August 14, 2000

TO: Dennis Sollenberger
Office of State and Tribal Programs

FROM: Steve Hsu
California Department of Health Services

SUBJECT: NOVEMBER 15, 1999 LETTER TO X. YIN, CALIFORNIA DEPARTMENT OF HEALTH SERVICES FROM M. SHARP, LOEB & LOEB, ENCLOSING SITE CHARACTERIZATION REPORT FOR 170 WEST PROVIDENCIA STREET, BURBANK, CALIFORNIA

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Radiologic Health
STATE DEPT OF
HEALTH SERVICES
NOV 19 1999
SACRAMENTO

November 15, 1999

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VIA TELECOPY AND
FIRST CLASS MAIL

Xiaosong Yin, Health Physicist
State of California
Department of Health Services
Radiologic Health Branch
Post Office Box 942732, MS-178
Sacramento, California 94234-7320

Re: 170 West Providencia Street, Burbank, California (the "Providencia Property")

Dear Mr. Yin:

Thank you for your letter of November 9, 1999 requesting the complete radiological survey results from the sampling and analysis of the Providenica Property which took place in March through April of 1999, and an update in connection with the workplan for the decontamination and decommissioning of the Providenica Property.

On November 9, 1999, we transmitted a complete copy of the Rogers & Associates site characterization report - - which includes the results of the March through April survey of the Providenica Property - - to Gerard Wong. Enclosed for your convenience is an additional copy of the site characterization report and a copy of our November 9 letter to Dr. Wong.

In regards to the workplan for the decontamination and decommissioning of the Providencia Property ("D&D Workplan"), Dr. Bernhardt advises that prior to completing a D&D Workplan that the results of the sampling and analysis as reported in the site characterization report must undergo pathways analysis modeling. Once the pathways modeling is complete, then the extent of the residual radioactive

contamination on the Providencia Property can be assessed, clean-up standards derived[1] and a D&D Workplan completed.

Dr. Bernhardt's implementation of the sampling and analysis plan on the Providenica Property cost Mr. Thomson over $180,000. Unfortunately, only one of the parties responsible for the residual radioactive contamination on the Providenica Property - - -Nucor Corporation - - agreed to help Mr. Thomson fund this work. ICN Pharmaceuticals and Rhone-Poulenc refused to share in the cost of the sampling and analysis of the Providenica Property. Thus, although Mr. Thomson is a retiree in his 80's with limited resources, in an effort to characterize the extent of the radioactive contamination on the Providenica Property and ultimately work with the State of California, the Nuclear Regulatory Commission and the United States Environmental Protection Agency to derive the clean-up levels, Mr. Thomson funded 75% of the cost to implement the sampling and analysis plan on the Providenica Property.

Based upon conversations with Dr. Bernhardt and other radiation experts, we anticipate that completing the pathways analysis modeling on the Providenica Property will cost Mr. Thomson anywhere from $50,000 to $100,000. Once the modeling is complete, the D&D Workplan and implementation of the D&D Workplan will run anywhere from the high thousands to millions of dollars. Mr. Thomson is not in a position to complete this work alone.

In an effort to resolve this issue, Mr. Thomson and the parties responsible for the residual radioactive contamination on the Providenica Property - - Nucor Corporation, ICN Pharmaceuticals, and Rhone-Poulenc - - have agreed to non-binding mediation on the issue of liability and responsibility. Once the mediation process is complete[2], it is anticipated that the party allocated the greatest responsibility will take the lead in completing the D&D Workplan and implementation of the D&D work on the Providenica Property.

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[1] By this letter, Mr. Thomson requests that the United States Environmental Protection Agency be part and party to the discussions concerning standards for clean-up of the Providenica Property.

[2] The parties are in the process of selecting a mediator. Depending upon the availability of the selected mediator, the parties anticipate holding mediation sessions in late January of 2000.

If you have any questions or need additional information please contact me. In the interim, we look forward to your comments on the site characterization report.

Sincerely,

Martha Sharp

Martha Sharp, Esq.

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Enclosure

cc: Mr. Joseph A. Thomson (w/o encl.)
Malissa H. McKeith, Esq. (w/o encl.)
Gerard Wong, Ph.D. (w/o encl.)
Donald Bunn, Ph.D. (w/encl.)

D&M-RAE-9824/2-1

SITE CHARACTERIZATION OF RESIDUAL RADIOACTIVITY FROM FORMER RADIOACTIVE MATERIALS LICENSE OPERATIONS THOMSON PROPERTY, BURBANK CALIFORNIA

Prepared For
Joseph Thomson

September 1999

Prepared by
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Radiologic Health
STATE DEPT OF HEALTH SERVICES
NOV 1 9 1999
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1. INTRODUCTION

Isotope Specialties Company (ISC), licensed by the Atomic Energy Commission (AEC), manufactured radioactive sealed sources and tracing materials (used in pharmaceutical applications) during the 1950's and early 1960's, in Burbank, California, at 170 West Providencia (denoted as "Site"). Research Chemicals Corporation (RCC) also performed operations at the Site, using thorium/rare earth ores under an AEC license. There were several name changes and changes in corporate identity and ownership of the companies during the operations at the site. Figure 1-1 shows the general location of the Site, which is just to the north of Los Angeles. The Site is southwest of I-5, in an industrial area of Burbank, CA.

The present property owner, Joseph Thomson, has used and leased the site to others for commercial and industrial operations. Part of the site is vacant. However, the rear (east) area is presently used as an impound lot for the City of Burbank; the front outdoor area is rented to adjoining businesses for parking; and a tenant/proposed owner uses some of the front offices (the lease for the impound lot was terminated in September 1999).

In the mid 1990's the U.S. Nuclear Regulatory Commission (NRC) (AEC was a predecessor of the NRC) initiated a program to review formerly-licensed sites where licensed radioactive material activities had been terminated. The objectives of the NRC review included determining the documentation that was available for the sites, and evaluating whether the available information indicated that the sites had been adequately decontaminated prior to termination of their licenses and whether the present site conditions met present NRC decontamination criteria. The review by the NRC did not identify information on the decontamination of the 170 West Providencia Site. Subsequently, as part of an inspection of formerly-licensed sites, a facility inspection was performed by the NRC to determine if the Burbank Site had been adequately decontaminated for unrestricted use (Cheney 1996).

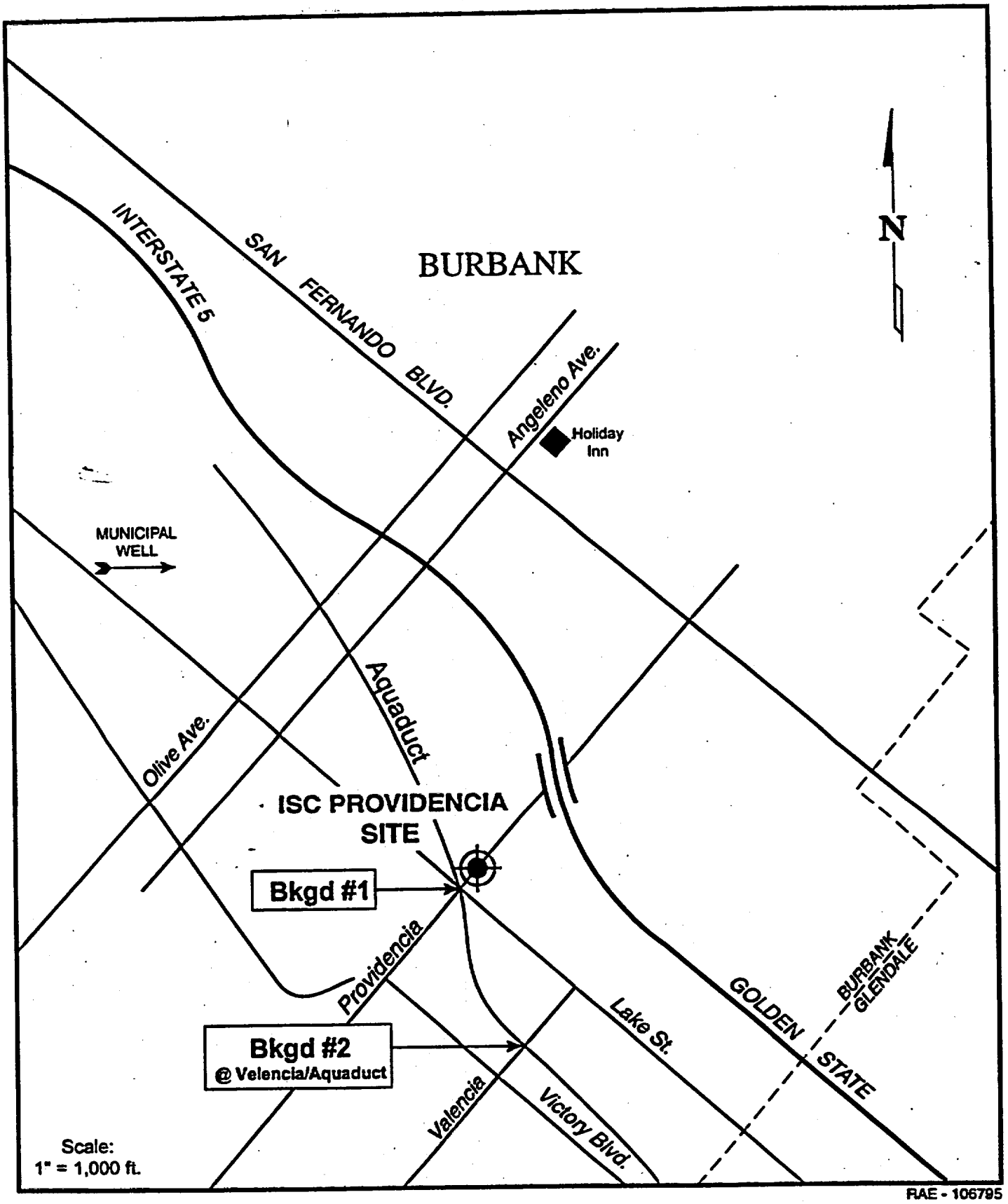


Figure 1-1. General area location map.

The NRC facility inspection identified several areas throughout the Site that contain elevated gamma radiation levels. The California Department of Health Services, Radiologic Health Branch (RHB) also participated in the inspection. Based on the inspector's findings, it was concluded that the Site contains radioactive contamination above the NRC's current residual radioactivity criteria for release of such facilities for unrestricted use, and that additional decontamination is necessary.

This site characterization report presents the methods and results of further radiological characterization performed at the initiative of the present site owner. The further characterization follows a Sampling and Analysis Plan (SAP), supplemented in response to requests from the RHB (Bernhardt 1998, Bernhardt 1999). The site characterization was performed during March 29 through April 17, 1999. The work performed during this period was supplemented during subsequent short visits to the site performed to audit that the controls for isolation of contaminated areas remain in place. Figure 1-2 shows the general layout of the site. The location of fences and new locks, installed as part of this work, are shown on the drawing.

The major activities and facilities at the Site during the radioactive material licensed activities of the 1950's and early 1960's are summarized in the SAP. The basic facilities include the following features (also shown in Figure 1-2):

- The Shop: in the eastern section of the main building, where the following facilities/operations were present:
  - Storage pool: denoted as Co-60 Pool or swimming pool, in the far southeast corner, where Co-60 was stored. The inventory was up to 5,000 Ci of Co-60, and the material was stored as metal bar stock in pie pans. The pool, constructed of concrete, was about 14 ft deep. Verbal communications with Mr. Donaldson (a former employee at the site) indicated that all of the plumbing for treating the water was inside the walls of the pool.
  - Five hot cells: for working with and storing radioactive materials, in the central eastern area of the shop. The hot cells were for working with and preparing high-level sources of Sr-90, Cs-137, Co-60, and neutron sources, plus other radionuclides. The hot cells were built of concrete walls up to 2-ft thick and contained subsurface tubes for storing radioactive material. The primary walls for the hot cells, which have since been removed, are shown approximately by dashed lines in Figure 1-2 based on earlier diagrams (Bernhardt 1998).

