)

x (4.63 (g) / 2 (sq. in.)) = 0185.5 pCi

Sample	Date	Sample ID	Category
60	09/29/00	G-2-1-092900	Salvage

Description: Stainless steel sample tubing with a 0.5 inch diameter was located in a "2-yard" container at a Phosphoric Acid plant. This tubing had a total length of 6 feet

Sample: A 1 inch section weighing 12.65 grams was collected.

Note: This container is for temporary disposal. These items will be segregated prior to determination of final disposition.

Survey Data: No exposure rates above background were detected on this sample.

Sample Analysis:

Nuclide	pCi/g
U-natural	22.3
Ra-226	2.4

Calculations: Uranium: 22.3 (pCi/g) x 6 (ft) x 12 (in. / ft.)

x (12.65 (g) / 1 (in.)) = 20.3 nCi

Radium: 2.4 (pCi/g) x 6 (ft.) x 12 (in. / ft.)

x (12.65 (g) / 1 (in.)) = 2.2 nCi

Sample	Date	Sample ID	Category
61	09/29/00	G-2-2-092900	Salvage

Description: Metal insulation wrapping that had a diameter of 8 inches was located in a "2-yard" container at a maintenance shop. There were three pieces of the insulation wrapping that were 36 inches long.

Sample: A 3 inch section weighing 4.81 grams was collected.

Survey Data: No exposure rates above background were detected on this sample.

Sample Analysis:

Nuclide	pCi/g
U-natural	66.1
Ra-226	1.8

Calculations: Uranium: 66.1 (pCi/g) x π x 8 (in.) x 36 (in.) x 3

x (4.81 (g) / 3 (sq. in.)) = 287.7 nCi

Radium: 1.8 (pCi/g) x π x 8 (in.) x 36 (in.) x 3

x (4.81 (g) / 3 (sq. in.)) = 7.8 nCi

Sample	Date	Sample ID	Category
62	09/29/00	G-4-3-092900	On-Site Disposal

Description: A rubber conveyor belt was located on the ground in a gypsum stack lay-down area. The conveyor belt was 30 inches wide and approximately 150 feet long. A 1 square inch section of this item was collected. The weight of the collected sample is 5.77 grams.

Sample: A 1 square inch section weighing 5.77 grams was collected.

Survey Data: No exposure rates above background were detected on this sample.

Sample Analysis:

Nuclide	pCi/g
U-natural	46.7
Ra-226	1.1

Calculations: Uranium: 46.7 (pCi/g) x 30 (in.) x 150 (ft.) x 12 (in./ft.)

x (5.77 (g) / 1 (sq. in.)) = 14546.8 nCi

Radium: 1.1 (pCi/g) x 30 (in.) x 150 (ft.) x 12 (in./ft.)

x (5.77 (g) / 1 (sq. in.)) = 342.7 nCi

Sample	Date	Sample ID	Category
63	09/29/00	G-2-3-092900	Salvage

Description: A 5 foot by 8 foot by 2 foot pile of small metal pieces and slag were located on the ground in a metals lay-down area.

Sample: Approximately 1.0 cu. in.. weighing 24.11 grams was collected.

Survey Data: No exposure rates above background were detected on this sample.

Sample Analysis:

Nuclide	pCi/g
U-natural	11.9
Ra-226	1.3

Calculations: Uranium: 11.9 (pCi/g) x 5 (ft.) x 8 (ft.) x 2 (ft.)

x 1728 (cu. in../cu. ft.)

x (24.11 (g) / 1 (cu. in..)) = 39.8 μCi

Radium: 1.3 (pCi/g) x 5 (ft.) x 8 (ft.) x 2 (ft.)

x 1728 (cu. in../cu. ft.)

x (24.11 (g) / 1 (cu. in..)) = 4.3 μCi

Sample	Date	Sample ID	Category
64	10/23/00	D-2-1-102300	Salvage

Description: A pipe spacer that had a diameter of 48 inches was located on the ground in a metals lay-down area. The pipe spacer was 10 inches long and had a 1/8-inch layer of scale throughout the inside.

Sample: A 1.22 cu. in.. sample that weighed 13.69 grams was collected.

Survey Data: No exposure rates above background were detected on this sample.

Sample Analysis:

Nuclide	pCi/g
U-natural	16.3
Ra-226	69.0

Calculations: Uranium: 16.3 (pCi/g) x π x ((24 (in.))^2

– (23.875 (in.))^2) x 10 (in.)

x (13.69 (g) / 1.22 (cu. in..)) = 34.5 nCi

Radium: 69.0 (pCi/g) x π x ((24 (in.))^2

– (23.875 (in.)^2) x 10 (in.)

x (13.69 (g) / 1.22 (cu. in..)) = 145.6 nCi

Sample	Date	Sample ID	Category
65	10/23/00	D-2-2-102300	Salvage

Description: A pipe that had a diameter of 18 inches was located on the ground in a metals lay-down area. The pipe was 20 feet long and had a 1-inch layer of scale throughout the inside.

Sample: A 1.22 cu. in.. sample that weighed 21.56 grams was collected.

Survey Data: Exposure rates of up to 100 μR/hr above background were detected on this item.

Note: This item is subject to On-Site Disposal upon survey by site personnel.

Sample Analysis:

Nuclide	pCi/g
U-natural	13.9
Ra-226	121.8

Calculations: Uranium: 13.9 (pCi/g) x π x ((9 (in.)^2) – (8 (in.)^2)))

x 20 (ft) x 12 (in./ft.)

x (21.56 (g) / 1.22 (cu. in..)) = 3.2 μCi

Radium: 121.8 (pCi/g) x π x ((9 (in.)^2) – 8 (in.)^2)))

x 20 (ft) x 12 (in./ft.)

x (21.56 (g) / 1.22 (cu. in..)) = 27.6 μCi

Sample	Date	Sample ID	Category
66	10/23/00	D-2-3-102300	Salvage

Description: A 3 foot by 2 foot by 2 foot pile of metal shavings was located on the ground in a metals lay-down area.

Sample: Approximately 0.5 cu. in.. of shavings weighing 3.19 grams was collected.

Survey Data: No exposure rates above background were detected on this sample.

Sample Analysis:

Nuclide	PCi/g
U-natural	64.8
Ra-226	1.3

Calculations: Uranium: 64.8 (pCi/g) x 3 (ft.) x 2 (ft.) x 2 (ft.)

x 1728 (cu. in../cu. ft.)

x (3.19 (g) / 0.5 (cu. in..)) = 8572.3 nCi

Radium: 1.3 (pCi/g) x 3 (ft.) x 2 (ft.) x 2 (ft.)

x 1728 (cu. in../cu. ft.)

x (3.19 (g) / 0.5 (cu. in..)) = 172.0 nCi

Sample	Date	Sample ID	Category
67	10/23/00	D-2-4-102300	Salvage

Description: A 5 foot by 4 foot by 1 foot pile of metal balls from the ball mill was located on the ground in a metals lay-down area.

Sample: Approximately 1.0 cu. in.. of metal balls weighing 53.09 grams was collected.

Survey Data: No exposure rates above background were detected on this sample.

Sample Analysis:

Nuclide	pCi/g
U-natural	4.8
Ra-226	0.4

Calculations: Uranium: 4.8 (pCi/g) x 5 (ft.) x 4 (ft.) x 1 (ft.)

x 1728 (cu. in../cu. ft.)

x (53.09 (g) / 1 (cu. in..)) = 8835.1 nCi

Radium: 0.4 (pCi/g) x 5 (ft.) x 4 (ft.) x 1 (ft.)

x 1728 (cu. in../cu. ft.)

x (53.09 (g) / 1.0 (cu. in..)) = 733.9 nCi

Sample	Date	Sample ID	Category
68	10/23/00	D-3-1-102300	Off-Site Disposal

Description: Approximately 1 cubic foot of cardboard boxes were located on the ground in a metals lay-down area mixed with the metal scrap.

Sample: Approximately 0.5 cu. in.. of the cardboard weighing 3.81 grams was collected.

Survey Data: No exposure rates above background were detected on this sample.

Sample Analysis:

Nuclide	PCi/g
U-natural	58.2
Ra-226	1.2

Calculations: Uranium: 58.2 (pCi/g) x 1.0 (cu. ft.)

x 1728 (cu. in../cu. ft.) x (3.81 (g) / 0.5 (cu. in..))

= 766.3 nCi

Radium: 1.2 (pCi/g) x 1.0 (cu. ft.)

x 1728 (cu. in../cu. ft.) x (3.81 (g) / 0.5 (cu. in..))

= 15.8 nCi

Sample	Date	Sample ID	Category
69	10/23/00	D-2-5-102300	Salvage

Description: A rubber lined pipe that had a diameter of 24 inches was located on the ground in a metals lay-down area. The pipe was 30 feet long and had a thin layer of scale throughout the inside.

Sample: A 3 square inch section of the rubber lining and scale weighing 8.60 grams was collected.

Survey Data: No exposure rates above background were detected on this sample.

Sample Analysis:

Nuclide	pCi/g
U-natural	30.5
Ra-226	6.8

Calculations: Uranium: 30.5 (pCi/g) x ((π x 24 (in.)) x 30 (ft.) x 12 (in./ft.))

x (8.60 (g) / 3 (sq. in.)) = 2370.3 nCi

Radium: 6.8 (pCi/g) x ((π x 24 (in.)) x 30 (ft.) x 12 (in./ft.))

x (8.60 (g) / 3 (sq. in.)) = 529.1 nCi

Sample	Date	Sample ID	Category
70	10/23/00	D-2-6-102300	Salvage

Description: A filter pan roller wheel was located in a metals lay-down area. The wheel hub was 8 inches in diameter with a 2 inch diameter axle opening. Scale was an average of approximately ½ inch thick on all exposed portions of the roller wheel.

Sample: A 0.915 cu. in.. scale sample weighing 12.07 grams was collected.

Survey Data: No exposure rates above background were detected on this sample.

Sample Analysis:

Nuclide	pCi/g
U-natural	33.3
Ra-226	15.1

Calculations: Uranium: 33.3 (pCi/g) x π x ((4 (in.))^2 – (1 (in.))^2)

x 2 x 0.5 (in.) x (12.07 (g) / 0.915 (cu. in..))

= 20.7 nCi

Radium: 15.1 (pCi/g) x π x ((4 (in.))^2 – (1 (in.))^2)

x 2 x 0.5 (in.) x (12.07 (g) / 0.915 (cu. in..))

= 9.4 nCi

Sample	Date	Sample ID	Category
71	10/23/00	D-3-2-102300	Off-Site Disposal

Description: A rubber gasket that had an outside diameter of 10 inches and an inside diameter of 7.5 inches was located in a metals lay-down area.

Sample: A 4 square inch section of the rubber gasket weighing 8.24 grams was collected.

Survey Data: No exposure rates above background were detected on this sample.

Sample Analysis:

Nuclide	pCi/g
U-natural	31.9
Ra-226	1.3

Calculations: Uranium: 31.9 (pCi/g) x π x ((5 (in.))^2 – (3.75 (in.))^2)

x (8.24 (g) / 4 (sq. in.)) = 2259.9 pCi

Radium: 1.3 (pCi/g) x π x ((5 (in.))^2 – (3.75 (in.))^2)

x (8.24 (g) / 4 (sq. in.)) = 92.0 pCi

Sample	Date	Sample ID	Category
72	10/23/00	B-2-1-102300	Salvage

Description: Insulated electrical wiring that had a diameter if ¼ inch was located in a "20-yard" Recyclable Metals container in the metals lay-down area. The total length of the wiring in the container is approximately 50 feet and it is covered with a thin layer of scale.

Sample: A 12-inch section of the wire weighing 6.47 grams was collected.

Survey Data: No exposure rates above background were detected on this sample.

Sample Analysis:

Nuclide	pCi/g
U-natural	46.4
Ra-226	2.7

Calculations: Uranium: 46.4 (pCi/g) x 50 (ft.) x 12 (in./ft.)

x (6.47 (g) / 12 (in.)) = 15001.2 pCi

Radium: 2.7 (pCi/g) x 50 (ft.) x 12 (in./ft.)

x (6.47 (g) / 12 (in.)) = 873.5 pCi

Sample	Date	Sample ID	Category
73	10/23/00	B-2-2-102300	Salvage

Description: An insulated 5-wire cable that had a diameter of ½ inch was located in a "20-yard" Recyclable Metals container in the metals lay-down area. The total length of the wiring in the container is approximately 100 feet and it is covered with a thin layer of scale.

Sample: A 1.5 inch section of the wire weighing 6.90 grams was collected.

Survey Data: No exposure rates above background were detected on this sample.

Sample Analysis:

Nuclide	pCi/g
U-natural	36.4
Ra-226	0.4

Calculations: Uranium: 36.4 (pCi/g) x 100 (ft.) x 12 (in./ft.)

x (6.90 (g) / 1.5 (in.)) = 201.0 nCi

Radium: 0.4 (pCi/g) x 100 (ft.) x 12 (in./ft.)

x (6.90 (g) / 1.5 (in.)) = 2.2 nCi

Sample	Date	Sample ID	Category
74	10/23/00	B-2-3-102300	Salvage

Description: A 3/8-inch diameter nylon rope was located in a "20-yard" Recyclable Metals container in the metals lay-down area. The rope was being used to tie up electrical cables and its total length was approximately 25 feet.

Note: This item is included as a recyclable metal because it will likely be shipped with the materials in the container and then disposed of by the salver.

Sample: A 6-inch section of the rope weighing 2.8 grams was collected.

Survey Data: No exposure rates above background were detected on this sample.

Sample Analysis:

Nuclide	pCi/g
U-natural	67.6
Ra-226	1.4

Calculations: Uranium: 67.6 (pCi/g) x 25 (ft.) x 12 (in./ft.)

x (2.80 (g) / 6 (in.)) = 9467.3 pCi

Radium: 1.4 (pCi/g) x 25 (ft.) x 12 (in./ft.)

x (2.80 (g) / 6 (in.)) = 196.0 pCi

Sample	Date	Sample ID	Category
75	10/23/00	B-2-4-102300	Salvage

Description: Metal filings and slag were located in a "20-yard" Recyclable Metals container in a metals lay-down area. There was estimated to be 0.5 cubic feet of these materials in the container.

Sample: A 1.068 cu. in.. sample weighing 30.41 grams was collected.

Survey Data: No exposure rates above background were detected on this sample.

Sample Analysis:

Nuclide	pCi/g
U-natural	9.8
Ra-226	1.4

Calculations: Uranium: 9.8 (pCi/g) x 0.5 (cu. ft.) x ((1728 cu. in..) / 1 (cu. ft.)) x (30.41 (g) / 1.068 (cu. in..))

= 242.1 nCi

Radium: 1.4 (pCi/g) x 0.5 (cu. ft.) x ((1728 cu. in..) / 1 (cu. ft.)) x (30.41 (g) / 1.068 (cu. in..))