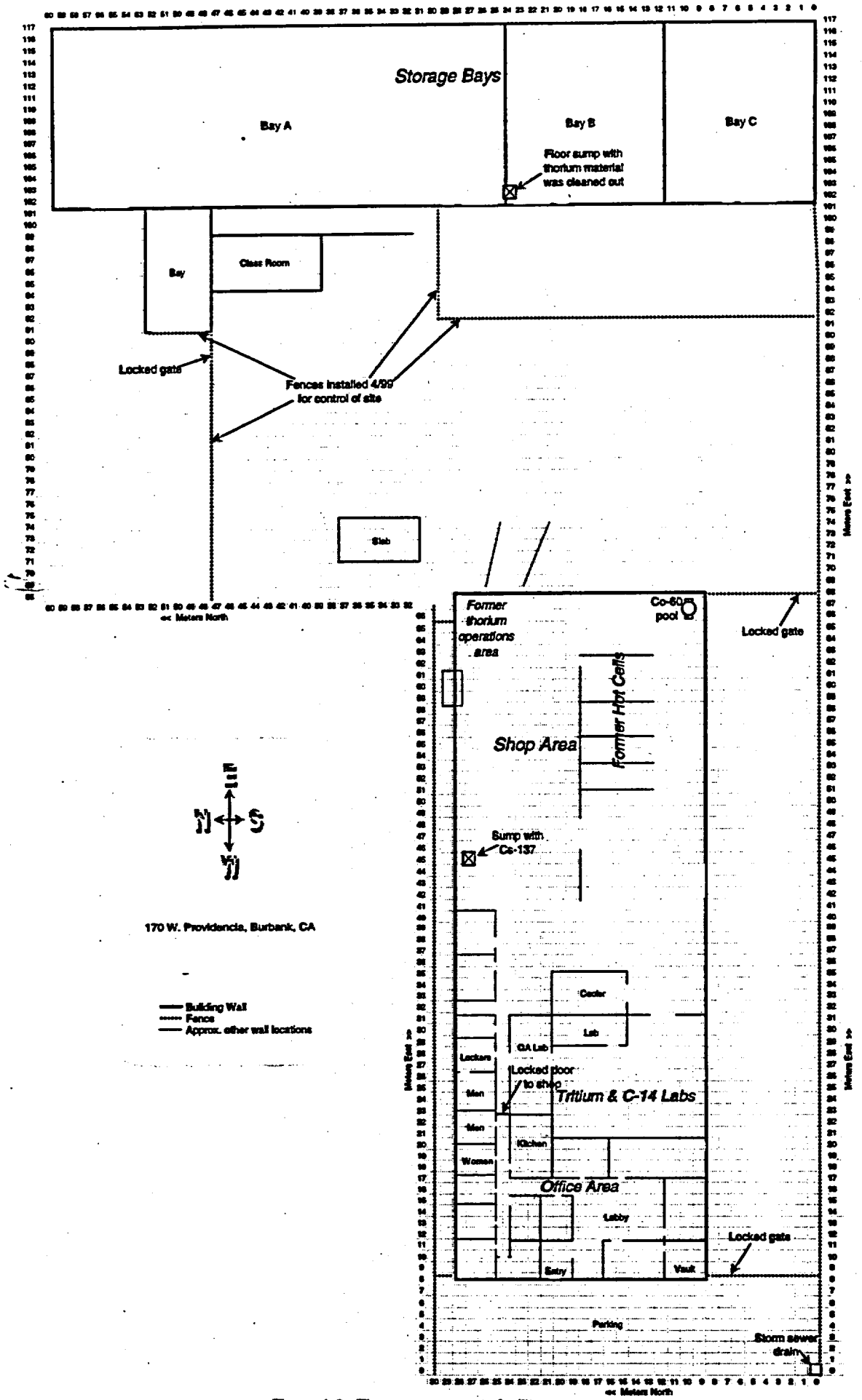


Figure 1-2. Thompson property facility map.

- Thorium operations areas: RCC performed work with rare earth materials and thorium, apparently under a license separate from ISC, in the northeastern section of the Shop, to the north of the hot cells. Information from the previous site characterization implies that thorium related operations may also have been performed on or near the small concrete slab in the northeast area of the Shop.

- **Tritium and C-14 labs:** The area to the east of the southern area of the office was used for tritium and C-14 work. After the decontamination of the building in the early 1960's a fire extensively burned this area.

- **Storage bays:** The Bays on the east of the property were apparently only used for storing radioactive waste and for some research with sealed radioactive sources. However, one of the highest areas of contamination identified by the NRC survey was a small area just inside of the door of Bay B, at 102E:23N.

- **Sewers:** The NRC inspection report (Chaney 1996) indicates that there had been discharges to the sewer as part of the thorium activities, possibly those by RCC. The available information from the present owner, including the deposition of the former ISC Radiation Safety Officer (Vaden 1998) has not identified any specific information concerning discharges to the sewer or connections of effluent lines to the sewer.

The buildings at the Site were built over many years. The original office building and other buildings were built in the 1940's and used for several purposes, including a dairy. The main building, shown as the office and shop on Figure 1-2, was build in several sections over a period of years. Additional buildings were built for the ISC radioactive materials activities in the 1950's, and the present owner (Joseph Thomson) has built several additions since the termination of the ISC and related radiation licensed work in the early 1960s.

The long sequence of operations at the facility adversely affects the interpretation of site conditions and makes it hard to interpret where contamination may be present. As an example, a major area of contamination identified by the NRC survey was a small area in Bay B at the rear of the site (see Figure 1-2) (Bernhardt 1998). Investigations as part of this Site Characterization showed that this was a floor sump (about 25 cm by 25 cm, 25 cm deep) which was filled with soil type material containing relatively high (more than 10 times the regulatory threshold for source material) concentrations of thorium containing materials. A similar sump in the northwest area of the shop, appeared to be filled with plaster-of-Paris type material, contained contamination from Cs-137. There are two or more similar sumps in the

rear area of the site, which are plugged, which do not appear to be contaminated. Whereas, the sump in Bay B appears to have been filled as part of the former licensed activities, the sump in the northwest area of the shop may have been sealed to prevent contamination by the licensed activities, but was possibly accidentally contaminated. The other sumps on the east end of the site may have been sealed to prevent contaminating the sewer system.

The present site characterization work was conducted by the Rogers & Associates Engineering Unit of the Dames & Moore Group, with assistance from Surface Technology Systems, Inc. (STS) (denoted as the Team). The work was performed under the Tennessee Radioactive Materials License of STS, which was accepted by the California RHB under reciprocity with Tennessee. The license has been retained in effect at the site to provide control of the contaminated areas and to allow specified sections of the site to be used for "temporary unrestricted use."

1.1 OBJECTIVE

This report presents the methods and results of field assessments to characterize the concentrations of residual radioactive material at the Site. The field assessments were based on implementation of the Sampling and Analysis Plan (Bernhardt 1998 and Bernhardt 1999), approved by the RHB for characterizing the Site, with field modifications of the SAP in response to site conditions. The objectives of the site characterization included characterizing the residual contamination on the surface and determining whether residual radioactive material was present in subsurface materials. The site characterization included extensive gamma-ray surveys of the buildings and outside areas of the site, of the roof of the primary facility (office, lab, shop building), and of applicable natural background areas. The characterization activities also included over 100 field gamma spectrometric measurements to determine the distribution and relative quantities of radionuclides contributing to the total intensities measured in the gamma-ray surveys. The field measurements were further supported by collection and analysis of numerous samples of materials from the site. The site characterization was based on the concepts of the Multiagency Radiation Survey and Site Investigation Manual, MARSSIM (MARSSIM 1998), and this report provides information for

possibly implementing MARSSIM in subsequent activities for the release of the Site for unrestricted use.

Based on the previous site characterizations, it appeared that there was not subsurface contamination, and it was anticipated that it would be viable to perform relatively easy remediation of the surface contamination. However, the field investigations indicated that there was more extensive contamination than originally anticipated and that there was subsurface contamination in several areas, with related radiation exposure rates of about 100 mrem per hour, and possibly higher. This report describes the limited remediation that was performed during the site characterization activities; however, much of the contamination was left in place. Some of the concentrated subsurface contamination was only located and not fully characterized. Materials were left in place to avoid exposing potentially high levels of contamination and to leave the materials confined during the time it will take to prepare a "Decontamination and Decommissioning Plan" and implement decontamination.

This report also identifies the controls used for isolating and posting areas of contamination on the site and the procedures implemented to allow specified use of areas of the site for "temporary unrestricted use."

1.2 RADIONUCLIDES OF CONCERN AND DERIVED CONCENTRATION GUIDELINE LEVELS

The SAP (Bernhardt 1998, Bernhardt 1999) presents information on the former site activities and identifies Cs-137, uranium and thorium, and the decay products of uranium and thorium as the primary radionuclides of concern. However, the former site activities also included a kilocurie inventory of Co-60 and work with Sr-90, Po-210, tritium, and C-14. Based on the half-lives of these radionuclides and the subsequent activities that have taken place at the site, the implementation of the SAP focused primarily on Cs-137, Co-60, uranium, and thorium. However, investigations were also performed for Sr-90, the long-half radioactive decay products of uranium and thorium, tritium, and C-14.

Interim Derived Concentration Guideline Levels (DCGLs), based on the concepts of MARSSIM (MARSSIM 1998) for the primary contaminants expected to be present on the site are (Bernhardt 1999):

1. **Mass Contamination:**

Radionuclide	Concentration
Total Ra (Ra-226 & Ra-228)	5 pCi/g
Total Th (Th-230, Th-232, Th-228)	10 pCi/g
Total U (U-238, U-234, U-235)	10 pCi/g
Cs-137	15 pCi/g
Co-60	8 pCi/g
Sr-90	5 pCi/g

2. **Surface contamination (dpm/100 sq cm):** The criterion for unrestricted use from NRC Reg Guide 1.86 and Cal DECON-1 for the primary radionuclides expected to be present on the site, based on an average over 1 square meter, are:

Cs-137	5,000 dpm/100 sq cm.
Sr-90	1,000 dpm/100 sq cm
Th-232 with decay products:	1,000 dpm/100 sq cm
Th-230 (alpha)	100 dpm/100 sq cm

Criteria are given for other radionuclides, and supplemental criteria are given for small areas of contamination (limited to 100 sq cm) and for removable or smearable contamination.

The interim DCGLs for activity concentrations per gram (pCi/g) are applicable to concentrations in soil and other bulk materials such as concrete and asphalt. The surface contamination DCGLs are for surface contamination on building materials. Interim DCGLs have not been provided for radionuclides that were not expected to be present in significant quantities on the site. However, applicable values can be derived, using radiation dosimetry parameters and general environmental pathways models. As a general approximation, the Interim DCGL for Cs-137 will be applied to other radionuclides, except tritium and C-14, where criteria have not been specified.

The purpose of the DCGLs is to provide activity concentration guidelines to meet the exposure criteria for decommissioning. The exposure criterion specified by the California RHB is 25 mrem/year, based on the NRC criterion of Title 10 Code of Federal Regulations Part 20

(10 CFR 20). Final DCGLs are to be derived using applicable environmental pathways modeling in the "Decommissioning Plan" for the scenarios applicable to the reclaimed site.

The primary assessment used by the NRC in the initial site surveys and the focus of the SAP was gamma radiation surveys to assess the levels of potential residual contamination. The results of the gamma survey measurements (uR/hr) are not explicitly equivalent to the DCGLs for surface contamination from California DECON-1 or the concentrations in pCi/g for solids. However, using dosimetry calculations it is possible to estimate the gamma exposure rate for various sources and geometries. Specifically, Federal Guidance Report No. 12 (EPA 1993) provides tabulations of the radiation dose from surface contamination equivalent to units of pCi/square meter, and from plane sources of thicknesses of 1 cm, 5 cm, 15 cm, and infinitely thick. The tabulations provide the external gamma doses from these source geometries for numerous radionuclides, including Cs-137, uranium, and thorium. Based on the parameters from Federal Guidance Report No. 12, the dose from a surface deposit of Cs-137, based on a concentration of 5,000 dpm/100 sq cm is about 2.5 uR/hr. The NaI detectors used for the gamma surveys tend to overestimate the exposure rate from Cs-137, and based on the measurement procedure (detector at the surface), a general field screening application of 5 uR/hr above background is estimated to be equivalent to Cs-137 contamination of 5,000 dpm/100 sq. cm, the DCGL from DECON-1 for Cs-137. The screening level of 5 uR/hr is equal to about 50 percent above background, the basic criterion used to identify areas with residual radioactive material on the Site.

1.3 CLOSURE OF CONTAMINATED AREAS OF SITE AND CONTROL OF SITE

After discovery of the elevated concentrations of subsurface contamination on the Site and the other contamination identified by the site characterization, license inspectors from the California RHB discussed the possibility of total closure of the site and/or issuance of a radioactive materials license for the Site. This issue evolved in part due to the use of areas of the Site by two tenants. After negotiations with the RHB, the application of the STS license was continued at the Site after completion of the site characterization and physical controls were installed to ensure proper isolation of areas with contamination and proper

consideration for the health and safety of the public and the two tenants using sections of the Site.

The isolation of contaminated areas included building fences to isolate exterior areas and placing new locks on gates. Tenants do not have the combinations for the locks on the gates and do not have access to areas with significant levels of contamination. Furthermore, a new lock was placed in the facility to prevent unauthorized personnel from going from the offices to the "shop" where residual contamination is also present. In addition to these controls, steel plates, weighing several hundred pounds per plate, were placed over investigation holes which had notable levels of contamination (i.e., concentrations well above the DCGLs).

1.4 ORGANIZATION OF SITE CHARACTERIZATION REPORT

This Site Characterization report consists of six chapters and supporting information in the appendices. Chapter 1 provides background information on the facility, the Interim DCGLs used to guide the site characterization work, and the site conditions at the facility. Chapter 1 also includes information on actions taken to provide controls for access to the Site, to prevent unnecessary radiation exposure to the public and tenants using the Site. Chapter 2 describes the implementation of the SAP, including the radiation survey and sampling procedures, the health and safety program, and other Radioactive Material License activities.

The results of the radiation surveys and the basic Site characterization are given in Chapter 3 This chapter includes the results of radiation surveys of the floors, walls, and roof, and the results of extensive field gamma spectrum measurements to identify the radionuclides present in the residual radioactive materials. The results for subsurface investigations are given in Chapter 4. These results include gamma borehole logging in the area of the former Co-60 pool and the results of sampling and analyses from more than 35 subsurface penetrations.

Chapter 5 contains a discussion of results and other information related to application of the concepts of MARSSIM to the characterization, remediation, and final radiation surveys for release of the site. This information includes a reclassification of the areas of the site according to the four categories used by MARSSIM. Chapter 6 provides a summary of the information from the characterization of the site.

2. SITE CHARACTERIZATION RADIATION SURVEY AND SAMPLING ACTIVITIES

This chapter describes the radiation survey and sampling tasks and procedures used to implement the SAP and characterize residual contamination at the Site. Due to the occupancy of many parts of the Site by two tenants and higher than anticipated levels of radioactive contamination, field adjustments to the SAP were required to maintain adequate control of the radioactive materials and provide proper health and safety while implementing the SAP. The major tasks of the SAP were developing a grid system for the Site, performing comprehensive radiation surveys of the Site, making boreholes or subsurface penetrations to collect samples and assess for subsurface radioactive contamination, and checking for contamination in the sewer.

2.1 SITE CONDITIONS AND GRID SYSTEM

2.1.1 Site Conditions, Preparation, and Access Controls

The Site was used by the owner from the early 1960's to late 1990's for industrial operations, some operated by the owner, and some by tenants. In recent years the Shop area has generally been vacant, but the rear bays and lot are leased to David Girard, who operates a towing and impound lot for the City of Burbank. The front offices are leased to Hi Tech Rentals, and the driveway on the south side and front parking lot were leased to neighborhood businesses for parking. Upon arrival for work on March 28, 1999, the Team encountered parked cars covering the front and south lots and impounded cars, parts, and debris covering the east lot and bays. The impounded cars and related material were moved to obtain access to the site. The grid system was marked and radiation surveys performed. Areas with residual contamination exceeding twice background on gamma surveys were isolated to prevent access by unauthorized personnel. Isolation measures initially included caution tape, which was later replaced by fences, locked gates, and signs.

Initial priority was given to laying out grids and performing radiation surveys in the east and north areas denoted as MARSSIM Category 3 and 4 areas based on the SAP (Bernhardt 1999) (areas that were not expected to be above the DCGLs). By working with the tenants, it was possible to provide proper control of the radiation work areas during minor decontamination, perform radiation surveys to verify the absence of contamination more then twice background (gross value), and still allow the tenants to have reasonable access to specified areas.

Based on the information from initial radiation surveys and information from the SAP, the gate at the southwest corner of the Site was locked to end access by the public to the driveway on the south of the facility. Access to the Shop area, the primary area of former licensed operations, was also limited to authorized personnel and personnel wearing designated personal protective equipment (PPE). After completion of radiation surveys of the eastern section of the Site and selected remediation of an area in Bay B and two areas in Bay A, 6-foot chain-link fencing was installed as shown in Figure 2-1. Temporary access for unrestricted use was granted for Bays A, B, and C and areas with access to the fenced area east of the 92E line. The fencing specifically excluded access to the un-named bay to the west of Bay A, the Training Class Room, and related areas. In addition to the fencing, a contaminated area, where contamination was not full removed, in the northeast of the site was filled with concrete and covered with a steel plate. An area with similar residual contamination, to the north of the un-named bay, was left in place and covered with a steel plate.

A wood awning along the east side of the neighbor building to the north of the shop (roughly 40N to 46N on grid line 68E) was removed to obtain access for monitoring. The initial radiation surveys indicated there was contamination under the structure of this awning. There was also contamination under the structure of a wood awning that extended to the east from the southeast corner of the Shop. Both of these structures were built by the present owner after the termination of the former radioactive materials work. The owner agreed to allow these structures to be removed. However, due to a live natural gas line which extended into the second structure, only a section could be removed, and the main frame work had to be left to support the gas line. Penhall Company, used as a subcontractor, removed the pertinent materials and loaded these and rubble from former tree trimming activities on the

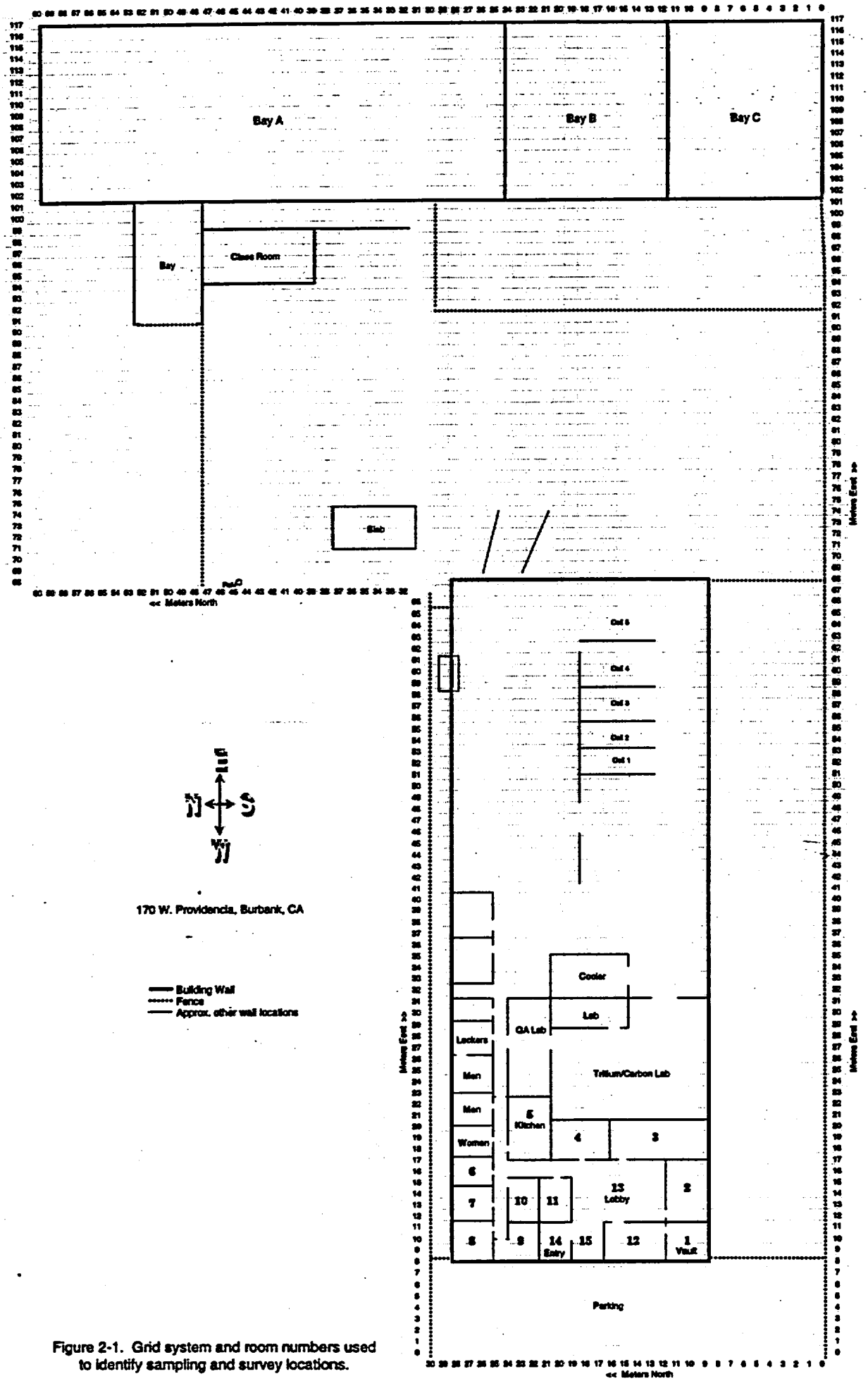


Figure 2-1. Grid system and room numbers used to identify sampling and survey locations.

Site (about a cord of wood) into a roll-off dumpster for disposal off-site. These materials did not relate to the former radioactive materials operations; they were removed before any related intrusive work related to the site characterization; and they were surveyed to ensure they were not contaminated.

After completion of the site characterization work, a request for temporary unrestricted use for Bays A, B, and C, the area to the north of the 92E fence, and the front offices was submitted by Loeb & Loeb to the RHB. The request for approval included agreement to keep the site under active license by STS, with periodic inspections to ensure the specified isolation was maintained. Approval for this temporary unrestricted use was granted (see approval in Appendix B).

2.1.2 Layout of Grids

As specified in the SAP, the Site grids were laid out in an organized fashion to ensure that all areas of the Site were identified by a common grid stem. The grid system was set up with the origin, 00E:00N, in the southwest corner of the property. This location is earmarked by the presence of a storm water catch basin. Figure 2-1 shows the general grid system for the Site. North is designated as a "facility north" to the left of the Site. The true north is roughly to the north-northwest of the designated north. Due to the clear locations of building corners and fence lines, a land surveyor was not used to document the system.

All grids were placed using a tape measure to ensure measurements were within ± 5 percent accuracy. The grids were placed using metric measurements. Initial grid markings were placed every 5 meters along the southern property boundary, which is characterized by a fence. Grid marks were then placed at progressive 5-meter increments to the north. This same pattern was then extended north and east throughout the entire property, so that 5-meter by 5-meter grids were established throughout the Site.

At each intersection of the 5 meter marks the ground was sprayed with paint to mark the intersection. Increments of 1 meter were then laid out along all of the grid lines using a measured template. Marks were placed for all 1-meter grid points, creating a complete

1-meter by 1-meter grid system for the Site. In addition, most of the grids located at the intersections of the 5 meter marks were labeled on the ground surface with spray paint. Grids are denoted by the coordinates in the southwest corner of the grid. For example, the 1 by 1 meter grid at the location 10E:10N is denoted as 10E:10N, and the grid 1 meter to the north would be 10E:11N. The grid system in the buildings is an extension of the outside grid system. The system for the roof is an elevated reproduction of the grid for the building floors. The grids for walls are tied to the grids on the floors, with indications of elevations on the wall in meters. Prior to leaving the Site, concrete nails were placed on many of the grid marks around the periphery of the site to allow future reconstruction of the grid system should the paint markings become obscured.

2.2 RADIOACTIVE MATERIALS LICENSE AND HEALTH AND SAFETY

Based on the requirements of the California RHB, the site characterization was performed under a Radioactive Materials License. The work was performed under the license of Surface Technology Systems (STS) , who assisted RAE in the work and provided a Site Radiation Safety Officer. Their license, issued by the State of Tennessee, authorizes characterization and remediation activities involving radioactive materials, and was accepted by RHB under a reciprocity agreement. Information for the STS license and a copy of the letter accepting the license is in Appendix B. Due to the levels of radioactive material found on the Site, RHB indicated the need for keeping the Site under license after the April 1999 activities and accepted continuation of the control of the Site under the authority of the STS license.

The characterization activities were conducted under license to provide a regulatory structure for ensuring the appropriate health and safety of the workers and the public, and to ensure the protection of the environment. The licensee, STS, was required to conduct site activities in accordance with the California regulations pertaining to radioactive materials and also to perform characterization activities as specified by the plans and procedures incorporated in their license. These two mechanisms help to ensure that the licensee conducted operations in a safe manner. Specific requirements of the license include: providing

radiation safety training for workers; designating radiation work areas based on the level of risk; performing appropriate air sampling; monitoring radiation on personnel and in work areas; providing an approved respiratory protection program as needed; performing appropriate bioassay monitoring for personnel; and providing radiation dosimeters to document any exposures to radiation.

The Site Radiation Protection Officer, Brad Squibb, had the primary responsibility to ensure that the characterization activities were conducted according to the appropriate radiation protection procedures and that all activities were in compliance with the requirements of the RHB radiation protection regulations. Copies of the STS license and California RHB regulations were maintained at the Site. These standard procedures covered all aspects of the characterization effort.

The use of radiation dosimeters and the collection and analysis of bioassay samples were key parts of the personnel monitoring program. Each worker at the site was required to wear a thermoluminescent dosimeter (TLD). The dosimeter was used to determine and document the external radiation dose to the worker. In addition, each worker was required to submit a urine bioassay sample at the beginning and end of the project. The urine bioassay samples were analyzed for uranium, Sr-90, tritium, and C-14 to assess potential exposures. In addition to the standard bioassay samples, three 1-liter bioassay samples were obtained from RAE personnel to provide more sensitive assessment for potential exposures to C-14 and Sr-90. The bioassay results are given in Appendix A. The results showed no indications of significant exposures to the workers from intake of the radionuclides at the site. The TLD results are given in Appendix A.

Of equal importance with the personnel monitoring program was the exposure control program. While the personnel monitoring program is used to determine the radiation exposure of workers, the exposure control program is used to reduce and/or prevent the radiation exposure of workers. This program was an important part of the site ALARA program used to reduce worker exposures. The exposure control program included the following elements:

1. Protective clothing.

2. Engineering controls.
3. Respiratory protection.
4. Proper handling and segregation of radioactive materials.
5. Radiation surveys and air sampling.
6. Radiation work permits.