= 34.4 nCi

Sample	Date	Sample ID	Category
76	10/23/00	B-2-5-102300	Salvage

Description: Electrical conduit with a diameter of 1.5 inches was located in a "20-yard" Recyclable Metals container in a metals lay-down area. The conduit was 6 feet long and had a 1/8-inch layer of scale on its outside surface.

Sample: Scale from a 2 square inch section of the conduit weighing 16.97 grams was collected.

Survey Data: No exposure rates above background were detected on this sample.

Sample Analysis:

Nuclide	pCi/g
U-natural	27.0
Ra-226	57.7

Calculations: Uranium: 27.0 (pCi/g) x ((π x 1.5 (in.)) x 6 (ft.) x 12 (in./ft.))

x (16.97 (g) / 2 (sq. in.)) = 77.7 nCi

Radium: 57.7 (pCi/g) x ((π x 1.5 (in.)) x 6 (ft.) x 12 (in./ft.))

x (16.97 (g) / 2 (sq. in.)) = 166.1 nCi

Sample	Date	Sample ID	Category
77	10/26/00	A-2-1-102600	Salvage

Description: "Black Beauty" Sandblast media was located in a "30-yard" Recyclable Metals container in a metals lay-down area. There was estimated to be 1.0 cubic feet of sandblast media mixed with the metal scrap in the container.

Sample: A 1.22 cu. in.. sample weighing 34.54 grams was collected.

Survey Data: No exposure rates above background were detected on this sample.

Sample Analysis:

Nuclide	pCi/g
U-natural	10.2
Ra-226	3.5

Calculations: Uranium: 10.2 (pCi/g) x 1.0 (cu. ft.) x ((1728 cu. in..) / 1 (cu. ft.)) x (34.54 (g) / 1.22 (cu. in..))

= 496.8 nCi

Radium: 3.5 (pCi/g) x 1.0 (cu. ft.) x ((1728 cu. in..) / 1 (cu. ft.)) x (34.54 (g) / 1.22 (cu. in..))

= 171.2 nCi

Sample	Date	Sample ID	Category
78	10/26/00	A-3-1-102600	Salvage

Description: Braided steel sample tubing with a diameter of ½ inch was located in a "20-yard" container of scrap fiberglass in the metals lay-down area. The tubing was attached to a fiberglass vessel and had a total length of 36 inches.

Sample: A 2 inch section of the tubing weighing 11.76 grams was collected.

Survey Data: No exposure rates above background were detected on this sample.

Sample Analysis:

Nuclide	pCi/g
U-natural	22.8
Ra-226	1.4

Calculations: Uranium: 22.8 (pCi/g) x 36 (in.)

x (11.76 (g) / 2 (in.)) = 4830.5 pCi

Radium: 1.4 (pCi/g) x 36 (in.)

x (11.76 (g) / 2 (in.)) = 296.4 pCi

Sample	Date	Sample ID	Category
79	10/26/00	A-3-2-102600	Off-Site Disposal

Description: Paper trash was located in a "2-yard" container at a Phosphoric Acid plant. There was estimated to be 5 cubic feet of paper in the container.

Sample: Approximately a 1.0 cu. in.. sample of paper weighing 3.69 grams was collected.

Survey Data: No exposure rates above background were detected on this sample.

Sample Analysis:

Nuclide	pCi/g
U-natural	74.1
Ra-226	0.2

Calculations: Uranium: 74.1 (pCi/g) x 5 (cu. ft.) x 1728 (cu. in../cu. ft.)

x (3.69 (g) / 1.0 (cu. in..)) = 2362.9 nCi

Radium: 0.2 (pCi/g) x 5 (cu. ft.) x 1728 (cu. in../cu. ft.)

x (3.69 (g) / 1.0 (cu. in..)) = 6.4 nCi

Sample	Date	Sample ID	Category
80	10/26/00	A-3-3-102600	Off-Site Disposal

Description: A Tyvex suit, with an estimated volume of 0.1 cubic feet, trash was located in a "2-yard" container at a Phosphoric Acid plant.

Sample: Approximately a 1.0 cu. in.. sample of tyvex weighed 2.10 grams.

Survey Data: No exposure rates above background were detected on this sample.

Sample Analysis:

Nuclide	pCi/g
U-natural	124.4
U-235	5.4
Ra-226	6.1

Calculations: Uranium: 124.4 (pCi/g) x 0.1 (cu. ft.) x 1728 (cu. in../cu. ft.)

x (2.10 (g) / 1.0 (cu. in..)) = 45.2 nCi

Radium: 6.1 (pCi/g) x 0.1 (cu. ft.) x 1728 (cu. in../cu. ft.)

x (2.10 (g) / 1.0 (cu. in..)) = 2.2 nCi

Sample	Date	Sample ID	Category
81	10/26/00	A-3-4-102600	Off-Site Disposal

Description: Two pairs of work gloves (4 gloves) were located in a "2-yard" container at a Phosphoric Acid plant.

Sample: A 1.5 inch section of a glove fingertip, representing an estimated 2% of the mass of one glove was collected. The sample weighed 6.27 grams.

Survey Data: No exposure rates above background were detected on this sample.

Nuclide	pCi/g
U-natural	26.6
Ra-226	8.7

Calculations: Uranium: 26.6 (pCi/g) x 4 x (6.27 (g) / 0.02) = 33.3 nCi

Radium: 8.7 (pCi/g) x 4 x (6.27 (g) / 0.02) = 10.9 nCi

Sample	Date	Sample ID	Category
82	10/26/00	A-2-2-102600	Salvage

Description: Seven pieces of grating measuring 3 foot by 2 foot were located in a "20-yard" container of Recyclable Metals at a Phosphoric Acid plant. The grating has an estimated scale coverage of 60% on both the front and back sides.

Sample: Scale from a 2 square inch section of the grating weighing 11.45 grams was collected.

Survey Data: No exposure rates above background were detected on this sample.

Sample Analysis:

Nuclide	pCi/g
U-natural	37.9
Ra-226	12.8

Calculations: Uranium: 37.9 (pCi/g) x 3 (ft.) x 2 (ft.) x 144 (sq. in./sq. ft.)

x 2 x 7 x 0.60 x (11.45 (g) / 2 (sq. in.)) = 1574.5 nCi

Radium: 12.8 (pCi/g) x 3 (ft.) x 2 (ft.) x 144 (sq. in./sq. ft.)

x 2 x 7 x 0.60 x (11.45 (g) / 2 (sq. in.)) = 531.8 nCi

Sample	Date	Sample ID	Category
83	10/26/00	A-3-5-102600	Off-Site Disposal

Description: Scrubber media used in the dry products process was located in a "20-yard" container of landfill scrap scrubber media adjacent to a DAP plant. The scrubber media was covered in a thin layer of scale. A one cubic foot sample contained 10 pieces of the scrubber media.

Sample: The scale from one piece of the scrubber media weighing 18.03 grams was collected.

Survey Data: No exposure rates above background were detected on this sample.

Sample Analysis:

Nuclide	pCi/g
U-natural	9.8
Ra-226	37.4

Calculations: Uranium: 9.8 (pCi/g) x 20 (cu. yd.) x 27 (cu. ft./cu. yd.)

x 10 (pcs. / cu. ft.) x (18.03 (g) / 1 (pc.))

= 9580.3 nCi

Radium: 37.4 (pCi/g) x 20 (cu. yd.) x 27 (cu. ft./cu. yd.)

x 10 (pcs. / cu. ft.) x (18.03 (g) / 1 (pc.))

= 354.4 nCi

Sample	Date	Sample ID	Category
84	10/26/00	A-3-6-102600	Off-Site Disposal

Description: An estimated 5 cubic feet of dirt was mixed in with scrubber media (see sample #83) was located in a "20-yard" container of landfill scrap scrubber media adjacent to a DAP plant.

Sample: A 1.068 cu. in.. sample weighing 24.94 grams was collected.

Survey Data: No exposure rates above background were detected on this sample.

Sample Analysis:

Nuclide	pCi/g
U-natural	9.9
Ra-226	6.5

Calculations: Uranium: 9.9 (pCi/g) x 5 (cu. ft.) x (1728 (cu. in../cu. ft.)

x (24.94 (g) / 1.068 (cu. in..)) = 2.0 μCi

Radium: 6.5 (pCi/g) x 5 (cu. ft.) x (1728 (cu. in../cu. ft.)

x (24.94 (g) / 1.068 (cu. in..)) = 1.3 μCi

Sample	Date	Sample ID	Category
85	10/26/00	A-3-6-102600	Off-Site Disposal

Description: Scrubber media from the dry products process was located in a "20-yard" container of landfill scrap scrubber media adjacent to a DAP plant (see sample #83). The scrubber media was covered in a thin layer of scale. A one cubic foot sample of the scrubber media contained 10 pieces. The estimated surface area of each piece of the scrubber media is 30 square inches.

Sample: A 2 sq. in. section of the scrubber media with the scale attached weighing 12.97 grams was collected.

Survey Data: No exposure rates above background were detected on this sample.

Sample Analysis:

Nuclide	pCi/g
U-natural	25.1
Ra-226	58.4

Calculations: Uranium: 25.1 (pCi/g) x 20 (cu. yd.) x 27 (cu. ft./cu. yd.)

x 10 (pcs. / cu. ft.) x 30 (sq. in. / pc.)

x (12.97 (g) / 2 (sq. in.)) = 26.4 μCi

Radium: 58.4 (pCi/g) x 20 (cu. yd.) x 27 (cu. ft./cu. yd.)

x 10 (pcs. / cu. ft.) x 30 (sq. in. / pc.)

x (12.97 (g) / 2 (sq. in.)) = 61.4 μCi

Sample	Date	Sample ID	Category
86	10/26/00	C-2-1-102600	Salvage

Description: A bucket conveyor assembly was located in a "20-yard" Recyclable Metals container in a metals lay-down area. The assembly was approximately 50 feet long and had approximately 50 buckets. The dimensions of each bucket were 30 inches by 12 inches by 12 inches. There was a thin layer of scale adhering to all of the outside surfaces of the buckets.

Sample: A scale sample from a 16 sq. in. area of the bucket assembly weighing 12.00 grams was collected.

Survey Data: No exposure rates above background were detected on this sample

Sample Analysis:

Nuclide	pCi/g
U-natural	37.4
Ra-226	2.8

Calculations: The total area covered with scale on this item was determined by calculating the surface areas for the exterior surfaces for one bucket (front, back, bottom, and both sides). These values were then added together to get the total surface area for each bucket. This value was then multiplied by the number of buckets (50) to get the total surface area for the assembly.

Surface Areas:

Front: (30 (in.) x 12 (in.)) = 360 (sq. in.)
Back: (30 (in.) x 12 (in.)) = 360 (sq. in.)
Bottom: (30 (in.) x 12 (in.)) = 360 (sq. in.)
Sides: ((12 (in.) x 12 (in.)) x 2) = 288 (sq. in.)

Total: (((360 (sq. in.) x 3) + 288 (sq. in.)) x 50) = 68400 (sq. in.)

Uranium: 37.4 (pCi/g) x 68400 (sq. in.)

x (12.00 (g) / 16 (sq. in.)) = 1917.1 nCi

Radium: 2.8 (pCi/g) x 68400 (sq. in.)

x (12.00 (g) / 16 (sq. in.)) = 143.6 nCi

Sample	Date	Sample ID	Category
87	10/26/00	C-3-1-102600	Off-Site Disposal

Description: A work glove was located in a "2-yard" container in a metal laydown area.

Sample: A 1-inch section of the glove fingertip, representing an estimated 2% the mass of the glove, was collected. The sample weighed 5.64 grams.

Survey Data: No exposure rates above background were detected on this sample

Sample Analysis:

Nuclide	pCi/g
U-natural	40.1
Ra-226	3.0

Calculations: Uranium: 40.1 (pCi/g) x 1.00

x (5.64 (g) / 0.02) = 12149.1 pCi

Radium: 3.0 (pCi/g) x 1.00

x (5.64 (g) / 0.02) = 846.0 pCi

Sample	Date	Sample ID	Category
88	10/26/00	C-2-2-102600	Salvage

Description: An I-beam was located in a "20-yard" Recyclable Metals container in a metals lay-down area. The I-beam is 10 feet long and has a ¼ inch bead of scale in all four inside corners along its entire length.

Sample: A 4-inch section of the scale bead weighing 14.13 grams was collected.

Survey Data: No exposure rates above background were detected on this sample.

Sample Analysis:

Nuclide	pCi/g
U-natural	20.1
Ra-226	4.7

Calculations: Uranium: 20.1 (pCi/g) x 10 (ft.) x 12 (in. / ft.)

x 4 x (14.13 (g) / 4 (in.)) = 34.1 nCi

Radium: 4.7 (pCi/g) x 10 (ft.) x 12 (in. / ft.)

x 4 x (14.13 (g) / 4 (in.)) = 8.0 nCi

Sample	Date	Sample ID	Category
89	10/26/00	C-2-3-102600	Salvage

Description: An estimated 3 cubic feet of metal slag was located in a "20-yard" Recyclable Metals container in a metals lay-down area

Sample: A 0.610 cu. in.. sample weighing 15.65 grams was collected.

Survey Data: No exposure rates above background were detected on this sample.

Sample Analysis:

Nuclide	pCi/g
U-natural	6.9
Ra-226	2.0

Calculations: Uranium: 6.9 (pCi/g) x 3 (cu. ft.) x ((1728 (cu. in..)

/ 1 (cu. ft.) x (15.65 (g) / 0.610 (cu. in..)) = 0.9 μCi

Radium: 2.0 (pCi/g) x 3 (cu. ft.) x ((1728 (cu. in..)

/ 1 (cu. ft.) x (15.65 (g) / 0.610 (cu. in..)) = 0.3 μCi

Sample	Date	Sample ID	Category
90	10/26/00	C-2-4-102600	Salvage

Description: A 20 inch by 36 inch stainless steel screen was located in a "20-yard" Recyclable Metals container in a metals lay-down area.

Sample: A 2 sq. in. section of the screen 7.93 grams was collected.

Survey Data: No exposure rates above background were detected on this sample.

Sample Analysis:

Nuclide	pCi/g
U-natural	14.0
Ra-226	3.0

Calculations: Uranium: 14.0 (pCi/g) x (20 (in.) x 36 (in.))

x (7.93 (g) / 2 (sq. in.)) = 40.0 nCi

Radium: 3.0 (pCi/g) x (20 (in.) x 36 (in.))

x (7.93 (g) / 2 (sq. in.)) = 8.6 nCi

Sample	Date	Sample ID	Category
91	10/26/00	C-2-5-102600	Salvage

Description: An estimated 20 feet of metal strips were located in a "20-yard" Recyclable Metals container in a metals lay-down area. These strips are cutoffs from sheet metal and are ¼ inch square.

Sample: A 1.5 inch sample of the metal strips weighing 29.12 grams was collected.

Survey Data: No exposure rates above background were detected on this sample.