2.3 RADIATION SURVEYS AND PROCEDURES

2.3.1 Calibration of Instruments and Daily Operational Checks

A wide variety of health physics instrumentation was used at the site due to the various alpha, beta, and gamma emitting isotopes which were potentially of concern and the wide range of radiation levels encountered. This equipment included hand-held radiation survey instruments, air-sampling pumps and equipment, and portable gamma spectroscopy equipment. The gamma survey measurements were generally performed using 1-inch diameter NaI scintillation detectors. However, for specific situations, a 2-inch NaI detector or a ½-inch scintillation detector were used, either because of needs for increased sensitivity or access to confined areas (e.g., sewers). The primary radiation detectors used were 1-inch NaI detectors for gamma measurements or 15-cm^2 Geiger Mueller (G.M.) pancake detectors for beta/gamma measurements. The instruments were calibrated by Health Physics Instruments, a division of Far West Technology of Goleta, California (licensed by the State of California for calibration).

Field check sources of Cs-137, Th-232, Sr-90, Cl-36, and Th-230 were used for calibrating the gamma spectrometer, the G.M. pancake detectors, and the alpha detector. The Sr-90, Cl-36, Cs-137, and Th-230 sources were NIST traceable. The Th-232 source was only used for energy calibration of the spectrometer and was not used to provide quantitative intensity measurements.

The instruments were checked one or more times per day to ensure proper operation. The records of the checks were recorded in bound field notebooks, which were subject to review during the RHB site visit. Each morning, prior to surveys, the review of proper instrument

functionality included a check of the batteries, the high voltage (if applicable), the general background, and an operational source check using a check source. NIST traceable sources were used to calibrate instruments used for measurements of surface contamination, counting air samples, and counting smears for release of equipment

2.3.2 Types of Radiation Measurements, Instruments Used

The primary instruments used were Ludlum Model 2220 or 2221 survey meters equipped with Ludlum Model 44-2 detectors. A Health Physics Instruments (HPS) Cypher with a HPS NaI detector and a Ludlum Model 44-9 thin window G.M. pancake detector was also used for some measurements. The gamma spectroscopy measurements were made using a Health Physics Instruments spectrometer (Rainbow Model 7000) with either a 1-inch NaI HPS detector,. a 2-inch NaI Ludlum detector, or a ½-inch high density gamma detector.

Measurements in relatively high radiation fields were made by using a 0.1 minute time integral, to optimize the ability to take measurements and prevent the instrument from going off scale (the Ludlum 2221 scaler only has a 5 digit display, giving a maximum 99,999 counts in 0.1 minute). However, in several of the site radiation fields, the activity exceeded the approximate 1 million counts per minute capability of the Ludlum Model 2221 using a Model 44-2 detector. In these situations, the HPS Cypher instrument with an HPS 1-inch NaI detector provided additional range to a count-rate of 19 million counts per minute (e.g., 1.9 E6 counts in 0.1 minute).

Other instruments that received limited use were a Bicron Surveyor M instrument with a Bicron G1/SN 1-inch NaI detector or G.M. pancake detector, Ludlum Model 12 and Model 3 detectors using either Ludlum Model 44-2 NaI detectors or G.M. pancake Ludlum (44-9) thin-window detectors. A Ludlum PR 1945 1-inch end window Zn-sulfide detector was used to count field air samples for alpha activity and for surface measurements of alpha activity.

A list of instruments and examples of the calibration sheets are given in Appendix A.

2.3.3 Sensitivity of Gamma Radiation Survey Measurements

Essentially all of the gamma radiation measurements were made using Ludlum Model 2221 type instruments with scalers. The measurements for surveying all areas of the site and documenting the presence, or absence, of residual radioactive material were based on time integral measurements of 0.5 minutes, 1 minutes, or 2 minutes. A sufficient time period was generally used to ensure that the standard deviation of the measurement (square root of the count) was less than 5 percent of the observed value. Minor exceptions to this were the alpha counting of air samples and smears, and some alpha counts of background and floor surface contamination.

The typical gamma radiation survey measurements were based on 1-minute integral measurements, with resulting values of about 2,500 counts and a standard deviation of 50 counts, or 2 percent of the observed value. In MARSSIM Class 3 and 4 areas, where there was high confidence of minimal or no impact, measurements of 0.5 minutes were used, giving observed values of about 1,200 counts (standard deviation of 3 percent). Counts of 0.1 minute were essentially only used in areas of high radiation exposure where count rates were about one million counts per minute. Counting intervals of 2 and 10 minutes were used in some instances to improve the sensitivity.

2.3.4 Determination of Natural Background

The determination of applicable radiation backgrounds was critical to assist in characterizing potential residual contamination on the roof; on floors in the offices, the shop, and bays; the walls of buildings; and the asphalt. The determination of background was based on using fixed locations on the Site which had no evidence of impacts from previous operations (i.e., MARSSIM Class 4). Appropriate areas of the offices, roof, and walls were selected for measurements of background, and additional background measurements were made at three off-site locations.

The area selected for daily Site background measurements was near the northwest corner of the property, in the front parking lot (4.4E:30.0N). The validity of this as a

background location was based on its remoteness from any of the former site operations (i.e., opposite side of the site from the driveway used for access to the Shop and areas at the rear of the building. Also, measurements with the field gamma spectrometer indicated there were no traces of Cs-137 in this area, contrary to many of the other areas of the site where survey measurements also appeared to be near background. The daily background measurements generally included three 1-minute integral measurements, with the detector about 2 inches above the asphalt, the same position used to perform the radiation surveys. The average daily background for this location was about 2,400 cpm counts/minute (cpm). The daily background measurements are given in Appendix B.

Other background measurements were made on the southwest corner of the site near a storm-water catch basin. However, this was not the desired location for the measurements since this was by the access route to the site during the operations in the 1950's. Also, the catch basin was found to contain low levels of Cs-137 contamination. However, the background measurements about 1 meter from the catch basin were similar to those for the un-impacted location at 4.4E:30.0N.

Background gamma radiation levels are dominated by naturally occurring radioactive material in the soil (terrestrial source) and cosmic radiation from space. The naturally occurring radioactivity in construction materials (e.g., asphalt, concrete, brick, and tile) also affects background measurements. Because of differences in elevation and materials in the walls and roof, compared to the parking lot surface used for the primary background, area- and material-specific radiation backgrounds were developed as needed. For example, the background for the roof was based on the grids on the roof in the northwest corner of the building. Based on information from the owner (Mr. Thomson), the complete roof, down to the sheathing was replaced since the radioactive materials work, and the radiation surveys verified that essentially all of the roof is a non-impacted area. The only area on the roof impacted by the former use of radioactive materials is a section of purlin related to a former vent on the east end of the building.

The SAP indicated that the background for the radiation surveys of the offices would be taken from the areas in the southwest section of offices. This area was selected because of the potential for workers bringing contamination from the shop up to the bathrooms and

locker room on the north-central part of the building. However, radiation surveys showed slightly elevated gamma radiation in the southwest office. The southwest office is a walk-in vault containing two additional safes and thickened concrete walls. Field gamma spectrometric measurements indicated that the anomaly was apparently due to natural K-40 in the concrete walls of the vault. Offices in the northwest corner of the building were at background, however.

Off-site backgrounds were measured in the commercial building to the north of the Site and at two locations isolated from the site. The commercial building is at 156 Providencia, Commercial Inspection Services. After meeting with Mel Squires of Commercial Inspection Services, measurements were made in their conference room. The facility uses machine generated ionizing radiation for inspection of welds and materials. According to drawings the building existed back in the 1950's and has construction similar to the 170 Providencia (Thomson) building.

Additional off-site backgrounds were measured at two locations along the "aquaduct" to the southwest of the facility. The background locations, shown in Figure 1-1, were at Lake and Providencia and at Valencia and the aquaduct (south side, away from the facility). The Lake and Providencia location is about one-half block from the Site, and the Valencia location is about one-half mile to the south of the Site. Background soil samples were also collected at these two locations.

2.3.5 Types of Radiation Surveys Performed; Procedures

The primary surveys were for assessing external gamma radiation from residual contamination of the surface of the site and facilities. Supplemental surveys were also performed to determine whether there is subsurface contamination, whether the sewers are contaminated, and to determine the concentrations of surface contamination. Since the primary contaminant was Cs-137, the surveys focused on gamma radiation instead of the much more time intensive measurements of beta and/or alpha radiation. Furthermore, given the age of any residual contamination, the efficiency for surveying for surface beta and alpha (especially alpha) contamination is adversely impacted by self-absorption in the material

surface and accumulated dirt. The gamma surveys were also used to identify anomalous areas that might relate to subsurface contamination.

2.3.5.1 External Gamma Surveys for Surface Contamination

The 1-meter by 1-meter grids were surveyed by slowly moving a 1-inch NaI detector in a serpentine pattern over the total area of the grid, to obtain measurements of the number of counts per survey interval. The basic survey interval was 1 minute, but in areas that were not expected to be impacted, or in areas that were known to be highly impacted survey times of 0.5 minutes were used. The detector was kept within about two inches of the surface to maximize the efficiency of detecting localized contamination. Areas more than twice background, and generally more than 50 percent above background were marked out by the surveyor with spray paint. In most cases, a transcriber recorded the data for two surveyors and provided coordination to ensure that the surveyors were working in the specified area. The data recorded in bound field log books included the integral count for the area and specific maximum count rates for any anomalous areas in the grid. The surveys were performed by using the audio output of instruments to maximize the ability to detect anomalous areas. Due to the time delay of the meter response it is desirable to use the audio response which is nearly instantaneous.

2.3.5.2 Surveys of Beta or Alpha Surface Contamination

Surveys for beta and alpha surface contamination were performed with the beta and alpha detectors described in Section 2.3.2. Most of these surveys were performed by placing the detector on the surface and making 1-minute measurements.

Roof drains were surveyed by inserting a G.M. pancake detector into the drain opening for a specified distance. Measurements were made over a specified period of time.

2.3.5.3 Special Gamma Surveys

Special gamma surveys were performed to assess the potential for subsurface contamination in boreholes, sewers, and rain down spouts. The measurements were made by inserting the NaI or other detector into the opening to a specified depth and making measurements over a specified period of time. Most measurements were made for periods of 0.5 minute or 1 minute.

A notable exception was for borings in the former Co-60 pool area. The count rate in a section of one borehole was over one million counts in a minute, and the scaler for the Ludlum Model 2221 only has five digits. Therefore, measurements were limited to 0.1 minute. The count-rate in one area of a borehole in the former Co-60 pool exceeded the saturation level of ~~all of~~ the NaI instruments. In order to provide additional assessments of the potential source term measurements were also made with a shielded G.M. pancake probe (can be used as a gamma detector) and with a HP Instruments Canary dosimeter (small size dosimeter with a cut off below 200 keV).

Assessments of sewers were made by lowering the detector into the opening for measured distances. In several cases, the detector was attached to a cleanout "snake" and the snake used to move the detector into the sewer. Measurements were based on timed intervals of 0.5 minute or 1 minute.

2.3.5.4 Gamma Spectrometry

A portable gamma spectrometer was used with several detectors to assess the presence of specific gamma-emitting nuclides throughout the facilities. The spectrometer was the Rainbow Model 7000 made by Health Physics Instruments (Goleta, California), equipped with either a 1-inch NaI detector from HP Instruments or a 2-inch Ludlum NaI detector. A one-half inch detector was also used in sewers where the larger detectors would not fit.

The spectrometer was calibrated using Cs-137 and Th-232 sources to ensure proper energy calibration. Spectra from the measurements were saved in the spectrometer memory

and downloaded to laptop computers for analysis and storage. The analysis included minor energy adjustments to correct for gain shifts that occur due to temperature changes during field measurements. Measurement integration times varied from minutes to several hours. Using the 2-inch NaI detector it was possible to detect trace quantities of Cs-137 in areas where the normal gamma survey measurements could not detect the presence of contamination. For example, spectra collected near the entrance to the shop (23E:25N) indicated the presence of low concentrations of Cs-137.

2.4 COLLECTION AND ANALYSIS OF SAMPLES

Borings were made in numerous areas of the shop to assess the potential presence of subsurface contamination. Holes in the concrete slab in the Shop and in the asphalt in the parking lot were cut/broken with an electric jackhammer. A dry technique was used to prevent the potential transport of contamination from the surface material to the subsurface. An electric jackhammer was used to minimize the amount of airborne material (i.e., a pneumatic jackhammer exhausts the air onto the work face). An enclosure, with a HEPA vacuum cleaner was used over the work face in the shop to further control the release of airborne material to the building environment.

After penetrations were cut into the concrete or asphalt, samples were collected using bucket augers or trowels. Samples were double packaged in ziplock bags to provide viable transport containers. Based on the amount of sample material per container, the samples were transported as excepted packages, exempt quantities, under the U.S. Department of Transportation regulations for shipment of radioactive material (49 Code of Federal Regulations).

Samples for facility characterization were analyzed by Paragon Analytics (Fort Collins, Colorado) or Thermo NUtech, Richmond, California. Both of these laboratories were approved for the required analyses by the California RHB (conversations with Jane Jensen, March 31 and April 27, et al.). Paragon Analytics performed analyses by gamma spectroscopy for Cs-137, Co-60, uranium and thorium and their decay products, and other gamma emitters.

Paragon Analytics also performed the analyses for isotopic uranium and thorium, tritium, and C-14. Therm NUtech performed analyses for Sr-90. These laboratories used procedures that have been approved by RHB (conversations with Jane Jensen).

Three large volume (1-liter) urine bioassay samples were sent to Thermo NUtech for Sr-90 and C-14 analyses. In order to expedite analysis of the standard small volume (about 25 ml) bioassay urine samples, they were sent to Accu Laboratories of Golden, Colorado, for uranium, Sr-90, tritium, and C-14.

2.5 QUALITY ASSURANCE

The quality assurance (QA) program was based on the standard RAE QA Manual. Instruments were calibrated at a qualified facility and appropriate checks performed when they were used in the field. Random checks were made of radiation survey measurements and the results of all measurements were scrutinized for outliers and values that needed validation.

About 10 percent of samples were split and submitted separately to the laboratories for duplicate analyses. Furthermore, the laboratories also performed independent duplicate analyses.

2.6 REMEDIATION OF THE SHOP FLOOR

Since the facility had supposedly been decontaminated for unrestricted use in the early 1960's and based on the results from the surveys performed to prepare the SAP, it was perceived that it would be possible to perform scabbling of limited areas of the shop floor to clean it for unrestricted use. The hypothesis was that the contamination was on the surface of the concrete and that it might be possible to remove the contamination with limited

scabbling or other concrete cleaning procedures. Also, the assumption was that there was not significant subsurface contamination.

The scabbling and chipping of concrete was performed in a tent-type enclosure, ventilated with a HEPA vacuum cleaner, with personnel in PPE with respiratory protection. After extensive scabbling of the concrete, it became apparent that in some cases the contamination was basically in the surface 0.2 cm to 0.5 cm, but in other cases the contamination went all the way through the concrete slab to the subsurface.

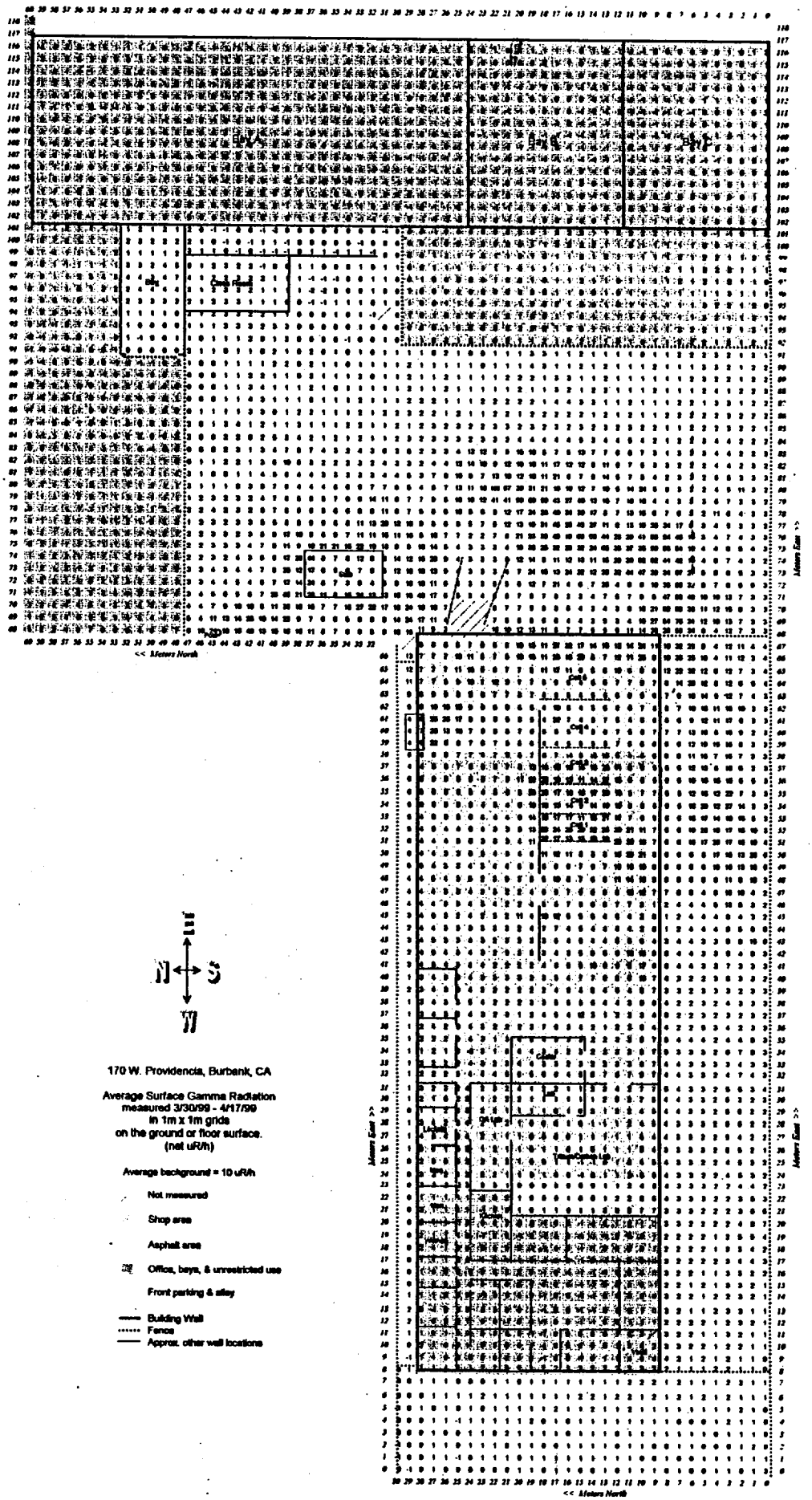


Figure 3-1. Results of ground and floor surface gamma radiation surveys.

3. RESULTS OF RADIATION SURVEYS

This chapter provides the results of the radiation surveys of the facilities on the Thomson Site. External gamma radiation surveys are reported in Section 3.1 for the ground surfaces of the Shop, the offices, the front parking lot, and the asphalt areas to the rear and side of the facility, and for the roof and walls of the main building. The results of the field gamma spectrometric measurements are given in Section 3.2. The surveys for surface beta and alpha activity, for selected areas, are given in Section 3.3. Localized surveys for the rain gutters, the storm drain catch basin in the southwest corner of the Site on Providencia are given in Section 3.4.

3.1 EXTERNAL GAMMA RADIATION SURVEYS

The primary focus of the site characterization was the detailed external gamma surveys of all areas of the site. In addition to providing assessments of the levels of residual surface contamination, these surveys were also used to identify areas where there was potential subsurface contamination. Most of the areas of subsurface contamination that were identified resulted from efforts to remove anomalies of surface contamination. In multiple locations in the Shop, as surface layers of contaminated concrete were removed, the gamma exposure-rate increased rather than decreasing, identifying contaminated soil beneath the concrete slab.

Figure 3-1 illustrates the detailed external gamma exposure rates for the site. The results are reported as microroentgen (uR) per hour above background. The areas in Figure 3-1 are color coded to relate to different areas of the site. The blue areas are the offices, Bays A, B, and C, and the asphalt area to the north of the control fence for the asphalt area on the rear (east end) of the site. The white background area is the parking area in the front of the facility and the narrow strip on the north of the building. The shop area, where the primary former radioactive material operations were conducted in the 1950's is colored orange. The yellow area is the asphalt area that is within the control fences, inside locked gates. Access to the small strip to the east of the Bays was only attainable by forcing a locked door in the Bay. Limited survey of this strip showed no indications of elevated levels of residual radioactive material.

Table 3-1. Locations with localized elevated areas of contamination.

Grid Locations East	Grid Locations North	Survey Book	Area of Site	Peak Countrate (cpm)
35	15	KKN p.41	Shop Area	7,595
52	11	KKN p.41	Shop Area	11,150
56	13	KKN p.41	Shop Area	7,500
57	17	KKN p.41	Shop Area	15,182
64	17	3	Roof	37,500
64	18	3	Roof	65,760
68	14@2m	4	Shop Walls	9,900
68	14@3m	4	Shop Walls	6,290
69	28	1	Back Asphalt	14,000
69	29	1	Back Asphalt	10,667
70	16	3	Back Asphalt	8,800
70	17	3	Back Asphalt	12,380
70	27	1	Back Asphalt	21,418
70	29	1	Back Asphalt	18,524
70	35	1	Back Asphalt	13,335
70	36	1	Back Asphalt	6,613
71	28	1	Back Asphalt	27,500
71	29	1	Back Asphalt	12,284
71	36	1	Back Asphalt	15,000
72	14	3	Back Asphalt	7,047
72	15	3	Back Asphalt	10,050
72	17	3	Back Asphalt	10,250
73	11	3	Back Asphalt	30,250
73	12	3	Back Asphalt	20,170
73	13	3	Back Asphalt	18,520
73	15	3	Back Asphalt	10,710
73	16	3	Back Asphalt	19,860
73	18	3	Back Asphalt	11,500
73	19	3	Back Asphalt	12,050
73	37	1	Back Asphalt	36,881
74	11	3	Back Asphalt	30,130
74	12	3	Back Asphalt	22,930
74	13	3	Back Asphalt	19,580
74	14	3	Back Asphalt	8,920
74	15	3	Back Asphalt	6,580
74	20	1	Back Asphalt	10,154
75	11	3	Back Asphalt	30,060
75.	12	3	Back Asphalt	24,930
75	13	3	Back Asphalt	27,450
75	15	3	Back Asphalt	14,820
75	16	3	Back Asphalt	20,070
75	17	3	Back Asphalt	22,260
75	18	3	Back Asphalt	21,180
75	19	3	Back Asphalt	24,240
75	20	1	Back Asphalt	27,760
76	11	3	Back Asphalt	14,970
76	13	3	Back Asphalt	25,990
76	14	3	Back Asphalt	76,710
76	15	3	Back Asphalt	78,890
76	16	3	Back Asphalt	19,710
76	17	3	Back Asphalt	19,470
76	18	3	Back Asphalt	24,490
76	21	3	Back Asphalt	10,530
76	27	1	Back Asphalt	11,044
76	30	1	Back Asphalt	8,295
77	11	3	Back Asphalt	8,410
77	12	3	Back Asphalt	8,830

The highest levels of residual surface contamination, based on averages over an area of 1 square meter, are outside of the Shop, on the asphalt to the east of the Shop. There are numerous grids with exposure rates over 50 uR/hr, and grid 80E:22N is over 100 uR/hr.

The exposure rates reported for the Shop in Figure 3-1 are based on conditions after extensive scabbling of the floor. Prior to scabbling the floor, the exposure rates in the shop ranged up to about 100 uR/hr, and there were numerous grids above 50 uR/hr. After the scabbling, as shown in Figure 3-1, the net exposure rates are generally below 10 uR/hr, with only a few values above 30 uR/hr.

Table 3-1 presents the results of many of the localized peak exposure rates that were detected during the surveys. These peaks are prior to any remediation. The values are organized according to the outside areas and the Shop. Values for the bays and the storm catch basin at the front of the site are also given. The values are given as gross counts, where background is about 2,500 cpm.

The net exposure rates in the driveway on the south of the building range from near background by the locked gate at the west end (the front of the Site) to tens of uR/near the rear locked gate at the east end of the driveway.

The area in the front of the facility is portrayed with a white background. The only location in this area with residual contamination from the prior operations is the storm sewer catch basin in the southwest corner (grid 0E:0N). Although the average for this grid was only 3 uR/hr above background, localized contamination in the basin ranged up to about 50 uR/hr. The catch basin is discussed in Section 3.4.

No residual contamination was detected in the office area, colored green in Figure 3-1. The net exposure rates of 2 to 4 uR/hr in the southwest corner of the offices are apparently due to K-40 in the concrete structure of the walk-in vault. However, access was not obtained for two locked safes, one in the walk-in vault and the other a wall safe adjoining it. The smaller safes are reportedly a system for night deposits which can fall into the larger safe.

Table 3-1. Locations with localized elevated areas of contamination.