Sample Analysis:

Nuclide	pCi/g
U-natural	1.4
Ra-226	0.9

Calculations: Uranium: 1.4 (pCi/g) x 20 (ft.) x 12 (in. / ft.)

x (29.12 (g) / 1.5 (in.)) = 6.4 nCi

Radium: 0.9 (pCi/g) x 20 (ft.) x 12 (in. / ft.)

x (29.12 (g) / 1.5 (in.)) = 4.2 nCi

Sample	Date	Sample ID	Category
92	11/30/00	E-4-1-113000	On-Site Disposal

Description: A 48 inch by 36 inch by 48 inch man basket was located in a disposal area on the ground at a Phosphoric Acid plant. The man basket is covered with a thin layer of scale on the interior and exterior surfaces.

Sample: A scale sample from a 16 sq. in. area of the man basket weighing 13.27 grams was collected.

Survey Data: No exposure rates above background were detected on this sample

Sample Analysis:

Nuclide	pCi/g
U-natural	13.2
Ra-226	21.8

Calculations: The total area covered with scale on man basket was determined by calculating the surface areas for the exterior surfaces (front, back, bottom, and both sides)and multiplying each by two to account for the interior surfaces. These values were then added together to get the total surface area for the man basket.

Surface Areas:

Front: ((48 (in.) x 48 (in.)) x 2) = 4608 (sq. in.)
Back: ((48 (in.) x 48 (in.)) x 2) = 4608 (sq. in.)
Bottom: ((48 (in.) x 36 (in.)) x 2) = 3456 (sq. in.)
Sides: (((48 (in.) x 36 (in.)) x 2) x 2) = 6912 (sq. in.)

Total: 4608 (sq. in.) x 2 + 3456 (sq. in.) + 6912 (sq. in.)

= 19584 (sq. in.)

Uranium: 13.2 (pCi/g) x 19584 (sq. in.)

x (13.27 (g) / 16 (sq. in.)) = 214.3 nCi

Radium: 21.8 (pCi/g) x 19584 (sq. in.)

x (13.27 (g) / 16 (sq. in.)) = 354.1 nCi

Sample	Date	Sample ID	Category
93	11/30/00	E-4-2-113000	On-Site Disposal

Description: Approximately 1.0 cubic feet of filter cloth remnants was located inside of the man basket (see sample #92) at a Phosphoric Acid plant.

Sample: Approximately 1.0 cu. in.. of filter cloth weighing 4.05 grams was collected.

Survey Data: Exposure rates of up to 100 μR/hr above background were detected on the filter cloth.

Sample Analysis:

Nuclide	pCi/g
U-natural	48.8
Ra-226	40.7

Calculations: Uranium: 48.8 (pCi/g) x 1.0 (cu. ft.) x (1728 (cu. in..) / (cu. ft.)) x (4.05 (g) / 1.0 (cu. in..)) = 341.4 nCi

Radium: 40.7 (pCi/g) x 1.0 (cu. ft.) x (1728 (cu. in..) / (cu. ft.)) x (4.05 (g) / 1.0 (cu. in..)) = 284.8 nCi

Sample	Date	Sample ID	Category
94	11/30/00	E-4-3-113000	On-Site Disposal

Description: A 3/8" diameter nylon rope inside of the man basket (see sample #92) at a Phosphoric Acid plant. The rope was approximately 20 feet in length and it was covered with a thick scale.

Sample: A 2 inch section of the rope weighing 8.78 grams was collected.

Survey Data: No exposure rates above background were detected on this sample.

Sample Analysis:

Nuclide	pCi/g
U-natural	14.7
Ra-226	19.1

Calculations: Uranium: 14.7 (pCi/g) x 20 (ft.) x 12 (in. / ft.)

x (8.78 (g) / 2 (in.)) = 15.4 nCi

Radium: 19.1 (pCi/g) x 20 (ft.) x 12 (in. / ft.)

x (8.78 (g) / 2 (in.)) = 20.1 nCi

Sample	Date	Sample ID	Category
95	11/30/00	E-2-1-113000	Salvage

Description: An estimated 2.0 cubic feet of metal shavings were located in a "20-yard" Recyclable Metals container in a metals lay-down area.

Sample: Approximately 0.5 cu. in.. of the metal shavings weighing 4.48 grams was collected.

Survey Data: No exposure rates above background were detected on this sample.

Sample Analysis:

Nuclide	pCi/g
U-natural	36.1
Ra-226	5.0

Calculations: Uranium: 36.1 (pCi/g) x 2.0 (cu. ft.) x (1728 cu. in../cu. ft.))

x (4.48 (g) / 0.5 (cu. in..)) = 1118.3 nCi

Radium: 5.0 (pCi/g) x 2.0 (cu. ft.) x (1728 cu. in../cu. ft.)

x (30.41 (g) / 1.068 (cu. in..)) = 154.8 nCi

Sample	Date	Sample ID	Category
96	11/30/00	E-2-2-113000	Salvage

Description: A 4 foot by 3 foot piece of thin rusted metal grating was located in a "20-yard" Recyclable Metals container in a metals lay-down area. An 8 square inch sample was collected of this item. The estimated volume of the collected sample 0.5 cu. in.., and weighs 10.17 grams.

Sample: An 8 sq. in. sample of the metal grating weighing 10.17 grams was collected.

Survey Data: No exposure rates above background were detected on this sample.

Sample Analysis:

Nuclide	pCi/g
U-natural	9.1
Ra-226	2.7

Calculations: Uranium: 9.1 (pCi/g) x (4 (ft.) x 3 (ft.)) x 144 (sq. in. / sq. ft.)

x (10.17 (g) / 8 (sq. in.)) = 20.0 nCi

Radium: 2.7 (pCi/g) x (4 (ft.) x 3 (ft.)) x 144 (sq. in. / sq. ft.)

x (10.17 (g) / 8 (sq. in.)) = 5.9 nCi

Sample	Date	Sample ID	Category
97	11/30/00	E-3-1-113000	Salvage

Description: A rubber pump impeller housing from the rock slurry pump was located in a "2-yard" trash container next to a maintenance shop. The impeller housing is solid rubber that had a diameter of 18 inches and was 2 inches thick. The weight of this item was 14 pounds.

Sample: Approximately 0.5 cu. in.. of the rubber pump housing weighing 8.43 grams was collected.

Survey Data: No exposure rates above background were detected on this sample.

Sample Analysis:

Nuclide	pCi/g
U-natural	13.1
Ra-226	1.7

Calculations: Due to the irregular shape of this item the volume of the impeller housing was determined by comparing its total weight to the weight of the known volume sample.

Volume:

(14 (lb.) x 453.6 (g. / lb.)) / (8.43 (g) / 0.5 (cu. in..) = 377 (cu. in..)

Uranium: 13.1 (pCi/g) x 377 (cu. in..)

x (8.43 (g) / 0.5 (cu. in..)) = 83.2 nCi

Radium: 1.7 (pCi/g) x 377 (cu. in..)

x (8.43 (g) / 0.5 (cu. in..)) = 10.8 nCi

Sample	Date	Sample ID	Category
98	12/14/00	F-2-1-121400	Salvage

Description: A 15 foot by 10 foot by 3 foot pile of metal liner plates from the ball mill were located in a recyclable metals lay-down area. Each of the metal plates was 36 inches by 18 inches by 3 inches and had a thin layer of scale on one side only. It is estimated that there were 80 of the metal plates in the pile.

Sample: A scale sample was collected from a 4 sq. in. area and weighed 30.04 grams.

Survey Data: No exposure rates above background were detected on this sample.

Sample Analysis:

Nuclide	pCi/g
U-natural	19.6
Ra-226	32.3

Calculations: Uranium: 19.6 (pCi/g) x (36 (in.) x 18 (in.)) x 80

x (30.04 (g) / 4 (sq. in.)) = 7.6 μCi

Radium: 32.3 (pCi/g) x (36 (in.) x 18 (in.)) x 80

x (30.04 (g) / 4 (sq. in.)) = 12.6 μCi

Sample	Date	Sample ID	Category
99	12/14/00	F-2-2-121400	Salvage

Description: Five railroad rails were located on the ground in a recyclable metals lay-down area. Each of the rails were 20 feet long and had a thin layer of scale buildup on approximately 60% of the length of the rails.

Sample: Scale from a 2 inch section of a rail weighing 20.68 grams was collected.

Survey Data: No exposure rates above background were detected on this sample.

Sample Analysis:

Nuclide	pCi/g
U-natural	5.9
Ra-226	2.7

Calculations: Uranium: 5.9 (pCi/g) x (20 (ft.) x 12 (in. / ft.) x 5) x 0.60

x (20.68 (g) / 2 (in.)) = 43.6 nCi

Radium: 2.7 (pCi/g) x (20 (ft.) x 12 (in. / ft.) x 5) x 0.60

x (20.68 (g) / 2 (in.)) = 20.1 nCi

Sample	Date	Sample ID	Category
100	12/14/00	F-2-3-121400	Salvage

Description: A 52-inch by 50-inch by 1/8-inch metal plate, with a thin layer of scale covering 90% of the surface on one side, was located in a recyclable metals lay-down area.

Sample: A 2 square inch area of the plate was scraped. The scale sample weighed 17.23 grams.

Survey Data: No exposure rates above background were detected on this sample.

Sample Analysis:

Nuclide	pCi/g
U-natural	15.0
Ra-226	10.8

Calculations: Uranium: 15.0 (pCi/g) x 52 (in.) x 50 (in.) x 0.90

x (17.23 (g) / 2 (sq. in.)) = 301.8 nCi

Radium: 10.8 (pCi/g) x 52 (in.) x 50 (in.) x 0.90

x (17.23 (g) / 2 (sq. in.)) = 217.7 nCi

Sample	Date	Sample ID	Category
101	12/14/00	F-4-1-121400	Off-Site Disposal

Description: Three pieces of fiberglass grating were located in a recyclable metals lay-down area. Each grating was 36 inches by 48 inches with a thin layer of scale over the entire surface.

Sample: A 4 square inch area was scraped. The scale weighed 13.5 grams.

Survey Data: No exposure rates above background were detected on this sample.

Sample Analysis:

Nuclide	pCi/g
U-natural	14.2
Ra-226	114.2

Calculations: Uranium: 14.2 (pCi/g) x 3 x 36 (in.) x 48 (in.) x 2

x (13.5 (g) / 4 (sq. in.)) = 498.2 nCi

Radium: 114.2 (pCi/g) x 3 x 36 (in.) x 48 (in.) x 2

x (13.5 (g) / 4 (sq. in.)) = 3996.1 nCi

Sample	Date	Sample ID	Category
102	12/14/00	F-2-4-121400	Salvage

Description: Sludge from seven stainless steel screens was located in a recyclable metals lay-down area. The stainless steel screen clothes were from the DAP plant and each measured 4 feet by 5 feet. Each stainless steel screen had a thick layer of sludge running along approximately 50% of the metal frames that were attached to each of the 5-foot sides.

Sample: A 1.0 square inch sample of sludge weighed 20.98 grams.

Survey Data: No exposure rates above background were detected on this sample.

Sample Analysis:

Nuclide	pCi/g
U-natural	21.7
Ra-226	2.4

Calculations: Uranium: 21.7 (pCi/g) x 7 x 5 (ft.) x 12 (in./ft.) x 2

x 0.50 x (20.98 (g) / 1.0 (in.)) = 190.9 nCi

Radium: 2.4 (pCi/g) x 7 x 5 (ft.) x 12 (in./ft.) x 2

x 0.50 x (20.98 (g) / 1.0 (in.)) = 21.1 nCi

Sample	Date	Sample ID	Category
103	12/14/00	F-2-5-121400	Salvage

Description: A 20-foot pipe with a 14-inch diameter was located in a recyclable metals lay-down area. The inside surface of the pipe had a thin layer of scale.

Sample: A 4 square inch area was scraped for scale that weighed 15.0 grams.

Survey Data: No exposure rates above background were detected on this sample.

Sample Analysis:

Nuclide	pCi/g
U-natural	13.9
Ra-226	5.2

Calculations: Uranium: 13.9 (pCi/g) x 20 (ft.) x 12 (in./ft.) x 2 x π x 7 (in.)

x (15.0 (g) / 4 (sq. in.)) = 551.1 nCi

Radium: 5.2 (pCi/g) x 20 (ft.) x 12 (in./ft.) x 2 x π x 7 (in.)

x (15.0 (g) / 4 (sq. in.)) = 205.8 nCi

Sample	Date	Sample ID	Category
104	12/14/00	F-3-1-121400	Off-Site Disposal

Description: A 20-foot long plastic ventilation trunk with an 18-inch diameter was located in a "20-yard" container of scrap plastic products in a lay-down area.

Sample: a 2-inch by 10-inch piece of plastic was collected which weighed 5.68 grams.

Survey Data: No exposure rates above background were detected on this sample.

Sample Analysis:

Nuclide	pCi/g
U-natural	24.4
Ra-226	4.1

Calculations: Uranium: 24.4 (pCi/g) x 20 (ft.) x 12 (in./ft.) x 2 x π x 9 (in.)

x (5.68 (g) / 20 (sq. in.)) = 94.0 nCi

Radium: 4.1 (pCi/g) x 20 (ft.) x 12 (in./ft.) x 2 x π x 9 (in.)

x (5.68 (g) / 20 (sq. in.)) = 15.8 nCi

Sample	Date	Sample ID	Category
105	12/14/00	F-3-2-121400	Off-Site Disposal

Description: Plastic baffles were located in a "20-yard" container of scrap plastic products in a lay-down area. Plastic baffles were 6 inches wide and 8 feet long. It is estimated that there were 200 of these strips in the container. The plastic strips were covered with a thin layer of scale.

Sample: A 4-inch by 6-inch sample weighed 12.15 grams.

Survey Data: No exposure rates above background were detected on this sample.

Sample Analysis:

Nuclide	pCi/g
U-natural	10.7
Ra-226	4.3

Calculations: Uranium: 10.7 (pCi/g) x 200 x 8 (ft.) x 12 (in./ft.) x 6 (in.)

x (12.15 (g) / 24 (sq. in.)) = 622.7 nCi

Radium: 4.3 (pCi/g) x 200 x 8 (ft.) x 12 (in./ft.) x 6 (in.)

x (12.15 (g) / 24 (sq. in.)) = 250.8 nCi

Sample	Date	Sample ID	Category
106	12/14/00	F-2-6-121400	Salvage

Description: A 42-inch by 30-inch by ¼-inch metal manway, with a thin layer of scale over the entire surface of one side, was located in a recyclable metals lay-down area.

Sample: A 4 square inch area was scraped for scale. The scale weighed 11.43 grams.

Survey Data: No exposure rates above background were detected on this sample.