(Continues, p 2 of 2)

Grid Locations East	Grid Locations North	Survey Book	Area of Site	Peak Countrate (cpm)
77	14	3	Back Asphalt	32,630
77	15	3	Back Asphalt	14,820
77	16	3	Back Asphalt	25,550
77	17	3	Back Asphalt	22,020
77	30	1	Back Asphalt	9,370
78	14	3	Back Asphalt	11,850
78	15	3	Back Asphalt	17,210
78	16	3	Back Asphalt	40,480
78	17	3	Back Asphalt	18,150
78	24	1	Back Asphalt	6,753
78	25	1	Back Asphalt	36,000
79	11	3	Back Asphalt	10,660
79	14	3	Back Asphalt	13,950
79	15	3	Back Asphalt	8,680
79	16	3	Back Asphalt	16,060
79	17	3	Back Asphalt	28,430
79	18	3	Back Asphalt	98,670
79	18			112,090
79	19	3	Back Asphalt	50,230
79	20	1	Back Asphalt	34,708
79	21	3	Back Asphalt	49,710
79	22	1	Back Asphalt	45,405
79	23	1	Back Asphalt	13,000
79	25	1	Back Asphalt	21,000
79	27	1	Back Asphalt	12,047
79	28	1	Back Asphalt	5,607
79	32	1	Back Asphalt	7,154
80	11	3	Back Asphalt	12,320
80	18	3	Back Asphalt	22,260
80	19	3	Back Asphalt	15,990
80	20	1	Back Asphalt	40,508
80	21	3	Back Asphalt	49,700
81	17	3	Back Asphalt	11,880
81	19	3	Back Asphalt	13,300
82	13	3	Back Asphalt	9,180
82	15	3	Back Asphalt	8,280
82	16	3	Back Asphalt	10,470
82	17	3	Back Asphalt	12,350
82	19	3	Back Asphalt	9,830
82	21	3	Back Asphalt	10,740
82	24	1	Back Asphalt	7,534
82	38	1	Back Asphalt	8,945
83	15	3	Back Asphalt	14,310
83	20	1	Back Asphalt	28,328
83	24	1	Back Asphalt	10,833
91	48	3	Back Asphalt	12,027
93	60	3	Back Asphalt	7,844
94	60	3	Back Asphalt	8,182
97	48	3	Back Asphalt	7,357
97	49	3	Back Asphalt	6,593
98	48	3	Back Asphalt	12,027
100	57	3	Back Asphalt	13,028
113	40	1	Bays	11,040
113	54	1	Bays	6,708

Bays A, B, and C contained three areas with residual radioactive material, all of which were remediated prior to providing temporary unrestricted use of these areas. The exposure rates in Figure 3-1 are for the conditions after remediation of these areas. Two small areas with residual Cs-137 were removed in Bay A and the floor sump in Bay B was remediated. The floor sump in Bay B, grid 102E:24N was one of the anomalies specifically identified in the surveys by the NRC (Chaney 1996), (Takahashi 1997) and identified in the SAP. Investigations indicated that this anomaly was due to a floor sump which had been filled with granular material containing relatively high concentrations of Th-232 (estimated to be well above 1 percent Th-232, compared to the common regulatory threshold of 0.05 percent to qualify as source material). The surveys in Figure 3-1 are for conditions after completion of the cleanup of these areas.

3.1.1 Radiation Surveys of Walls

3.1.1.1 Walls in Offices

Figure 3-2 shows the general layout of rooms in the office area. The figure is not drawn to a precise scale. Numbers in the rooms key to the survey results for the rooms in Figure 3-3. No residual radioactive material from the former operations was detected on the walls of the offices.

3.1.1.2 Interior Walls of the Shop

The gamma survey results for the walls in the Shop are given in Figure 3-4. The walls were surveyed up to a height of 2 meters from the floor, except for the western and northern section in the northwest corner. The only area with definitive contamination was a window ledge on the eastern wall, in grids 13N to 18 N. Other areas of minor elevation appeared to be due to shine from the floor and exterior asphalt. However, the actual cause for exposure rates above background should be evaluated after completing the final cleaning of the surfaces.

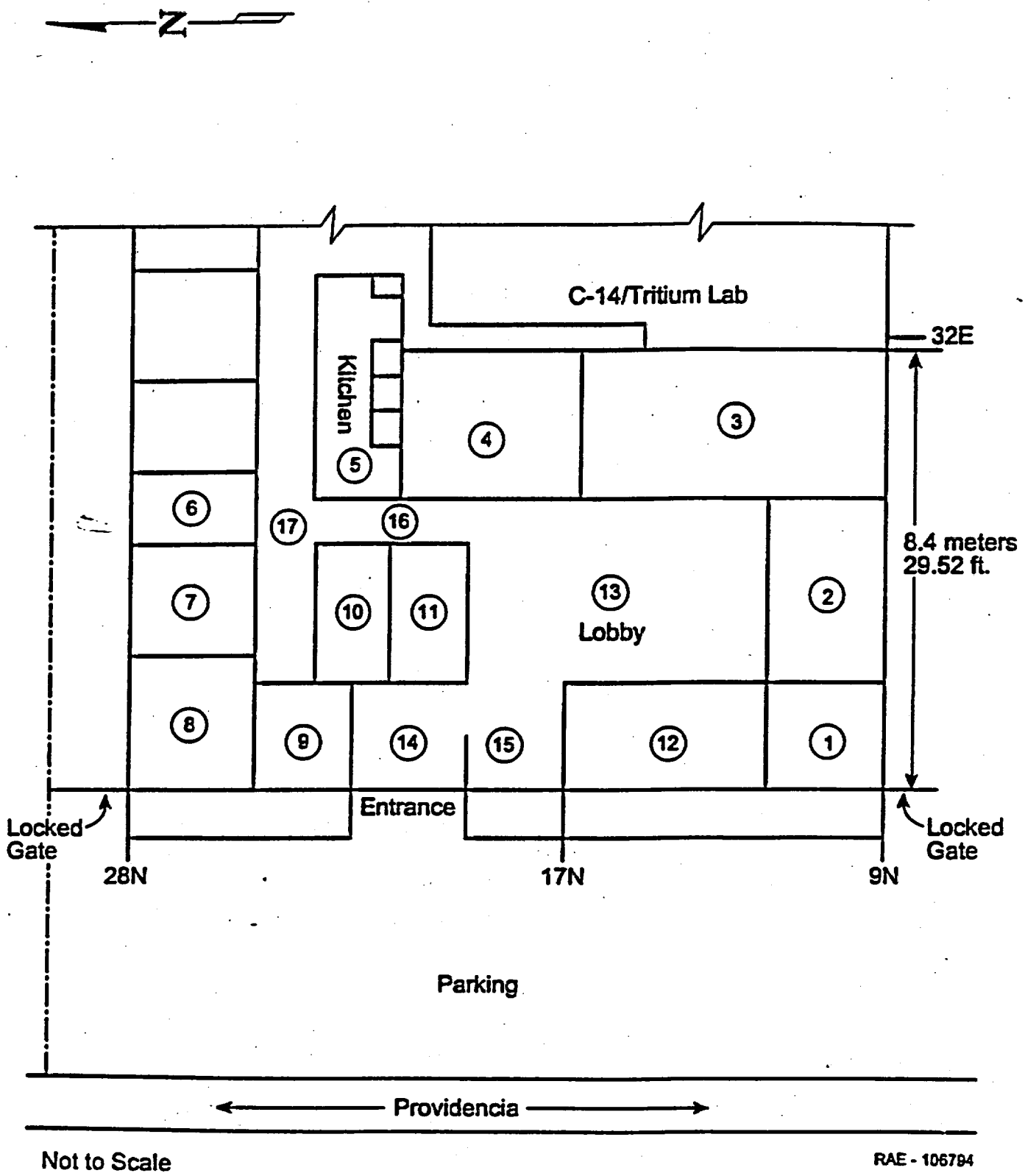
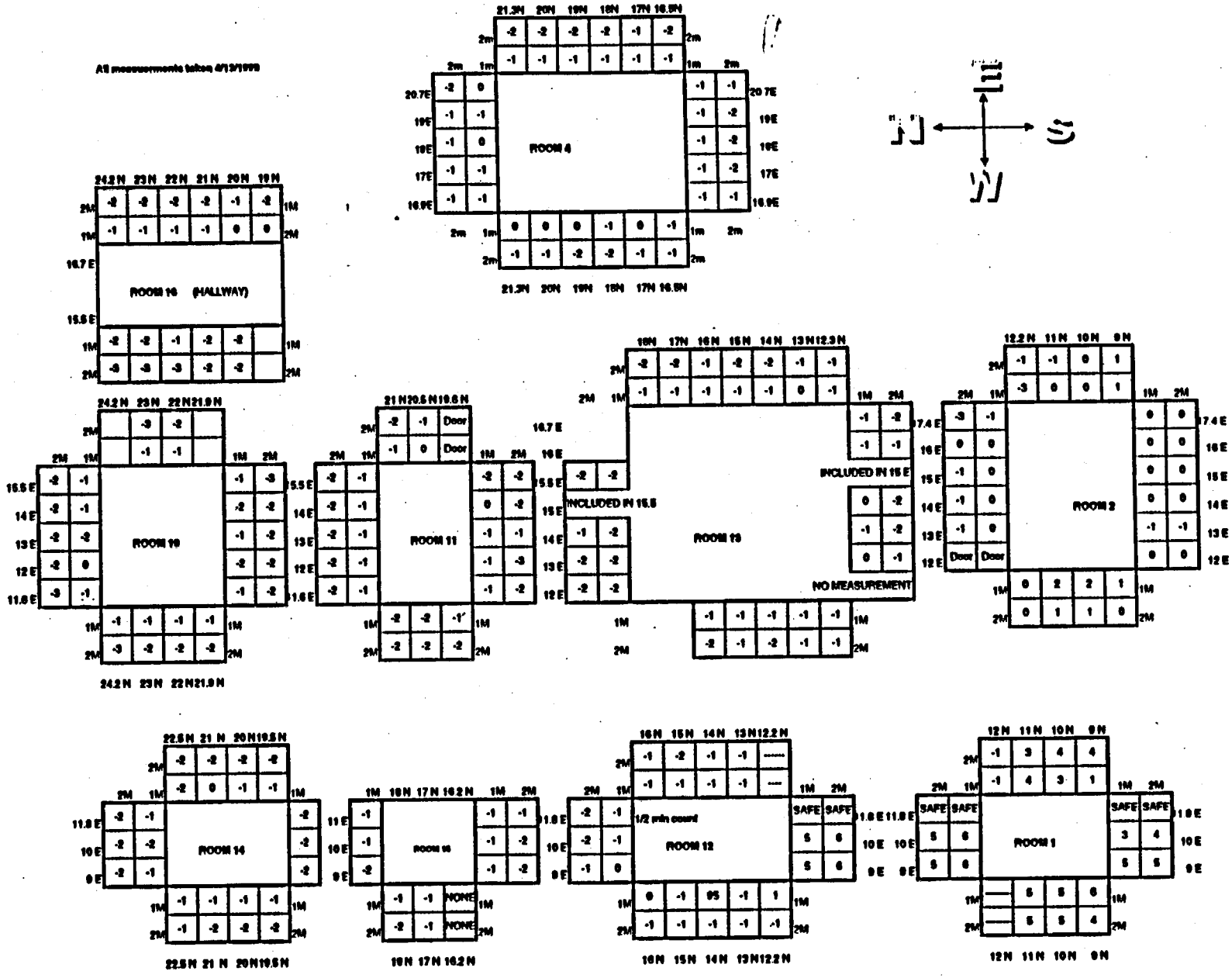


Figure 3-2. Layout of offices for radiation surveys.

Figure 3-3. Radiation survey results for office walls (uR/hr).



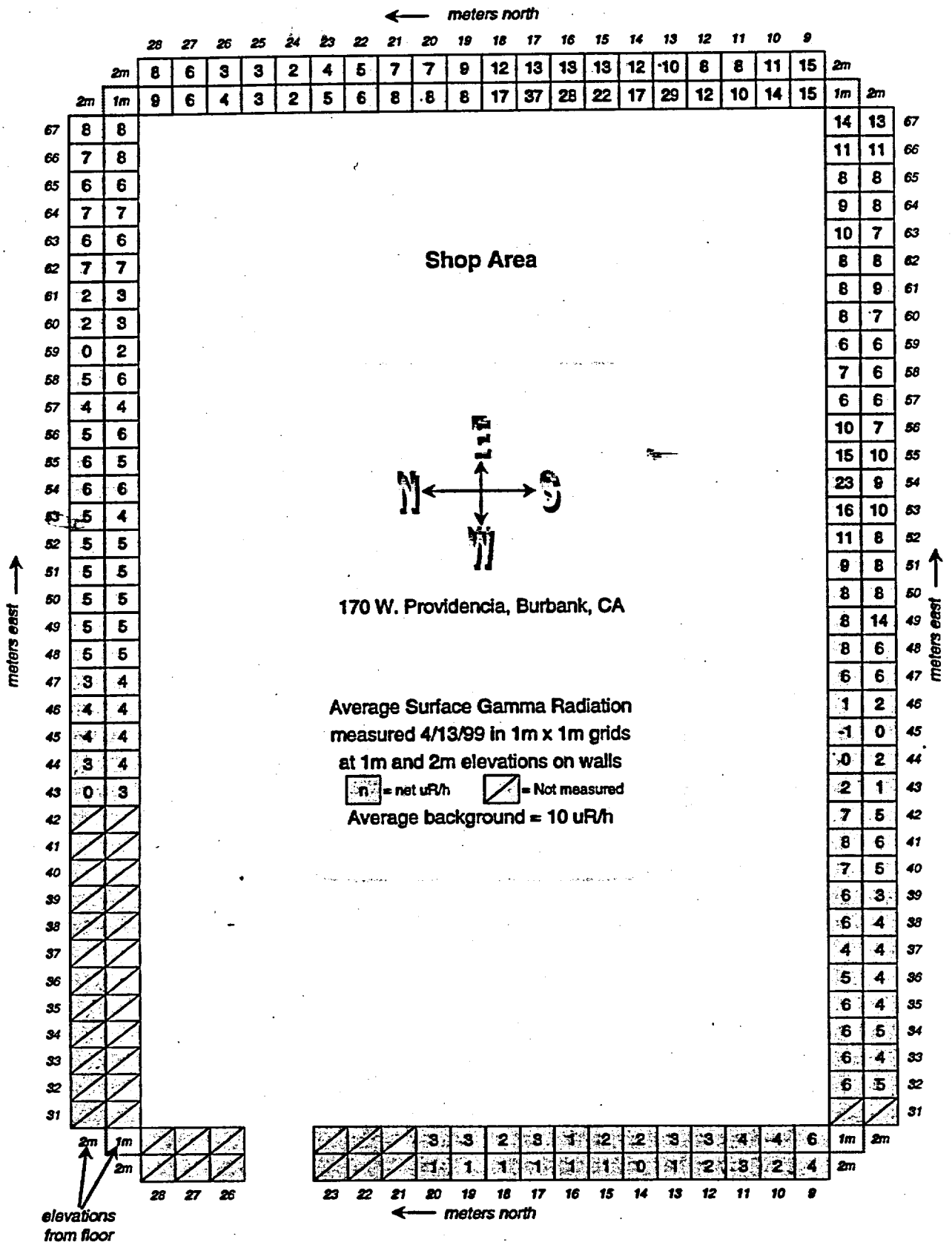


Figure 3-4. Surface gamma radiation measurements on the interior walls of the shop area.