Sample Analysis:

Nuclide	pCi/g
U-natural	11.5
Ra-226	6.6

Calculations: Uranium: 11.5 (pCi/g) x 1260 (sq. in.)

x (11.43 (g) / 4 (sq. in.)) = 41.4 nCi

Radium: 6.6 (pCi/g) x 1260 (sq. in.)

x (11.43 (g) / 4 (sq. in.)) = 23.8 nCi

Sample	Date	Sample ID	Category
107	12/14/00	F-4-2-121400	Off-Site Disposal

Description: Two rubber valve liners ("rubber boots") from a gypsum stack pump were located in a recyclable metals lay-down area. Each "rubber boot" was 36 inches in diameter and 10 inches deep. There was an average of ¼ inch scale on the inside surface of each "rubber boot."

Sample: A 0.915 cubic inch sample weighing 22.04 grams was collected.

Survey Data: Exposure rates of up to 100 μR/hr above background were detected on this item.

Sample Analysis:

Nuclide	pCi/g
U-natural	13.3
Ra-226	363.3

Calculations: Uranium: 13.3 (pCi/g) x 2 x 10 (in.) x 2 x π x 18 (in.)

x ¼ (in.) x (22.04 (g) / 0.915 (cu. in..)) = 181.1 nCi

Radium: 363.3 (pCi/g) x 2 x 10 (in.) x 2 x π x 18 (in.)

x ¼ (in.) x (22.04 (g) / 0.915 (cu. in..)) = 4948.6 nCi

Sample	Date	Sample ID	Category
108	12/14/00	B-4-1-121400	On-Site Disposal

Description: Two rubber lined pipes, with a 12-inch diameter, were located in a "20-yard" gypsum stack materials container in a metals lay-down area. One pipe was 14 feet long and the other was 20 feet long. The pipes had a 1-inch layer of scale throughout the inside.

Sample: A 0.915 cu. in.. sample of scale weighed 14.51 grams.

Survey Data: Exposure rates of up to 600 μR/hr above background were detected on these items.

Sample Analysis:

Nuclide	pCi/g
U-natural	13.2
Ra-226	298.5

Calculations: Uranium: 13.2 (pCi/g) x 34 (ft.) x 12 (in./ft.) x π

x ((6 (in.))^2 – (5 (in.))^2) x 1 (in.)

x (14.51 (g) / 0.915 (cu. in..)) = 3.0 μCi

Radium: 298.5 (pCi/g) x 34 (ft.) x 12 (in./ft.) x π

x ((6 (in.))^2 – (5 (in.))^2) x 1 (in.)

x (14.51 (g) / 0.915 (cu. in..)) = 66.7 μCi

Sample	Date	Sample ID	Category
109	12/14/00	B-2-1-121400	Salvage

Description: A junction box was located in a "20-yard" recyclable metals container in a metals lay-down area. The box was 18 inches by 16 inches by 8 inches and the exterior surfaces were covered with a thin layer of mud residue.

Sample: Residue was collected from a 4 square inch area. The sample weighed 13.45 grams.

Survey Data: No exposure rates above background were detected on this sample.

Sample Analysis:

Nuclide	pCi/g
U-natural	19.8
Ra-226	30.2

Calculations: Uranium: 19.8 (pCi/g) x (18 (in.) x 16 (in.) x 2)

+ 18 (in.) x 8 (in.) x 2 + 16 (in.) x 8 (in.) x 2)

x (13.45 (g) / 4 (sq. in.)) = 74.5 nCi

Radium: 30.2 (pCi/g) x (18 (in.) x 16 (in.) x 2)

+ 18 (in.) x 8 (in.) x 2 + 16 (in.) x 8 (in.) x 2)

x (13.45 (g) / 4 (sq. in.)) = 113.7 nCi

Sample	Date	Sample ID	Category
110	12/14/00	B-2-2-121400	Salvage

Description: A 12-foot long I-beam was located in a "20-yard" recyclable metals container in a metals lay-down area. Cross member of the I-beam is 8" wide and the side plates are 6" wide. Scale covered approximately 90% of the I-beam.

Sample: A 2 square inch area was scraped for scale which weighed 18.32 grams.

Survey Data: No exposure rates above background were detected on this sample.

Sample Analysis:

Nuclide	pCi/g
U-natural	18.9
Ra-226	33.4

Calculations:

Uranium: 18.9 (pCi/g) x 12 (ft.) x 12 (in./ft.)

x (8 (in.) x 2 + 6 (in.) x 4) x 0.90

x (18.32 (g) / 2 (sq. in.)) = 0.9 μCi

Radium: 33.4 (pCi/g) x 12 (ft.) x 12 (in./ft.)

x (8 (in.) x 2 + 6 (in.) x 4) x 0.90

x (18.32 (g) / 2 (sq. in.)) = 1.6 μCi

Sample	Date	Sample ID	Category
111	12/14/00	B-2-3-121400	Salvage

Description: Many small pieces of angle iron and metal cuttings were located in a "20-yard" recyclable metals container in the metals lay-down area. Approximately 200 square inches of mud residue was deposited along the surfaces of these items.

Sample: Scale was collected from a 2.0 square inch area. The scale weighed 31.91 grams.

Survey Data: No exposure rates above background were detected on this sample.

Sample Analysis:

Nuclide	pCi/g
U-natural	18.1
Ra-226	39.4

Calculations: Uranium: 18.1 (pCi/g) x 200 (sq. in.)

x (31.91 (g) / 2.0 (sq. in.)) = 57.8 nCi

Radium: 39.4 (pCi/g) x 200 (sq. in.)

x (31.91 (g) / 2.0 (sq. in.)) = 125.7 nCi

Sample	Date	Sample ID	Category
112	12/14/00	B-2-4-121400	Salvage

Description: Twelve sections of 24-inch diameter pipe, each 6 feet long, with a thin layer of yellowish scale covering approximately 70% of the interior surface, was located in a "20-yard" recyclable metals container in a metals lay-down area.

Sample: A 2 square inch area was scraped and a scale sample weighing 14.60 grams was collected.

Survey Data: No exposure rates above background were detected on this sample.

Sample Analysis:

Nuclide	pCi/g
U-natural	13.0
Ra-226	11.1

Calculations: Uranium: 13.0 (pCi/g) x 12 x 6 (ft.) x 12 (in./ft.)

x 2 x π x 12 (in.) x 0.70

x (14.60 (g) / 2 (sq. in.)) = 4.4 μCi

Radium: 11.1 (pCi/g) x 12 x 6 (ft.) x 12 (in./ft.)

x 2 x π x 12 (in.) x 0.70

x (14.60 (g) / 2 (sq. in.)) = 3.7 μCi

Sample	Date	Sample ID	Category
113	12/14/00	B-3-1-121400	Off-Site Disposal

Description: Approximately 10 square feet of filter cloth, that appear to be unused, was located in a "20-yard" trash container located adjacent to a phosphoric acid plant.

Sample: A 12 square inch sample weighing 3.05 grams was collected.

Survey Data: No exposure rates above background were detected on this sample.

Sample Analysis:

Nuclide	pCi/g
U-natural	36.4
Ra-226	14.5

Calculations: Uranium: 36.4 (pCi/g) x 10 (sq. ft.) x 144 (sq. in./sq. ft.)

x (3.05 (g) / 12 (sq. in.)) = 13.3 nCi

Radium: 14.5 (pCi/g) x 10 (sq. ft.) x 144 (sq. in./sq. ft.)

x (3.05 (g) / 12 (sq. in.)) = 5.3 nCi

Sample	Date	Sample ID	Category
114	12/14/00	B-3-2-121400	Off-Site Disposal

Description: A Tyvex suit, with an estimated volume of 0.1 cubic feet, was located in a "20-yard" trash container located adjacent to a phosphoric acid plant.

Sample: A 1.0 cu. in.. sample weighing 1.55 grams was collected.

Survey Data: No exposure rates above background were detected on this sample.

Sample Analysis:

Nuclide	pCi/g
U-natural	105.8
Ra-226	37.6

Calculations: Uranium: 105.8 (pCi/g) x 0.1 (cu. ft.) x 1728 (cu. in../cu. ft.)

x (1.55 (g) / 1.0 (cu. in..)) = 28.3 nCi

Radium: 37.6 (pCi/g) x 0.1 (cu. ft.) x 1728 (cu. in../cu. ft.)

x (1.55 (g) / 1.0 (cu. in..)) = 10.1 nCi

Sample	Date	Sample ID	Category
115	12/28/00	D-2-1-122800	Salvage

Description: A 24-inch by 40-inch grating with scale covering 40% of its surface, was located on the ground in a recyclable metals lay-down area.

Sample: A 2 square inch area was scraped. The scale weighed 11.41 grams.

Survey Data: No exposure rates above background were detected on this sample.

Sample Analysis:

Nuclide	pCi/g
U-natural	8.1
Ra-226	78.8

Calculations: Uranium: 8.1 (pCi/g) x 24 (in.) x 40 (in.) x 0.40 x 2

x (11.41 (g) / 2 (sq. in.)) = 35.3 nCi

Radium: 78.8 (pCi/g) x 24 (in.) x 40 (in.) x 0.40 x 2

x (11.41 (g) / 2 (sq. in.)) = 345.3 nCi

Sample	Date	Sample ID	Category
116	12/28/00	D-2-2-122800	Salvage

Description: A 2-foot by 4-foot by 2-foot pile of metal shavings was located in a recyclable metals lay-down area.

Sample: A 0.5 cu. in.. sample weighing 2.59 grams was collected.

Survey Data: No exposure rates above background were detected on this sample.

Sample Analysis:

Nuclide	pCi/g
U-natural	65.4
Ra-226	6.7

Calculations: Uranium: 65.4 (pCi/g) x 16 (cu. ft.) x 1728 (cu. in../cu. ft.)

x (2.59 (g) / 0.5 (cu. in..)) = 9.4 μCi

Radium: 6.7 (pCi/g) x 16 (cu. ft.) x 1728 (cu. in../cu. ft.)

x (2.59 (g) / 0.5 (cu. in..)) = 1.0 μCi

Sample	Date	Sample ID	Category
117	12/28/00	D-2-3-122800	Salvage

Description: An 8-inch diameter, stainless steel float ball (tank level monitor) was located in a recyclable metals lay-down area. Scale covered approximately 50% of its surface.

Sample: A 6 square inch area was scraped. The scale weighed 6.11 grams.

Survey Data: No exposure rates above background were detected on this sample.

Sample Analysis:

Nuclide	pCi/g
U-natural	52.2
Ra-226	143.1

Calculations: Uranium: 52.2 (pCi/g) x 4 x π x (4 (in.))^2 x 0.50

x (6.11 (g) / 6 (sq. in.)) = 5.3 nCi

Radium: 143.1 (pCi/g) x 4 x π x (4 (in.))^2 x 0.50

x (6.11 (g) / 6 (sq. in.)) = 14.7 nCi

Sample	Date	Sample ID	Category
118	12/28/00	D-2-4-122800	Salvage

Description: A 3-foot by 3-foot by 2-foot pile of metal balls from the ball mill was located in a recyclable metals lay-down area.

Sample: A 1.0 cu. in.. sample weighed 49.49 grams.

Survey Data: No exposure rates above background were detected on this sample.

Sample Analysis:

Nuclide	pCi/g
U-natural	4.3
Ra-226	2.4

Calculations: Uranium: 4.3 (pCi/g) x 18 (cu. ft.) x 1728 (cu. in../cu. ft.)

x (49.49 (g) / 1.0 (cu. in..)) = 6.6 μCi

Radium: 2.4 (pCi/g) x 18 (cu. ft.) x 1728 (cu. in../cu. ft.)

x (49.49 (g) / 1.0 (cu. in..)) = 3.7 μCi

Sample	Date	Sample ID	Category
119	12/28/00	D-2-5-122800	Salvage

Description: A 10-foot long I-beam, with scale covering 80% of its surface, was located in a recyclable metals lay-down area. The cross member of the I-beam was 6" wide and the side plates were 6" wide

Sample: A 3 square inch sample of scale weighing 19.78 grams was collected.

Survey Data: No exposure rates above background were detected on this sample.

Sample Analysis:

Nuclide	PCi/g
U-natural	8.7
Ra-226	17.2

Calculations: Uranium: 8.7 (pCi/g) x 10 (ft.) x 12 (in./ft.) x (6 x 6 (in.))

x 0.80 x (19.78 (g) / 3 (sq. in.)) = 198.0 nCi

Radium: 17.2 (pCi/g) x 10 (ft.) x 12 (in./ft.) x (6 x 6 (in.))

x 0.80 x (19.78 (g) / 3 (sq. in.)) = 391.9 nCi

Sample	Date	Sample ID	Category
120	12/28/00	D-4-1-122800	On-Site Disposal

Description: A rubber liner from a phosphoric acid tank was located in a phosphoric acid plant area. A contractor replacing the material inside of the tank provided a sample of the rubber lining. No estimate of the total area of liner was available.

Sample: A 2 square inch piece of rubber liner weighing 12.19 grams was collected.

Survey Data: No exposure rates above background were detected on this sample.

Sample Analysis:

Nuclide	pCi/g
U-natural	14.9
Ra-226	1.9

Calculations: Uranium: 14.9 (pCi/g) x (12.19 (g) / 2 (sq. in.))

= 90.6 pCi/(sq. in.)

Radium: 1.9 (pCi/g) x (12.19 (g) / 2 (sq. in.))

= 11.6 pCi/(sq. in.)

Sample	Date	Sample ID	Category
121	02/07/01	G-2-1-020701	Salvage

Description: A 16-foot long rubber lined pipe with an 8-inch diameter was located in a recyclable metals lay-down area. Scale sediment had settled to the bottom of the pipe along the length of the pipe. The maximum dimensions of the scale in this pipe were 1/16 inches deep by 2 inches wide

Sample: A 0.763 cu. in.. sample weighing 11.68 grams was collected.

Survey Data: No exposure rates above background were detected on this sample.

Sample Analysis:

Nuclide	pCi/g
U-natural	15.0
Ra-226	91.8

Calculations: Uranium: 15.0 (pCi/g) x 16 (ft.) x 12 (in./ft.) x 2 (in.)

x 1/16 (in.) x (11.68 (g) / 0.763 (cu. in..)) = 5.5 nCi

Radium: 91.8 (pCi/g) x 16 (ft.) x 12 (in./ft.) x 2 (in.)

x 1/16 (in.) x (11.68 (g) / 0.763 (cu. in..)) = 33.7 nCi

Sample	Date	Sample ID	Category
122	02/07/01	G-2-2-020701	Salvage

Description: A 12-foot pipe with a 24-inch diameter was located in a recyclable metals lay-down area. The inside of the pipe had a thin layer of scale covering approximately 10% of its surface.

Sample: A 9 square inch area was scraped. The scale weighed 17.24 grams.

Survey Data: No exposure rates above background were detected on this sample.

Sample Analysis:

Nuclide	PCi/g
U-natural	5.8
Ra-226	89.4

Calculations: Uranium: 5.8 (pCi/g) x 12 (ft.) x 12 (in./ft.) x 2 x π x 12 (in.)

x 0.10 x (17.24 (g) / 9 (sq. in.)) = 12.0 nCi

Radium: 89.4 (pCi/g) x 12 (ft.) x 12 (in./ft.) x 2 x π x 12 (in.)

x 0.10 x (17.24 (g) / 9 (sq. in.)) = 185.9 nCi

Sample	Date	Sample ID	Category
123	02/07/01	G-2-3-020701	Salvage

Description: A 12-foot long pipe with a 26-inch outside diameter was located in a recyclable metals lay-down area. The outside of the pipe had a 1/8-inch layer of scale covering approximately 20% of its surface.