3.1.1.3 Exterior Walls of Shop

Figure 3-5 provides the gamma survey results for the exterior western wall of the Shop. The net exposure rates above background appear to be due to shine from the surface. However, this should be evaluated after the surface contamination is removed.

3.1.1.4 Interior Walls of Bays, West End of Site

Figure 3-6 provides the gamma survey results for surveys performed on the walls of Bays B and C. The only area of significant impact in the bays was the floor sump in Bay B; therefore the focus of surveys was on the nearby walls in Bay B.

3.1.2 Radiation Survey of Roof of Shop

Figure 3-7 presents the results from the gamma surveys of the surface of the roof. The features from the building are included on the figure to show the location of the different areas of the building. In addition to these surveys smears were taken from many of the vents on the roof and beta/gamma surveys were performed. These additional surveys did not indicate the presence of any residual radioactive contamination. The only indication of residual radioactive contamination identified by the gamma and other radiation surveys of the roof is for the area of 64.5E:18.2N. Although the gamma survey only indicates a minor increase in the average gamma exposure rate for the grid, a small area of residual contamination gave over 300 uR/hr at the surface of the roof, with only about 6 uR/hr above background at a height of 1 meter from the roof. Assessments performed in the ceiling of the shop indicated that this anomaly was due to a purlin, apparently related to a former roof vent in the area of the hot cells and Co-60 pool. The field gamma spectrometer indicated that essentially all of the anomaly was due to Cs-137 with a minor contribution from Co-60.

Figure 3-5. Radiation survey outside wall on east end of Shop; surveyed to height of 4 meters (uR/hr).

Rows @ 3&4 m on p. 3

← NORTH

	18	17	16	15	14	13	12	11	10	9	
	7	6	5	4	6	7	9	9	12	12	4 m high
	7	6	6	6	8	6	7	8	12	13	3 m high
	7	7	6	6	4	7	7	8	12	17	2 m high
	10	9	9	7	7	7	8	9	19	24	1 m high 68E

26	25	24	23	22	21	20	19
3	3	2	3	7	7	7	7
4	3	2	4	12	10	10	10

10	16
10	11

67E

66E

East Wall of Shop

North Wall of Shop

exterior shop walls final.xls

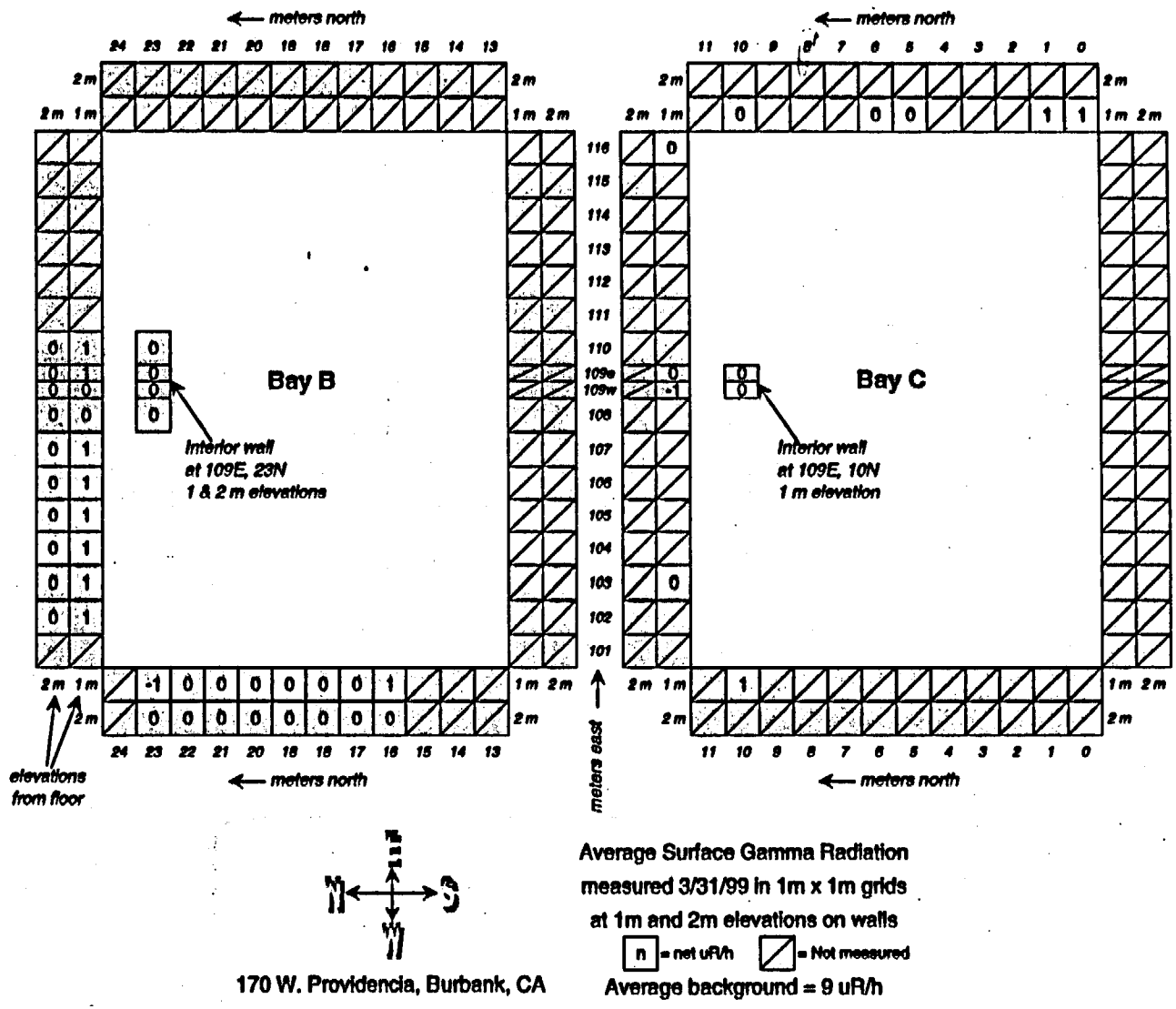


Figure 3-6. Surface gamma radiation measurements on the interior walls of Bays B and C.

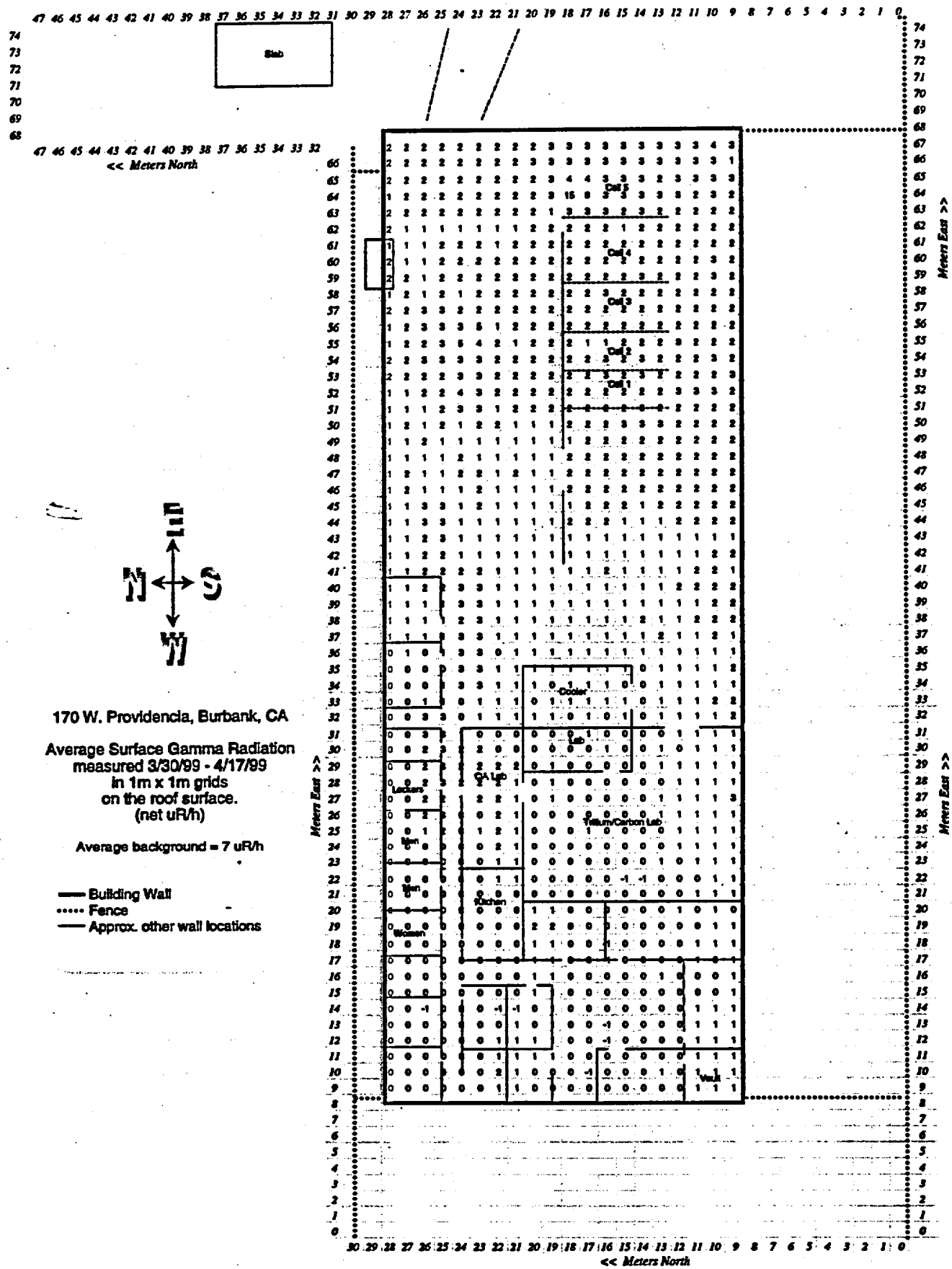


Figure 3-7. Results of roof surface gamma radiation surveys.

Except for the localized area at 64.5E:18.2N, no significant residual radioactive material was found on the roof. The owner reported that essentially all of the roofing, down to the wood sheeting had been removing during re-roofing the facility after termination of the radioactive materials work. The minor elevations above background appear to be due to the gamma shine from the floor of the shop.

3.1.3 Fenced Alley Area to North of Building

A fenced alley area, with a locked gate at the front, extends along the north side of the main building. This area is about 1.5 meters wide. There are areas with apparent residual radioactive material from about 60E to 67E, as indicated by several elevated gamma readings recorded in this area, primarily on a cement slab and some wooden retaining timbers. Some of the spots located next to the building could be due to contamination inside the building, but other spots exhibited higher readings away from the building

3.2 GAMMA SPECTROMETRIC MEASUREMENTS

The surface gamma radiation surveys of the site were supplemented with spectrometric gamma radiation measurements at selected locations to help identify the radionuclides that were causing the observed levels of total gamma radiation. Because the spectrometric measurements take more time than the gross gamma surveys, spectrometric measurements were performed only at selected locations to characterize local anomalies, verify background, and demonstrate general trends in radionuclide contamination patterns.

The locations of each gamma spectrometric measurement are illustrated by the circles in Figure 3-8, which relate each measurement location to a listing in Table 3-2 of the corresponding grid coordinates, and the corresponding gamma ray spectrum in Appendix C. Different colors identify the presence of contributions of several key radionuclides or groups of their decays products. The circle size indicated the approximate gamma ray intensity.

Individual spectra were accumulated at the measurement point for several minutes to several hours, depending on activity levels and available time, and stored in the multichannel analyzer. They were later downloaded into computer files for processing, which consisted of

visual shifts to account for thermally-induced gain shifts and smoothing of the spectra. The shifts utilized alignments of the 662-keV peak from Cs-137 (when present), the 1,461-keV peak from natural K-40, and the 2,615-keV peak from Tl-208 (a decay product of Th-232).

A plot of four typical spectra collected at different locations is illustrated in Figure 3-9. The background spectrum shows traces of K-40 and Th-232 decay products (d.p.) from naturally-occurring materials in the concrete slab. The spectrum from Cs-137 contamination shows a single large peak centered at 662 keV superimposed on a background similar to the slab background spectrum. The spectrum with Cs-137 and Co-60 contamination is similar to the Cs-137 spectrum plus two small additional peaks at 1,173-keV and 1,332-keV. The Th-232 decay product spectrum contains elevated levels (compared to background) of all Th-232 series peaks, particularly those at 583-keV, 860 keV, 911 keV, and 2,615 keV. Similar plots showing each of the spectra compared to a background spectrum are contained in Appendix C, as indexed by the tabulation in Table 3-2.