Sample: A 2 square inch area was scraped. The scale weighed 17.08 grams.

Survey Data: No exposure rates above background were detected on this sample.

Sample Analysis:

Nuclide	pCi/g
U-natural	13.7
Ra-226	20.5

Calculations: Uranium: 13,7 (pCi/g) x 12 (ft.) x 12 (in./ft.) x 2 x π x 13 (in.) x 0.20 x (17.08 (g) / 2 (sq. in.)) = 275.5 nCi

Radium: 20.5 (pCi/g) x 12 (ft.) x 12 (in./ft.) x 2 x π x 13 (in.) x 0.20 x (17.08 (g) / 2 (sq. in.)) = 411.8 nCi

Sample	Date	Sample ID	Category
124	02/07/01	G-2-4-020701	Salvage

Description: A stainless steel agitator shaft was located in a recyclable metals lay-down area. The agitator shaft had been sandblasted and scale deposits were only present in the recesses where the blades were attached. It was estimated that the total volume of scale on this item was 6 cu. in..

Sample: A 1.068 cu. in. sample weighing 18.37 grams was collected.

Survey Data: No exposure rates above background were detected on this sample.

Sample Analysis:

Nuclide	pCi/g
U-natural	8.9
Ra-226	14.4

Calculations: Uranium: 8.9 (pCi/g) x 6 (cu. in.)

x (18.37 (g) / 1.068 (cu. in..)) = 0.9 nCi

Radium: 14.4 (pCi/g) x 6 (cu. in.)

x (18.37 (g) / 1.068 (cu. in..)) = 1.5 nCi

Sample	Date	Sample ID	Category
125	02/07/01	G-2-5-020701	Salvage

Description: A stainless steel distribution box was located in a recyclable metals lay-down area. The distribution box was 3 feet by 3 feet by 4 feet and there was a one inch layer of scale evenly distributed on the inside surfaces.

Sample: A 0.915 cu. in.. sample weighing 20.31 grams was collected.

Survey Data: No exposure rates above background were detected on this sample.

Sample Analysis:

Nuclide	pCi/g
U-natural	2.9
Ra-226	3.2

Calculations: Uranium: 2.9 (pCi/g) x (3 (ft.) x 3(ft.) x 2 + 3 (ft.) x 4 (ft.) x 4)

x 144 (sq. in./sq. ft.) x 1 (in.)

x (20.31 (g) / 0.915 (cu. in..)) = 0.6 μCi

Radium: 3.2 (pCi/g) x (3 (ft.) x 3(ft.) x 2 + 3 (ft.) x 4 (ft.) x 4)

x 144 (sq. in./sq. ft.) x 1 (in.)

x (20.31 (g) / 0.915 (cu. in..)) = 0.7 μCi

Sample	Date	Sample ID	Category
126	02/07/01	G-4-1-020701	On-Site Disposal

Description: A 35-foot long rubber pipe with an 8-inch diameter was located in a gypsum stack lay-down area. A layer of scale sediment had settled to the bottom along the length of the pipe. The maximum dimensions of the scale was ¼ inches deep by 3 inches wide.

Sample: A 1.22 cu. in.. sample weighing 26.89 grams was collected.

Survey Data: Exposure rates of up to 6 μR/hr above background were detected on this item.

Sample Analysis:

Nuclide	pCi/g
U-natural	4.4
Ra-226	55.8

Calculations: Uranium: 4.4 (pCi/g) x 35 (ft.) x 12 (in./ft.) x ¼ (in.) x 3 (in.)

x (26.89 (g) / 1.22 (cu. in..)) = 30.5 nCi

Radium: 55.8 (pCi/g) x 35 (ft.) x 12 (in./ft.) x ¼ (in.) x 3 (in.)

x (26.89 (g) / 1.22 (cu. in..)) = 387.4 nCi

Sample	Date	Sample ID	Category
127	02/07/01	G-4-2-020701	On-Site Disposal

Description: A 36-inch wide by 100-foot long rubber conveyor belt was located in a gypsum stack lay-down area.

Sample: A 1 square inch section weighing 9.57 grams was collected.

Survey Data: No exposure rates above background were detected on this sample.

Sample Analysis:

Nuclide	pCi/g
U-natural	21.3
Ra-226	4.4

Calculations: Uranium: 21.3 (pCi/g) x 36 (in.) x 100 (ft.) x 12 (in. ft.)

x (9.57 (g) / 1 (sq. in.)) = 8.9 μCi

Radium: 4.4 (pCi/g) x 36 (in.) x 100 (ft.) x 12 (in. ft.)

x (9.57 (g) / 1 (sq. in.)) = 1.8 μCi

Sample	Date	Sample ID	Category
128	02/07/01	G-4-3-020701	On-Site Disposal

Description: A 90-degree pipe elbow with a 14-inch diameter and a total length of 24 inches was located in a gypsum stack lay-down area. A ½-inch layer of scale covered the inside of the pipe.

Sample: A 1.22 cu. in.. sample weighing 14.25 grams was collected.

Survey Data: No exposure rates above background were detected on this sample.

Sample Analysis:

Nuclide	pCi/g
U-natural	13.2
Ra-226	9.4

Calculations: Uranium: 13.2 (pCi/g) x 24 (in.) x 2 x π x 7 (in.) x ½ (in.)

x (14.25 (g) / 1.22 (cu. in..)) = 81.3 nCi

Radium: 9.4 (pCi/g) x 24 (in.) x 2 x π x 7 (in.) x ½ (in.)

x (14.25 (g) / 1.22 (cu. in..)) = 57.9 nCi

Sample	Date	Sample ID	Category
129	02/27/01	A-2-1-022701	Salvage

Description: A 3-foot by 5-foot by 3-inch pile of rusted metal was located on the ground in a recyclable metals lay-down area.

Sample: A 1.0 cu. in.. sample weighed 25.45 grams.

Survey Data: No exposure rates above background were detected on this sample.

Sample Analysis:

Nuclide	pCi/g
U-natural	4.5
Ra-226	1.2

Calculations: Uranium: 4.5 (pCi/g) x 3 (ft.) x 5 (ft.) x 3 (in.)

x 144 (sq. in./sq. ft.)

x (25.45 (g) / 1.0 (cu. in..)) = 742.3 nCi

Radium: 1.2 (pCi/g) x 3 (ft.) x 5 (ft.) x 3 (in.)

x 144 (sq. in./sq. ft.)

x (25.45 (g) / 1.0 (cu. in..)) = 197.9 nCi

Sample	Date	Sample ID	Category
130	02/27/01	A-2-2-022701	Salvage

Description: A metal shaft with 14 rings was located on the ground in a recyclable metals sandblast area. The metal shaft was 5 feet long and 4 inches in diameter. Each ring was 14 inches in diameter and had approximately ¼ inches of scale on the surfaces.

Sample: A 1.22 cu. in.. sample weighing 19.73 grams was collected.

Survey Data: No exposure rates above background were detected on this sample.

Sample Analysis:

Nuclide	pCi/g
U-natural	28.4
Ra-226	10.7

Calculations:

Uranium: 28.4 (pCi/g) x 14 x π x ((7 (in.))^2 – (2 (in.))^2) x 2 x ¼ (in.) x (19.73 (g) / 1.22 (cu. in..)) = 454.0 nCi

Radium: 10.7 (pCi/g) x 14 x π x ((7 (in.))^2 – (2 (in.))^2) x 2 x ¼ (in.) x (19.73 (g) / 1.22 (cu. in..)) = 171.2 nCi

Sample	Date	Sample ID	Category
131	02/27/01	A-2-3-022701	Salvage

Description: An industrial oil filter was located in a "40-yard" container of recyclable metals in the metals lay-down area. The oil filter was 12 inches in diameter and 13 inches long. The walls and the bottom of the filter were constructed of several layers of mesh and filter media that were 1.5 inches thick.

Sample: A 1.5 cu. in.. sample weighing 7.86 grams was collected.

Survey Data: No exposure rates above background were detected on this sample.

Sample Analysis:

Nuclide	pCi/g
U-natural	17.5
Ra-226	4.5

Calculations: Uranium: 17.5 (pCi/g) x π x ((6 (in.))^2 x 13 (in.)

– (5.25 (in.))^2 x 11.5 (in.))

x (7.86 (g) / 1.5 (cu. in..)) = 43.5 nCi

Radium: 4.5 (pCi/g) x π x ((6 (in.))^2 x 13 (in.)

– (5.25 (in.))^2 x 11.5 (in.))

x (7.86 (g) / 1.5 (cu. in..)) = 11.2 nCi

Sample	Date	Sample ID	Category
132	02/27/01	A-2-4-022701	Salvage

Description: A 21-inch long metal exhaust pipe with a 4-inch diameter was located in a "40-yard" container of recyclable metals in the metals lay-down area.

Sample: A 2.0 square inch section weighing 8.43 grams was collected.

Survey Data: No exposure rates above background were detected on this sample.

Sample Analysis:

Nuclide	pCi/g
U-natural	11.9
Ra-226	2.7

Calculations: Uranium: 11.9 (pCi/g) x 21 (in.) x 2 x π x 2 (in.)

x (8.43 (g) / 2.0 (sq. in.)) = 13.3 nCi

Radium: 2.7 (pCi/g) x 21 (in.) x 2 x π x 2 (in.)

x (8.43 (g) / 2.0 (sq. in.)) = 3.0 nCi

Sample	Date	Sample ID	Category
133	02/27/01	A-4-1-022701	On-Site Disposal

Description: Two large (~ 1.0 cu. yd.) bags filled with used filter cloth were located in a lay-down area at a phosphoric acid plant.

Sample: A 0.5 cu. in.. sample of filter cloth weighing 3.92 grams was collected.

Survey Data: Exposure rates of up to 1200 μR/hr above background were detected on this item.

Sample Analysis:

Nuclide	pCi/g
U-natural	32.2
Ra-226	7367.6

Calculations: Uranium: 32.2 (pCi/g) x 2.0 (cu. yd.) x 46656 (cu. in../cu. yd.)

x (3.92 (g) / 0.5 (cu. in..)) = 23.6 μCi

Radium: 7367.6 (pCi/g) x 2.0 (cu. yd.) x 46656 (cu. in../cu. yd.)

x (3.92 (g) / 0.5 (cu. in..)) = 5389.9 μCi

Sample	Date	Sample ID	Category
134	02/27/01	A-4-2-022701	On-Site Disposal

Description: An estimated 2 cubic yards of sludge was located in a lay-down area at a phosphoric acid plant.

Sample: A 1.526 cu. in.. sample weighing 40.64 grams was collected.

Survey Data: Exposure rates of up to 50 μR/hr above background were detected on this item.

Sample Analysis:

Nuclide	pCi/g
U-natural	7.0
Ra-226	13.5

Calculations: Uranium: 7.0 (pCi/g) x 2 (cu. yd.) x 46656 (cu. in../cu. yd.)

x (40.64 (g) / 1.526 (cu. in..)) = 17.4 μCi

Radium: 13.5 (pCi/g) x 2 (cu. yd.) x 46656 (cu. in../cu. yd.)

x (40.64 (g) / 1.526 (cu. in..)) = 33.6 μCi

Sample	Date	Sample ID	Category
135	02/27/01	A-2-5-022701	Salvage

Description: A motor shaft safety shroud was located in a "20-yard" recyclable metals container adjacent to a phosphoric acid plant. The motor shroud had a 4-foot by 6-foot cover and 4 legs that were 1 square inch by 12 inches long. The top surface of the cover and all surfaces of the legs are covered with a thin layer of scale.

Sample: A 2.0 square inch area was scraped and a sample weighing 15.26 grams was collected.

Survey Data: No exposure rates above background were detected on this sample.

Sample Analysis:

Nuclide	pCi/g
U-natural	8.3
Ra-226	30.9

Calculations:

Uranium: 8.3 (pCi/g) x (4 (ft.) x 6 (ft.) x 144 (sq. in./sq. ft.)

+ 4 x 4 x 1 (in.) x 12 (in.))

x (15.26 (g) / 2.0 (sq. in.)) = 230.2 nCi

Radium: 30.9 (pCi/g) x (4 (ft.) x 6 (ft.) x 144 (sq. in./sq. ft.)

+ 4 x 4 x 1 (in.) x 12 (in.))

x (12.9 (g) / 2.0 (sq. in.)) = 860.1 nCi

Sample	Date	Sample ID	Category
136	02/27/01	A-2-6-022701	Salvage

Description: A 16-foot ladder was located in a "20-yard" recyclable metals container adjacent to a phosphoric acid plant. The ladder rungs were relatively free of scale buildup. The side rails of the ladder were 4 inches wide with a 1 inch lip along each side of the rail. A thin layer of scale covered the side rails.

Sample: A 2.0 square inch area of scale was scraped which weighed 9.71 grams.

Survey Data: No exposure rates above background were detected on this sample.

Sample Analysis:

Nuclide	pCi/g
U-natural	40.7
Ra-226	12.9

Calculations: Uranium: 40.7 (pCi/g) x 6 (in.) x 16 (ft.) x 12 (in./ft.)

x 2 x 2 x (9.71 (g) / 2 (sq. in.)) = 911.0 nCi

Radium: 12.9 (pCi/g) x 6 (in.) x 16 (ft.) x 12 (in./ft.)

x 2 x 2 x (9.71 (g) / 2 (sq. in.)) = 288.6 nCi

Appendix C

SAMPLE ANALYSIS RESULTS

Library	Energy (keV)	#1 A-2-7-032200	
		time (s):	7200
		weight (g):	1.05
		(μCi)	Activity Conc. (pCi/g)
Th-234	63	0	0.0
Th-234	92	0	0.0
Pb-214	295	0.1498	142666.7
Ac-228	338		
Pb-214	352	0.1637	155904.8
Bi-214	609	0.1467	139714.3
Ac-228	911		
Ac-228	969		
		U-nat	0.0
		Ra-226	146095.2

		#2		#3		#4		#5		#6	
		D-2-1-070600		D-2-2-070600		D-4-1-070600		C-4-1-071800		C-3-1-071800	
		time (s):	7200	time (s):	7200	time (s):	7200	time (s):	1800	time (s):	3600
		weight (g):	9.38	weight (g):	3.27	weight (g):	10.75	weight (g):	13.33	weight (g):	9.22
Library	**Energy (keV)**	Counts	Activity Conc. (pCi/g)	Counts	Activity Conc. (pCi/g)	Counts	Activity Conc. (pCi/g)	Counts	Activity Conc. (pCi/g)	Counts	Activity Conc. (pCi/g)
Th-234	63	143	36.8	86	63.4	373	83.7	41	29.7	70	36.6
Th-234	92	190	39.1	155	91.4	0	0.0	17	9.8	74	31.0
Pb-214	295	429	54.6	32	11.7	131381	14588.2	468	167.6	17	4.4
Ac-228	338	0	0.0	6	4.1	473	99.2	1	0.7	15	7.3
Pb-214	352	677	51.0	43	9.3	221424	14564.6	848	179.9	21	3.2
Bi-214	609	523	46.9	64	16.5	171389	13418.1	564	142.4	21	3.8
Ac-228	911	0	0.0	0	0.0	52	9.3	8	4.6	0	0.0
Ac-228	969	0	0.0	0	0.0	107	97.3	11	32.3	14	29.7
		U-nat	39.7	U-nat	81.1	U-nat	43.8	U-nat	20.7	U-nat	35.4
		Ra-226	50.9	Ra-226	12.5	Ra-226	14190.3	Ra-226	163.3	Ra-226	3.8

		#7		#8		#9		#10		#11	
		C-3-2-071800		C-4-2-071800		E-2-1-071900		E-4-1-071900		E-4-2-071900	
		time (s):	43200	time (s):	7200	time (s):	3600	time (s):	3600	time (s):	43200
		weight (g):	1.55	weight (g):	2.61	weight (g):	6.64	weight (g):	2.47	weight (g):	3.91
Library	**Energy (keV)**	Counts	Activity Conc. (pCi/g)	Counts	Activity Conc. (pCi/g)	Counts	Activity Conc. (pCi/g)	Counts	Activity Conc. (pCi/g)	Counts	Activity Conc. (pCi/g)
Th-234	63	679	176.1	97	89.7	61	44.3	34	66.4	706	72.6
Th-234	92	719	149.1	117	86.5	124	72.0	61	95.3	928	76.3
Pb-214	295	87	11.2	859	392.9	68	24.4	2662	2572.9	710	36.1
Ac-228	338	105	25.5	0	0.0	10	6.8	69	126.0	55	5.3
Pb-214	352	189	14.4	1513	409.9	100	21.3	4608	2638.3	1082	32.6
Bi-214	609	224	20.3	1161	374.4	78	19.8	3578	2438.3	951	34.1
Ac-228	911	36	7.5	16	11.8	10	5.8	51	79.5	92	7.6
Ac-228	969	4	4.2	10	37.5	1	2.9	33	261.2	63	26.3
		U-nat	170.2	U-nat	92.2	U-nat	60.9	U-nat	84.6	U-nat	77.9
		Ra-226	15.3	Ra-226	392.4	Ra-226	21.8	Ra-226	2549.8	Ra-226	34.3

		#12		#13		#14		#15		#16	
		F-2-1-071900		F-2-2-071900		F-4-1-071900		A-2-1-081600		A-2-2-081600	
		time (s):	3600	time (s):	3600	time (s):	3600	time (s):	7200	time (s):	7200
		weight (g):	6.87	weight (g):	9.79	weight (g):	19.00	weight (g):	7.61	weight (g):	12.16
Library	**Energy (keV)**	Counts	Activity Conc. (pCi/g)	Counts	Activity Conc. (pCi/g)	Counts	Activity Conc. (pCi/g)	Counts	Activity Conc. (pCi/g)	Counts	Activity Conc. (pCi/g)
Th-234	63	60	42.1	133	65.5	57	14.5	171	54.2	265	52.6
Th-234	92	100	56.1	109	42.9	57	11.6	137	34.7	388	61.5
Pb-214	295	90	31.3	393	95.8	86	10.8	47	7.4	76	7.5
Ac-228	338	3	2.0	19	8.8	0	0.0	33	9.8	37	6.9
Pb-214	352	126	25.9	643	92.9	156	11.6	105	9.8	116	6.7
Bi-214	609	114	27.9	506	87.0	129	11.4	66	7.3	60	4.2
Ac-228	911	17	9.5	4	1.6	11	2.2	21	5.3	19	3.0
Ac-228	969	0	0.0	-16	0.0	0	0.0	13	16.7	20	16.1
		U-nat	51.4	U-nat	56.8	U-nat	13.6	U-nat	46.5	U-nat	59.7
		Ra-226	28.4	Ra-226	91.9	Ra-226	11.3	Ra-226	8.1	Ra-226	6.1

		#17		#18		#19		#20		#21	
		A-2-3-081600		B-2-1-082500		B-4-1-082500		B-4-2-082500		B-4-3-082500	
		time (s):	7200	time (s):	7200	time (s):	7200	time (s):	7200	time (s):	7200
		weight (g):	13.66	weight (g):	20.65	weight (g):	11.69	weight (g):	9.92	weight (g):	3.58
Library	**Energy (keV)**	Counts	Activity Conc. (pCi/g)	Counts	Activity Conc. (pCi/g)	Counts	Activity Conc. (pCi/g)	Counts	Activity Conc. (pCi/g)	Counts	Activity Conc. (pCi/g)
Th-234	63	466	82.3	148	17.3	178	36.7	200	48.6	110	74.1
Th-234	92	597	84.3	46	4.3	197	32.5	189	36.7	154	83.0
Pb-214	295	10	0.9	2942	170.1	202	20.6	246	29.6	116	38.7
Ac-228	338	13	2.1	19	2.1	0	0.0	0	0.0	0	0.0
Pb-214	352	96	5.0	4906	168.0	334	20.2	403	28.7	137	27.1
Bi-214	609	56	3.5	4035	164.5	255	18.4	310	26.3	134	31.5
Ac-228	911	12	1.7	25	2.3	0	0.0	0	0.0	3	1.6
Ac-228	969	1	0.7	0	0.0	0	0.0	0	0.0	0	0.0
		U-nat	87.2	U-nat	11.3	U-nat	36.2	U-nat	44.7	U-nat	82.2
		Ra-226	3.1	Ra-226	167.5	Ra-226	19.7	Ra-226	28.2	Ra-226	32.4

		#22		#23		#24		#25		#26	
		G-4-1-083000		G-4-2-083000		G-2-1-083000		G-2-2-083000		G-2-3-083000	
		time (s):	7200	time (s):	64800	time (s):	7200	time (s):	43200	time (s):	43200
		weight (g):	10.83	weight (g):	31.39	weight (g):	13.48	weight (g):	12.16	weight (g):	10.43
Library	**Energy (keV)**	Counts	Activity Conc. (pCi/g)	Counts	Activity Conc. (pCi/g)	Counts	Activity Conc. (pCi/g)	Counts	Activity Conc. (pCi/g)	Counts	Activity Conc. (pCi/g)
Th-234	63	89	19.8	1778	15.2	145	25.9	569	18.8	570	22.0
Th-234	92	214	38.1	2489	17.0	173	24.8	891	23.6	609	18.8
Pb-214	295	140	15.4	1355	5.7	426	37.7	136	2.2	188	3.6
Ac-228	338	36	7.5	160	1.3	3	0.5	0	0.0	0	0.0
Pb-214	352	255	16.6	2323	5.8	754	39.6	85	0.8	350	4.0
Bi-214	609	188	14.6	1656	4.9	555	34.7	153	1.8	304	4.1
Ac-228	911	51	9.1	168	1.1	11	1.6	94	2.5	76	2.3
Ac-228	969	34	30.7	111	3.8	14	10.2	67	9.0	15	2.3
		U-nat	30.3	U-nat	16.8	U-nat	26.5	U-nat	22.2	U-nat	21.3
		Ra-226	15.6	Ra-226	5.5	Ra-226	37.3	Ra-226	1.6	Ra-226	3.9

		#27		#28		#29		#30		#31	
		A-3-1-092700		A-3-2-092700		A-3-3-092700		A-3-4-092700		A-2-1-092700	
		time (s):	3600	time (s):	3600	time (s):	3600	time (s):	3600	time (s):	3600
		weight (g):	6.33	weight (g):	8.41	weight (g):	3.31	weight (g):	6.31	weight (g):	20.66
Library	**Energy (keV)**	Counts	Activity Conc. (pCi/g)	Counts	Activity Conc. (pCi/g)	Counts	Activity Conc. (pCi/g)	Counts	Activity Conc. (pCi/g)	Counts	Activity Conc. (pCi/g)
Th-234	63	410	312.5	58	33.3	59	86.0	63	48.2	57	13.3
Th-234	92	522	318.1	57	26.1	96	111.9	64	39.1	96	17.9
Pb-214	295	67	25.3	0	0.0	44	31.7	550	208.1	0	0.0
Ac-228	338	28	19.9	0	0.0	0	0.0	8	5.7	20	4.4
Pb-214	352	137	30.6	3	0.5	68	29.1	937	210.0	43	2.9
Bi-214	609	50	13.3	5	1.0	56	28.5	711	189.7	42	3.4
Ac-228	911	5	3.0	13	6.0	0	0.0	4	2.4	9	1.7
Ac-228	969	0	0.0	6	13.9	5	29.5	0	0.0	4	3.8
		U-nat	330.0	U-nat	31.1	U-nat	103.6	U-nat	45.7	U-nat	16.3
		Ra-226	23.1	Ra-226	0.5	Ra-226	29.8	Ra-226	202.6	Ra-226	2.1

		#32		#33		#34		#35		#36	
		A-2-2-092700		A-2-3-092700		A-4-1-092700		C-2-1-092700		C-2-2-092700	
		time (s):	3600	time (s):	3600	time (s):	3600	time (s):	1800	time (s):	1800
		weight (g):	15.60	weight (g):	10.04	weight (g):	20.32	weight (g):	15.36	weight (g):	19.99
Library	**Energy (keV)**	Counts	Activity Conc. (pCi/g)	Counts	Activity Conc. (pCi/g)	Counts	Activity Conc. (pCi/g)	Counts	Activity Conc. (pCi/g)	Counts	Activity Conc. (pCi/g)
Th-234	63	185	57.2	48	23.1	127	30.2	96	60.3	12	5.8
Th-234	92	208	51.4	72	27.7	170	32.3	104	52.2	23	8.9
Pb-214	295	71	10.9	0	0.0	248	29.1	138	42.9	90	21.5
Ac-228	338	40	11.6	1	0.4	5	1.1	5	2.9	3	1.4
Pb-214	352	87	7.9	34	4.8	343	23.9	206	37.9	130	18.4
Bi-214	609	64	6.9	31	5.2	301	24.9	173	37.9	88	14.8
Ac-228	911	23	5.7	0	0.0	0	0.0	9	4.5	6	2.3
Ac-228	969	10	12.5	6	11.7	0	0.0	3	0.0	9	17.6
		U-nat	56.9	U-nat	26.6	U-nat	32.7	U-nat	58.9	U-nat	7.7
		Ra-226	8.6	Ra-226	3.3	Ra-226	26.0	Ra-226	39.6	Ra-226	18.2

		#37		#38		#39		#40		#41	
		C-2-3-092700		C-2-4-092700		C-3-1-092700		C-3-2-092700		C-3-3-092700	
		time (s):	7200	time (s):	3600	time (s):	7200	time (s):	43200	time (s):	43200
		weight (g):	2.08	weight (g):	2.19	weight (g):	2.07	weight (g):	2.17	weight (g):	5.90
Library	**Energy (keV)**	Counts	Activity Conc. (pCi/g)	Counts	Activity Conc. (pCi/g)	Counts	Activity Conc. (pCi/g)	Counts	Activity Conc. (pCi/g)	Counts	Activity Conc. (pCi/g)
Th-234	63	332	385.0	29	63.9	90	104.9	618	114.5	550	37.5
Th-234	92	365	338.4	59	103.9	146	136.0	820	121.5	886	48.3
Pb-214	295	38	21.8	26	28.3	14	8.1	79	7.2	130	4.4
Ac-228	338	25	27.1	8	16.5	6	6.5	8	1.4	130	8.3
Pb-214	352	64	21.8	0	0.0	41	14.0	161	8.7	235	4.7
Bi-214	609	47	19.0	30	23.1	44	17.9	202	13.1	215	5.1
Ac-228	911	10	9.3	9	15.8	37	34.4	85	12.6	14	0.8
Ac-228	969	3	14.1	10	89.3	0	0.0	51	38.3	55	15.2
		U-nat	378.7	U-nat	87.8	U-nat	126.1	U-nat	123.5	U-nat	44.9
		Ra-226	20.9	Ra-226	17.1	Ra-226	13.3	Ra-226	9.7	Ra-226	4.7

		#37		#38		#39		#40		#41	
		C-2-3-092700		C-2-4-092700		C-3-1-092700		C-3-2-092700		C-3-3-092700	
		time (s):	7200	time (s):	3600	time (s):	7200	time (s):	43200	time (s):	43200
		weight (g):	2.08	weight (g):	2.19	weight (g):	2.07	weight (g):	2.17	weight (g):	5.90
Library	**Energy (keV)**	Counts	Activity Conc. (pCi/g)	Counts	Activity Conc. (pCi/g)	Counts	Activity Conc. (pCi/g)	Counts	Activity Conc. (pCi/g)	Counts	Activity Conc. (pCi/g)
Th-234	63	332	385.0	29	63.9	90	104.9	618	114.5	550	37.5
Th-234	92	365	338.4	59	103.9	146	136.0	820	121.5	886	48.3
Pb-214	295	38	21.8	26	28.3	14	8.1	79	7.2	130	4.4
Ac-228	338	25	27.1	8	16.5	6	6.5	8	1.4	130	8.3
Pb-214	352	64	21.8	0	0.0	41	14.0	161	8.7	235	4.7
Bi-214	609	47	19.0	30	23.1	44	17.9	202	13.1	215	5.1
Ac-228	911	10	9.3	9	15.8	37	34.4	85	12.6	14	0.8
Ac-228	969	3	14.1	10	89.3	0	0.0	51	38.3	55	15.2
		U-nat	378.7	U-nat	87.8	U-nat	126.1	U-nat	123.5	U-nat	44.9
		Ra-226	20.9	Ra-226	17.1	Ra-226	13.3	Ra-226	9.7	Ra-226	4.7

		#42		#43		#44		#45		#46	
		F-3-1-092800		F-3-2-092800		F-3-3-092800		F-2-1-092800		F-2-2-092800	
		time (s):	7200	time (s):	7200	time (s):	5400	time (s):	43200	time (s):	14400
		weight (g):	9.24	weight (g):	8.80	weight (g):	2.05	weight (g):	5.64	weight (g):	10.32
Library	**Energy (keV)**	Counts	Activity Conc. (pCi/g)	Counts	Activity Conc. (pCi/g)	Counts	Activity Conc. (pCi/g)	Counts	Activity Conc. (pCi/g)	Counts	Activity Conc. (pCi/g)
Th-234	63	105	27.4	65	17.8	66	103.6	590	42.1	267	31.2
Th-234	92	190	39.7	145	31.8	112	140.5	848	48.3	161	15.0
Pb-214	295	14	1.8	22	3.0	11	8.5	70	2.5	554	32.0
Ac-228	338	2	0.5	0	0.0	16	23.5	0	0.0	62	6.8
Pb-214	352	94	7.2	42	3.4	45	20.7	188	3.9	1011	34.6
Bi-214	609	92	8.4	69	6.6	51	27.9	193	4.8	698	28.5
Ac-228	911	16	3.3	17	3.7	0	0.0	36	2.0	45	4.2
Ac-228	969	8	8.5	19	21.1	0	0.0	51	14.7	8	3.8
		U-nat	35.1	U-nat	26.0	U-nat	127.7	U-nat	47.3	U-nat	24.2
		Ra-226	5.8	Ra-226	4.3	Ra-226	19.1	Ra-226	3.7	Ra-226	31.7

		#47		#48		#49		#50		#51	
		F-2-3-092800		F-2-4-092800		F-3-4-092800		E-3-1-092800		E-3-2-092800	
		time (s):	53053	time (s):	7200	time (s):	7200	time (s):	7200	time (s):	7200
		weight (g):	9.65	weight (g):	2.89	weight (g):	3.01	weight (g):	3.18	weight (g):	9.66
Library	**Energy (keV)**	Counts	Activity Conc. (pCi/g)	Counts	Activity Conc. (pCi/g)	Counts	Activity Conc. (pCi/g)	Counts	Activity Conc. (pCi/g)	Counts	Activity Conc. (pCi/g)
Th-234	63	880	29.9	126	105.2	119	95.4	63	47.8	111	27.7
Th-234	92	1159	31.4	141	94.1	151	96.7	134	81.3	140	28.0
Pb-214	295	1559	26.2	30	12.4	17	6.7	38	14.3	12	1.5
Ac-228	338	25	0.8	7	5.5	0	0.0	2	1.4	18	4.2
Pb-214	352	2464	24.5	39	9.5	28	6.6	16	3.6	41	3.0
Bi-214	609	1956	23.2	27	7.9	29	8.1	52	13.8	31	2.7
Ac-228	911	139	3.8	26	17.3	6	3.8	5	3.0	13	2.6
Ac-228	969	33	4.5	19	64.3	12	39.0	10	30.7	7	7.1
		U-nat	32.1	U-nat	104.3	U-nat	100.6	U-nat	67.5	U-nat	29.1
		Ra-226	24.6	Ra-226	9.9	Ra-226	7.1	Ra-226	10.5	Ra-226	2.4

		#52		#53		#54		#55		#56	
		E-3-3-092800		E-3-4-092800		E-3-5-092800		E-2-1-092800		E-2-2-092800	
		time (s):	43200	time (s):	7200	time (s):	7200	time (s):	43200	time (s):	7200
		weight (g):	3.80	weight (g):	5.21	weight (g):	2.28	weight (g):	14.57	weight (g):	6.84
Library	**Energy (keV)**	Counts	Activity Conc. (pCi/g)	Counts	Activity Conc. (pCi/g)	Counts	Activity Conc. (pCi/g)	Counts	Activity Conc. (pCi/g)	Counts	Activity Conc. (pCi/g)
Th-234	63	677	71.6	83	38.4	78	82.5	735	20.3	89	31.4
Th-234	92	938	79.3	150	55.5	123	104.0	1151	25.4	210	59.2
Pb-214	295	109	5.7	3	0.7	7	3.7	52	0.7	0	0.0
Ac-228	338	74	7.3	0	0.0	0	0.0	37	1.0	8	2.6
Pb-214	352	129	4.0	18	2.4	24	7.4	235	1.9	41	4.2
Bi-214	609	166	6.1	50	8.1	40	14.8	241	2.3	21	2.6
Ac-228	911	35	3.0	9	3.3	0	0.0	65	1.4	25	7.0
Ac-228	969	37	15.9	16	30.0	26	111.5	0	0.0	4	5.7
		U-nat	79.0	U-nat	49.2	U-nat	97.6	U-nat	23.9	U-nat	47.4
		Ra-226	5.3	Ra-226	3.7	Ra-226	8.6	Ra-226	1.6	Ra-226	2.3

		#57		#58		#59		#60		#61	
		E-2-3-092800		G-4-1-092900		G-4-2-092900		G-2-1-092900		G-2-2-092900	
		time (s):	7200	time (s):	7200	time (s):	43158	time (s):	7200	time (s):	7193
		weight (g):	19.14	weight (g):	3.18	weight (g):	4.63	weight (g):	12.65	weight (g):	4.81
Library	**Energy (keV)**	Counts	Activity Conc. (pCi/g)	Counts	Activity Conc. (pCi/g)	Counts	Activity Conc. (pCi/g)	Counts	Activity Conc. (pCi/g)	Counts	Activity Conc. (pCi/g)
Th-234	63	154	19.4	169	128.2	1017	88.4	146	27.8	121	60.7
Th-234	92	228	23.0	0	0.0	1247	86.7	97	14.8	163	65.4
Pb-214	295	90	5.6	21484	8064.3	145	6.2	23	2.2	0	0.0
Ac-228	338	17	2.0	589	417.7	66	5.4	25	4.5	9	4.2
Pb-214	352	122	4.5	36007	8006.5	153	3.9	36	2.0	15	2.2
Bi-214	609	110	4.8	27950	7397.3	170	5.2	44	2.9	19	3.3
Ac-228	911	0	0.0	489	296.1	93	6.5	23	3.5	12	4.8
Ac-228	969	12	6.1	191	587.1	52	18.3	15	11.6	0	0.0
		U-nat	22.2	U-nat	67.1	U-nat	91.6	U-nat	22.3	U-nat	66.0
		Ra-226	5.0	Ra-226	7822.7	Ra-226	5.1	Ra-226	2.4	Ra-226	1.8

		#62		#63	
		G-4-3-092900		G-2-3-092900	
		time (s):	7193	time (s):	43200
		weight (g):	5.77	weight (g):	24.11
Library	**Energy (keV)**	Counts	Activity Conc. (pCi/g)	Counts	Activity Conc. (pCi/g)
Th-234	63	98	41.0	677	11.3
Th-234	92	144	48.2	868	11.6
Pb-214	295	0	0.0	112	0.9
Ac-228	338	19	7.4	57	0.9
Pb-214	352	26	3.2	317	1.5
Bi-214	609	0	0.0	240	1.4
Ac-228	911	4	1.3	75	1.0
Ac-228	969	0	0.0	27	1.8
		U-nat	46.7	U-nat	12.0
		Ra-226	1.1	Ra-226	1.3

		#64		#65		#66		#67		#68	
		D-2-1-102300		D-2-2-102300		D-2-3-102300		D-2-4-102300		D-3-1-102300	
		time (s):	6000	time (s):	6000	time (s):	6000	time (s):	6000	time (s):	6000
		weight (g):	13.69	weight (g):	21.56	weight (g):	3.19	weight (g):	53.09	weight (g):	3.81
Library	**Energy (keV)**	Counts	Activity Conc. (pCi/g)	Counts	Activity Conc. (pCi/g)	Counts	Activity Conc. (pCi/g)	Counts	Activity Conc. (pCi/g)	Counts	Activity Conc. (pCi/g)
Th-234	63	257	18.1	286	12.8	214	64.7	234	4.3	225	57.0
Th-234	92	225	13.1	370	13.7	236	59.1	328	4.9	258	54.1
Pb-214	295	1971	72.5	6200	144.8	9	1.4	43	0.4	17	2.2
Ac-228	338	71	4.9	128	5.6	0	0.0	22	0.4	8	2.0
Pb-214	352	3389	74.1	10329	143.4	27	2.5	140	0.8	16	1.3
Bi-214	609	2043	60.4	4106	77.1	0	0.0	2	0.0	2	0.2
Ac-228	911	80	5.9	0	0.0	33	10.5	0	0.0	10	2.7
Ac-228	969	31	11.8	38	9.2	0	0.0	11	1.1	7	9.6
		U-nat	16.4	U-nat	13.9	U-nat	64.8	U-nat	4.8	U-nat	58.2
		Ra-226	69.0	Ra-226	121.8	Ra-226	1.3	Ra-226	0.4	Ra-226	1.2

		#69		#70		#71		#72		#73		#74	
		D-2-5-102300		D-2-6-102300		D-2-3-102300		B-2-1-102300		B-2-2-102300		B-2-3-102300	
		time (s):	6000	time (s):	6000	time (s):	6000	time (s):	6000	time (s):	6000	time (s):	6000
		weight (g):	8.60	weight (g):	12.07	weight (g):	8.24	weight (g):	6.47	weight (g):	6.90	weight (g):	2.80
Library	**Energy (keV)**	Counts	Activity Conc. (pCi/g)	Counts	Activity Conc. (pCi/g)	Counts	Activity Conc. (pCi/g)	Counts	Activity Conc. (pCi/g)	Counts	Activity Conc. (pCi/g)	Counts	Activity Conc. (pCi/g)
Th-234	63	231	25.9	367	29.3	239	28.0	302	45.0	237	33.1	170	58.6
Th-234	92	347	32.3	516	34.2	340	33.0	352	43.5	315	36.5	247	70.5
Pb-214	295	155	9.1	473	19.7	17	1.0	40	3.1	0	0.0	0	0.0
Ac-228	338	11	1.2	22	1.7	51	5.9	25	3.7	1	0.1	34	11.5
Pb-214	352	297	10.3	809	20.1	39	1.4	109	5.0	27	1.2	38	4.1
Bi-214	609	20	0.9	168	5.6	32	1.6	0	0.0	1	0.1	0	0.0
Ac-228	911	0	0.0	20	1.7	0	0.0	6	0.9	0	0.0	19	6.9
Ac-228	969	0	0.0	23	9.9	0	0.0	33	0.0	32	24.1	10	18.6
		U-nat	30.4	U-nat	33.2	U-nat	31.9	U-nat	46.3	U-nat	36.4	U-nat	67.6
		Ra-226	6.8	Ra-226	15.1	Ra-226	1.3	Ra-226	2.7	Ra-226	0.4	Ra-226	1.4

		#75		#76		#77		#78		#79		#80	
		B-2-4-102300		B-2-5-102300		A-2-1-102600		A-3-1-102600		A-3-2-102600		A-3-3-102600	
		time (s):	6000	time (s):	6000	time (s):	6000	time (s):	6000	time (s):	6000	time (s):	6000
		weight (g):	30.41	weight (g):	16.97	weight (g):	34.54	weight (g):	11.76	weight (g):	3.69	weight (g):	2.10
Library	**Energy (keV)**	Counts	Activity Conc. (pCi/g)	Counts	Activity Conc. (pCi/g)	Counts	Activity Conc. (pCi/g)	Counts	Activity Conc. (pCi/g)	Counts	Activity Conc. (pCi/g)	Counts	Activity Conc. (pCi/g)
Th-234	63	244	8.2	428	25.7	277	8.2	203	17.6	245	67.5	239	115.8
Th-234	92	363	10.6	495	25.9	436	11.2	345	26.1	308	74.2	288	121.8
Pb-214	295	136	2.4	2614	81.0	346	5.3	38	1.7	0	0.0	41	10.3
Ac-228	338	11	0.4	26	1.5	64	1.8	0	0.0	3	0.8	40	18.9
Pb-214	352	149	1.5	3637	66.9	416	3.8	64	1.7	8	0.7	14	2.1
Bi-214	609	25	0.3	1081	25.2	130	1.5	27	0.9	0	0.0	31	5.8
Ac-228	911	21	0.7	41	2.4	0	0.0	0	0.0	9	2.4	24	11.1
Ac-228	969	0	0.0	0	0.0	9	1.3	15	6.4	0	0.0	12	28.8
		U-nat	9.8	U-nat	27.0	U-nat	10.1	U-nat	22.8	U-nat	74.2	U-nat	124.4
		Ra-226	1.4	Ra-226	57.7	Ra-226	3.5	Ra-226	1.4	Ra-226	0.2	Ra-226	6.1

		#81		#82		#83		#84		#85	
		A-3-4-102600		A-2-2-102600		A-3-5-102600		A-3-6-102600		A-3-7-102600	
		time (s):	6000	time (s):	6000	time (s):	6000	time (s):	6000	time (s):	6000
		weight (g):	6.27	weight (g):	11.45	weight (g):	18.03	weight (g):	24.94	weight (g):	12.97
Library	**Energy (keV)**	Counts	Activity Conc. (pCi/g)	Counts	Activity Conc. (pCi/g)	Counts	Activity Conc. (pCi/g)	Counts	Activity Conc. (pCi/g)	Counts	Activity Conc. (pCi/g)
Th-234	63	90	47.2	223	64.0	85	15.5	131	17.3	179	45.4
Th-234	92	77	3.5	339	8.4	207	3.3	156	1.8	119	2.6
Pb-214	295	32	8.0	100	13.8	468	40.9	88	5.6	457	55.6
Ac-228	338	0	0.0	0	0.0	54	8.9	32	3.8	44	10.1
Pb-214	352	40	6.0	126	10.3	766	39.7	217	8.1	892	64.3
Bi-214	609	66	12.2	142	14.4	488	31.4	124	5.8	617	55.2
Ac-228	911	5	2.2	13	3.1	44	6.7	13	1.4	12	2.5
Ac-228	969	19	42.6	20	24.6	24	18.7	13	7.3	0	0.0
		U-nat	26.5	U-nat	37.9	U-nat	9.8	U-nat	10.0	U-nat	25.1
		Ra-226	8.7	Ra-226	12.8	Ra-226	37.4	Ra-226	6.5	Ra-226	58.4

		#86		#87		#88		#89		#90		#91	
		C-2-1-102600		C-3-1-102600		C-2-2-102600		C-2-3-102600		C-2-4-102600		C-2-5-102600	
		time (s):	6000	time (s):	6000	time (s):	6000	time (s):	6000	time (s):	6000	time (s):	6000
		weight (g):	12.00	weight (g):	5.64	weight (g):	14.13	weight (g):	15.65	weight (g):	7.93	weight (g):	29.12
Library	**Energy (keV)**	Counts	Activity Conc. (pCi/g)	Counts	Activity Conc. (pCi/g)	Counts	Activity Conc. (pCi/g)	Counts	Activity Conc. (pCi/g)	Counts	Activity Conc. (pCi/g)	Counts	Activity Conc. (pCi/g)
Th-234	63	235	64.4	117	68.2	146	34.0	54	11.3	56	23.2	17	1.9
Th-234	92	295	7.0	164	8.3	219	4.4	102	1.9	98	3.5	63	0.6
Pb-214	295	22	2.9	0	0.0	60	6.7	0	0.0	0	0.0	6	0.3
Ac-228	338	17	4.2	25	13.2	21	4.4	16	3.0	5	1.9	20	2.0
Pb-214	352	16	1.2	30	5.0	53	3.5	63	3.8	26	3.1	36	1.2
Bi-214	609	43	4.2	20	4.1	49	4.0	31	2.3	41	6.0	34	1.4
Ac-228	911	1	0.2	18	8.8	2	0.4	4	0.7	7	2.4	0	0.0
Ac-228	969	0	0.0	15	37.4	17	16.9	8	7.2	21	37.2	0	0.0
		U-nat	37.4	U-nat	40.0	U-nat	20.1	U-nat	6.9	U-nat	14.0	U-nat	1.3
		Ra-226	2.8	Ra-226	3.0	Ra-226	4.7	Ra-226	2.0	Ra-226	3.0	Ra-226	0.9

		#92		#93		#94		#95		#96	
		E-4-1-113000		E-4-2-113000		E-4-3-113000		E-2-1-113000		E-2-2-113000	
		time (s):	6000	time (s):	6000	time (s):	6000	time (s):	6000	time (s):	6000
		weight (g):	13.27	weight (g):	4.05	weight (g):	8.78	weight (g):	4.48	weight (g):	10.17
Library	**Energy (keV)**	Counts	Activity Conc. (pCi/g)	Counts	Activity Conc. (pCi/g)	Counts	Activity Conc. (pCi/g)	Counts	Activity Conc. (pCi/g)	Counts	Activity Conc. (pCi/g)
Th-234	63	90	22.3	106	86.1	61	22.8	82	60.2	45	14.5
Th-234	92	134	2.9	102	7.2	159	5.2	140	8.9	101	2.8
Pb-214	295	214	25.4	106	41.3	110	19.8	19	6.7	16	2.5
Ac-228	338	26	5.8	0	0.0	0	0.0	0	0.0	28	8.2
Pb-214	352	278	19.6	208	48.0	174	18.5	16	3.3	40	3.7
Bi-214	609	234	20.5	115	33.0	145	19.2	19	4.9	17	1.9
Ac-228	911	1	0.2	29	19.7	15	4.7	28	17.2	8	2.2
Ac-228	969	0	0.0	0	0.0	14	22.4	0	0.0	15	20.7
		U-nat	13.2	U-nat	48.8	U-nat	14.7	U-nat	36.2	U-nat	9.1
		Ra-226	21.8	Ra-226	40.7	Ra-226	19.1	Ra-226	5.0	Ra-226	2.7

		#97		#98		#99		#100		#101	
		E-3-1-113000		F-2-1-121400		F-2-2-121400		F-2-3-121400		F-4-1-121400	
		time (s):	6000	time (s):	6000	time (s):	6000	time (s):	6000	time (s):	6000
		weight (g):	8.43	weight (g):	30.04	weight (g):	20.68	weight (g):	17.23	weight (g):	13.50
Library	**Energy (keV)**	Counts	Activity Conc. (pCi/g)	Counts	Activity Conc. (pCi/g)	Counts	Activity Conc. (pCi/g)	Counts	Activity Conc. (pCi/g)	Counts	Activity Conc. (pCi/g)
Th-234	63	55	21.5	311	34.0	63	10.0	133	25.4	108	26.3
Th-234	92	107	3.6	360	3.4	93	1.3	195	3.2	41	0.9
Pb-214	295	14	2.6	598	31.4	49	3.7	111	10.2	969	113.2
Ac-228	338	0	0.0	31	3.1	40	5.8	0	0.0	0	0.0
Pb-214	352	0	0.0	1058	32.9	49	2.2	219	11.9	1687	116.8
Bi-214	609	17	2.3	843	32.6	37	2.1	152	10.2	1309	112.5
Ac-228	911	0	0.0	0	0.0	0	0.0	21	3.3	44	9.0
Ac-228	969	0	0.0	37	17.3	0	0.0	3	2.4	25	26.0
		U-nat	13.1	U-nat	19.6	U-nat	5.9	U-nat	15.0	U-nat	14.2
		Ra-226	1.7	Ra-226	32.3	Ra-226	2.7	Ra-226	10.8	Ra-226	114.2

		#102		#103		#104		#105		#106	
		F-2-4-121400		F-2-5-121400		F-3-1-121400		F-3-2-121400		F-2-6-121400	
		time (s):	6000	time (s):	6000	time (s):	6000	time (s):	6000	time (s):	6000
		weight (g):	20.98	weight (g):	15.00	weight (g):	5.68	weight (g):	12.15	weight (g):	11.43
Library	**Energy (keV)**	Counts	Activity Conc. (pCi/g)	Counts	Activity Conc. (pCi/g)	Counts	Activity Conc. (pCi/g)	Counts	Activity Conc. (pCi/g)	Counts	Activity Conc. (pCi/g)
Th-234	63	233	36.5	111	24.3	70	40.5	67	18.1	63	18.1
Th-234	92	357	4.9	118	2.2	121	6.1	99	2.3	157	3.9
Pb-214	295	36	2.7	58	6.1	17	4.7	42	5.5	61	8.4
Ac-228	338	26	3.7	0	0.0	0	0.0	0	0.0	0	0.0
Pb-214	352	37	1.6	81	5.0	1	0.2	38	2.9	48	3.9
Bi-214	609	50	2.8	58	4.5	36	7.4	46	4.4	72	7.3
Ac-228	911	25	3.3	14	2.6	21	10.2	33	7.5	13	3.1
Ac-228	969	9	6.0	11	10.3	0	0.0	0	0.0	5	6.2
		U-nat	21.7	U-nat	13.9	U-nat	24.4	U-nat	10.7	U-nat	11.5
		Ra-226	2.4	Ra-226	5.2	Ra-226	4.1	Ra-226	4.3	Ra-226	6.6

		#107		#108		#109		#110		#111	
		F-4-2-121400		B-4-1-121400		B-2-1-121400		B-2-2-121400		B-2-3-121400	
		time (s):	6000	time (s):	6000	time (s):	6000	time (s):	6000	time (s):	6000
		weight (g):	22.04	weight (g):	14.51	weight (g):	13.45	weight (g):	18.32	weight (g):	31.91
Library	**Energy (keV)**	Counts	Activity Conc. (pCi/g)	Counts	Activity Conc. (pCi/g)	Counts	Activity Conc. (pCi/g)	Counts	Activity Conc. (pCi/g)	Counts	Activity Conc. (pCi/g)
Th-234	63	156	23.3	102	23.1	144	35.2	181	32.5	302	31.1
Th-234	92	158	2.0	110	2.2	121	2.6	235	3.7	383	3.4
Pb-214	295	5174	370.2	2854	310.1	271	31.8	426	36.7	774	38.2
Ac-228	338	35	4.7	0	0.0	43	9.5	1	0.2	10	0.9
Pb-214	352	8564	363.3	4599	296.4	431	30.0	635	32.4	1421	41.6
Bi-214	609	6767	356.3	3613	289.0	333	28.7	492	31.2	1056	38.4
Ac-228	911	9	1.1	22	4.2	8	1.6	25	3.7	9	0.8
Ac-228	969	33	21.1	38	36.8	21	22.0	5	3.8	4	1.8
		U-nat	13.3	U-nat	13.2	U-nat	19.8	U-nat	18.9	U-nat	18.1
		Ra-226	363.3	Ra-226	298.5	Ra-226	30.2	Ra-226	33.4	Ra-226	39.4

		#112		#113		#114		#115		#116	
		B-2-4-121400		B-3-1-121400		B-3-2-121400		D-2-1-122800		D-2-2-122800	
		time (s):	6000	time (s):	6000	time (s):	6000	time (s):	6000	time (s):	6000
		weight (g):	14.60	weight (g):	3.05	weight (g):	1.55	weight (g):	11.41	weight (g):	2.59
Library	**Energy (keV)**	Counts	Activity Conc. (pCi/g)	Counts	Activity Conc. (pCi/g)	Counts	Activity Conc. (pCi/g)	Counts	Activity Conc. (pCi/g)	Counts	Activity Conc. (pCi/g)
Th-234	63	99	22.3	56	60.4	82	173.9	41	11.8	90	114.3
Th-234	92	130	2.5	99	9.3	153	28.2	146	3.7	98	10.8
Pb-214	295	98	10.6	47	24.3	40	40.7	612	84.6	1	0.6
Ac-228	338	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
Pb-214	352	193	12.4	33	10.1	50	30.2	951	77.9	38	13.7
Bi-214	609	129	10.3	24	9.1	56	41.9	726	73.8	13	5.8
Ac-228	911	27	5.1	0	0.0	0	0.0	0	0.0	8	8.5
Ac-228	969	2	1.9	0	0.0	11	99.8	28	34.5	0	0.0
		U-nat	13.0	U-nat	36.4	U-nat	105.8	U-nat	8.1	U-nat	65.5
		Ra-226	11.1	Ra-226	14.5	Ra-226	37.6	Ra-226	78.8	Ra-226	6.7

		#117		#118		#119		#120	
		D-2-3-122800		D-2-4-122800		D-2-5-122800		D-4-1-122800	
		time (s):	6000	time (s):	6000	time (s):	6000	time (s):	6000
		weight (g):	6.11	weight (g):	49.49	weight (g):	19.78	weight (g):	12.19
Library	**Energy (keV)**	Counts	Activity Conc. (pCi/g)	Counts	Activity Conc. (pCi/g)	Counts	Activity Conc. (pCi/g)	Counts	Activity Conc. (pCi/g)
Th-234	63	167	89.9	114	7.6	83	13.8	94	25.4
Th-234	92	212	9.9	118	0.7	198	2.9	127	3.0
Pb-214	295	561	144.8	66	2.1	215	17.1	39	5.0
Ac-228	338	30	14.6	20	1.2	0	0.0	3	0.7
Pb-214	352	979	149.8	135	2.6	372	17.6	8	0.6
Bi-214	609	709	134.7	112	2.6	290	17.0	2	0.2
Ac-228	911	16	7.2	14	0.8	36	5.0	16	3.6
Ac-228	969	0	0.0	0	0.0	30	21.3	23	26.5
		U-nat	52.2	U-nat	4.3	U-nat	8.7	U-nat	14.8
		Ra-226	143.1	Ra-226	2.4	Ra-226	17.2	Ra-226	1.9

		#121		#122		#123		#124		#125	
		G-2-1-020701		G-2-2-020701		G-2-3-020701		G-2-4-020701		G-2-5-020701	
		time (s):	6000	time (s):	6000	time (s):	6000	time (s):	6000	time (s):	6000
		weight (g):	11.68	weight (g):	17.24	weight (g):	17.08	weight (g):	18.37	weight (g):	20.31
Library	**Energy (keV)**	Counts	Activity Conc. (pCi/g)	Counts	Activity Conc. (pCi/g)	Counts	Activity Conc. (pCi/g)	Counts	Activity Conc. (pCi/g)	Counts	Activity Conc. (pCi/g)
Th-234	63	98	27.6	47	9.0	123	23.7	88	15.8	25	4.0
Th-234	92	44	1.1	117	1.9	146	2.4	79	1.2	114	1.6
Pb-214	295	662	89.4	976	89.3	197	18.2	154	13.2	5	0.4
Ac-228	338	58	14.8	35	6.0	5	0.9	10	1.6	12	1.8
Pb-214	352	1217	97.4	1703	92.4	404	22.1	316	16.1	89	4.1
Bi-214	609	893	88.7	1285	86.5	313	21.3	222	14.0	89	5.1
Ac-228	911	36	8.5	30	4.8	26	4.2	18	2.7	20	2.7
Ac-228	969	37	44.6	0	0.0	22	18.1	15	11.5	7	4.8
		U-nat	15.0	U-nat	5.7	U-nat	13.7	U-nat	8.9	U-nat	3.0
		Ra-226	91.8	Ra-226	89.4	Ra-226	20.5	Ra-226	14.4	Ra-226	3.2

		#126		#127		#128		#129		#130	
		G-4-1-020701		G-4-2-020701		G-4-3-020701		A-2-1-022701		A-2-2-022701	
		time (s):	6000	time (s):	6000	time (s):	6000	time (s):	6000	time (s):	6000
		weight (g):	26.89	weight (g):	9.57	weight (g):	14.25	weight (g):	25.45	weight (g):	19.73
Library	**Energy (keV)**	Counts	Activity Conc. (pCi/g)	Counts	Activity Conc. (pCi/g)	Counts	Activity Conc. (pCi/g)	Counts	Activity Conc. (pCi/g)	Counts	Activity Conc. (pCi/g)
Th-234	63	57	7.0	111	38.1	97	22.4	57	7.4	280	46.7
Th-234	92	127	1.3	90	2.7	145	2.9	112	1.3	520	7.5
Pb-214	295	974	57.1	54	8.9	65	7.2	27	1.7	131	10.5
Ac-228	338	27	3.0	0	0.0	59	12.3	0	0.0	22	3.3
Pb-214	352	1518	52.8	36	3.5	189	12.4	19	0.7	240	11.4
Bi-214	609	1332	57.5	7	0.8	104	8.5	27	1.2	176	10.4
Ac-228	911	0	0.0	27	7.8	28	5.4	0	0.0	4	0.6
Ac-228	969	16	8.4	0	0.0	25	24.7	14	7.7	13	9.3
		U-nat	4.4	U-nat	21.4	U-nat	13.2	U-nat	4.5	U-nat	28.4
		Ra-226	55.8	Ra-226	4.4	Ra-226	9.4	Ra-226	1.2	Ra-226	10.7

		#131		#132		#133		#134		#135		#136	
		A-2-3-022701		A-2-4-022701		A-4-1-022701		A-4-2-022701		A-2-5-022701		A-2-6-022701	
		time (s):	6000	time (s):	6000	time (s):	6000	time (s):	6000	time (s):	6000	time (s):	6000
		weight (g):	7.86	weight (g):	8.43	weight (g):	3.92	weight (g):	40.64	weight (g):	15.26	weight (g):	9.71
Library	**Energy (keV)**	Counts	Activity Conc. (pCi/g)	Counts	Activity Conc. (pCi/g)	Counts	Activity Conc. (pCi/g)	Counts	Activity Conc. (pCi/g)	Counts	Activity Conc. (pCi/g)	Counts	Activity Conc. (pCi/g)
Th-234	63	72	30.1	50	19.5	69	57.9	142	11.5	64	13.8	203	68.7
Th-234	92	93	3.4	95	3.2	50	3.6	268	1.9	108	2.0	305	9.0
Pb-214	295	28	5.6	2	0.4	18655	7503.8	340	13.2	266	27.5	67	10.9
Ac-228	338	13	4.9	0	0.0	150	113.9	41	3.0	0	0.0	15	4.6
Pb-214	352	28	3.3	24	2.7	31501	7514.0	633	14.6	523	32.0	112	10.8
Bi-214	609	31	4.6	37	5.1	23933	7084.9	447	12.8	437	33.2	142	17.0
Ac-228	911	8	2.8	11	3.6	225	157.7	10	0.7	34	6.1	0	0.0
Ac-228	969	17	30.4	6	10.0	105	376.8	5	1.7	21	19.4	6	8.7
		U-nat	17.5	U-nat	11.9	U-nat	32.2	U-nat	7.0	U-nat	8.3	U-nat	40.7
		Ra-226	4.5	Ra-226	2.7	Ra-226	7367.6	Ra-226	13.5	Ra-226	30.9	Ra-226	12.9