The sizes and colors of the dots in Figure 3-8 give a visual estimate of the locations and relative concentrations of the main radionuclides identified by gamma spectrometry. An unexpected identification of Eu-154 occurred at 92E:48N, where a routine spectrum measurement gave peak energy and intensity patterns that did not correspond to the more common Cs-137, Co-60, Ra-226 d.p., or Th-232 d.p. at the site. Further study of the measured spectrum showed it to be Eu-154, an isotope that was not previously expected or identified in connection with the site activities. The localized (point source) nature of its gamma activity suggests it may be a buried, sealed radioactive source.

3.3 RADIATION SURVEYS FOR SURFACE BETA AND ALPHA ACTIVITY

The focus of the radiation surveys was the external gamma exposure rate, due to the aged and weathered nature of any residual contamination. Furthermore, since most of the contamination is due to Cs-137, gamma survey techniques are much more efficient in detecting residual material. However, surveys were also performed to determine levels of gross beta and gross alpha activity, with the results converted to the common regulatory units of disintegrations per minute (dpm) per 100 square centimeters (i.e., dpm/100 sq.cm).

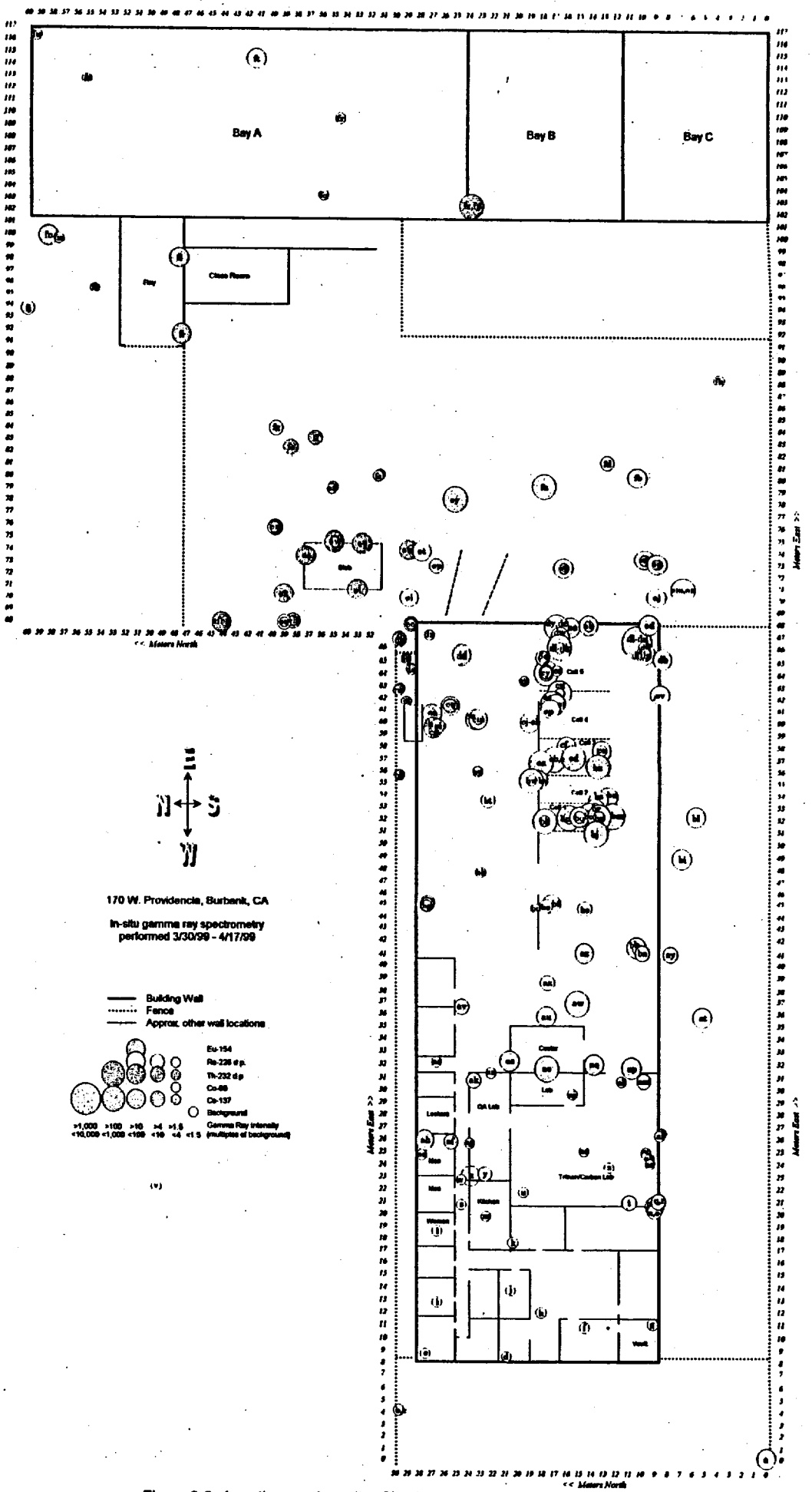


Figure 3-8. Locations and results of in-situ gamma ray spectrometry.

Table 3-2. Gamma spectrometry locations, plot locations, and interpretations.

Location ID	East (m)	North (m)	Spectrum Plot Set	Spectrum Plot Chart	Gamma Ray Intensity[a,b] Bkg.	Cs-137	Co-60	Th-232	Ra-226	Eu-154
aw	37.3	15.6	4-2c	8		4				
ax	39.0	18.0	4-15b	10		2				
ay	41.4	8.0	4-13a	10		2				
az	41.5	15.0	4-2c	9		3				
ba	41.5	10.3	4-13a	7		2				
bb	41.7	10.7	4-2c	7		3	1			
bc	45.0	15.0	4-15b	10		2				
bd	45.1	19.0	4-14	9		1				
be	45.4	18.3	4-13a	7		2				
bf	45.5	17.9	4-2c	8		3				
bg	45.5	27.7	4-9b	7		2	1	2		
bh	48.0	23.5	4-15b	9	X					
bi	49.2	17.2	4-2b	7		3				
bj	51.3	14.2	4-2a	8		4				
bk	52.3	18.3	4-2b	7		4	1			
bl	52.4	5.9	4-13a	10		3				
bm	52.5	12.9	4-1	7		4				
bn	52.5	13.9	4-2a	7		4	1			
bo	52.5	14.7	4-2a	7		4	1			
bp	52.5	16.2	4-2a	7		4	1			
bq	52.5	15.4	4-2a	7		3	1			
br	53.2	14.1	4-2a	8		3	1			
bs	53.7	13.9	4-2a	8		3				
bt	53.7	22.9	4-16	10		2				
bu	54.1	13.1	4-2a	9		3				
bv	55.4	18.8	4-13a	7		3				
bw	55.5	19.0	4-2b	10		4	1			
bx	56.0	30.2	4-9a	9				1		
by	56.3	23.8	4-13b	8		1				
bz	56.6	13.9	4-2b	9		4				
ca	57.0	18.5	4-2b	9		4				
cb	57.3	17.5	4-2a	9		4				
cc	57.3	17.5	4-2b	9		4				
cd	57.6	15.9	4-2b	8		4				
ce	58.1	13.6	4-2b	8		3	1			
cf	58.2	16.5	4-15a	8		3				
cg	59.7	27.3	4-13a	9				1		
ch	59.8	27.4	4-2b	7				3		
ci	59.9	27.3	4-6	7				2		
cj	60.2	19.5	4-14	9		3				
ck	60.2	19.5	4-15b	7		1				
cl	60.2	19.5	4-15b	7		2				
cm	60.5	23.8	4-15b	7		3	1			
cn	60.5	23.9	4-17	9		3				
co	61.0	27.4	4-2b	7				3		
cp	61.6	17.6	4-6	7		3				
cq	61.7	26.0	4-3	10		3		2		
cr	61.8	17.5	4-2a	9		3				

Table 3-2. Gamma spectrometry locations, plot locations, and interpretations.

Location ID	East (m)	North (m)	Spectrum Plot Set	Spectrum Plot Chart	Gamma Ray Intensity[a,b] Bkg.	Cs-137	Co-60	Th-232	Ra-226	Eu-154
cs	61.8	17.6	4-13a	8		4	1			
ct	62.0	29.6	4-9a	10				1		
cu	62.7	17.1	4-13a	8		4	1			
cv	62.8	9.0	4-13b	7		3				
cw	63.0	30.2	4-9a	9		1		1		
cx	63.8	20.0	4-15a	8				1		
cy	64.5	18.2	4-13b	8		4	1		2	
cz	64.6	17.3	4-15a	7		1				
da	64.9	29.1	4-9a	10				1		
db	65.4	8.8	4-17	10		3				
dc	65.5	29.4	4-9a	9				1		
dd	65.8	25.0	4-2c	9		3				
de	65.8	18.4	4-3	10		2	1			
df	66.0	10.0	4-15b	9		2				
dg	66.0	10.0	4-15b	9		3	1			
dh	66.3	10.2	4-2b	8		1				
di	66.3	17.1	4-13a	8		4	1			
dj	66.4	17.2	4-2a	10		3				
dk	66.4	17.2	4-6	7		3				
dl	66.9	10.8	4-1	7		3				
dm	66.9	10.8	4-2a	10		3				
dn	66.9	10.7	4-5	8		2				
do	66.9	10.7	4-5	8		4				
dp	66.9	10.7	4-5	8		3				
dq	66.9	10.7	4-6	7		5				
dr	66.9	10.7	4-7	7		3				
ds	66.9	10.7	4-7	7		3				
dt	66.9	10.7	4-9a	8		3				
du	66.9	10.7	4-9a	8		3				
dv	67.0	30.0	4-3	8				2		
dw	67.3	17.0	4-13a	9		3				
dx	67.4	27.7	4-15a	8	X					
dy	68.0	17.3	4-2a	10		3				
dz	68.0	17.3	4-13a	9		4				
ea	68.0	16.2	4-13a	9		3				
eb	68.1	14.8	4-17	10		3	1			
ec	68.2	29.1	3-30	9		1		2		
ed	68.2	9.9	4-17	7		3				
ee	68.3	39.5	4-3	8				1	2	
ef	68.3	44.6	4-8	9				3		
eg	68.5	44.4	3-30	9		1				
eh	68.5	38.8	4-8	8				2	1	
ei	70.5	29.3	4-8	10					3	
ej	70.6	9.2	4-17	7		3				
ek	70.8	39.7	4-3	7				3		
el	71.0	33.6	3-30	9				3		
em	71.2	7.0	4-15a	7		4				
en	71.2	7.0	4-15b	8		4				

Table 3-2. Gamma spectrometry locations, plot locations, and interpretations.

Location ID	East (m)	North (m)	Spectrum Plot Set	Spectrum Plot Chart	Gamma Ray Intensity[a,b] Bkg.	Cs-137	Co-60	Th-232	Ra-226	Eu-154
eo	73.0	16.7	4-17	8		3		1		
ep	73.2	27.1	4-8	10					2	
eq	73.4	9.1	4-17	8		3		1		
er	73.8	10.1	4-17	8		3		1		
es	74.0	37.7	4-3	7				3		
et	74.4	28.3	4-8	10					3	
eu	74.5	29.3	3-30	8				3		
ev	75.0	33.1	4-8	7				3		
ew	75.1	35.4	4-15b	8		1		3		
ex	76.3	40.3	4-8	8				2	1	
ey	78.6	25.6	4-3	8		4				
ez	79.6	35.5	4-8	8		1			1	
fa	79.7	18.4	3-30	7		4				
fb	80.5	10.8	3-30	8		3				
fc	80.6	31.7	4-8	9		1			1	
fd	81.7	13.2	3-30	8		2				
fe	82.8	39.0	4-3	7				2		
ff	83.6	37.0	4-8	9				2		
fg	84.4	40.3	4-8	8					2	
fh	88.6	4.1	4-1	8	X					
fi	92.0	48.0	4-5	7						3
fj	94.0	60.7	4-5	7		2				
fk	95.9	55.1	3-31	8		1				
fl	98.4	48.2	4-5	7		3				
fm	100.0	58.0	4-9a	8	X					
fn	100.2	58.9	4-5	7		3				
fo	102.9	24.3	3-30	7				4		
fp	102.9	24.3	3-30	7				4		
fq	103.7	36.4	3-31	7	X					
fr	110.0	35.0	3-31	8	X					
fs	113.1	55.8	4-1	7		1				
ft	114.9	41.9	3-31	7		3				
fu	116.6	59.8	3-31	7	X					
fv			4-9a	7		4				
fw			4-9a	7				3		
fx			4-9a	7				1		
fy			4-9a	7		1				
fz			4-15b	8		4				
ga			4-15b	8				3		
gb			4-17	9		3				
gc			4-17	9		3				
gd			4-17	10	X					

[a]Th-232 and Ra-226 are represented by their decay products.

[b]Bkg = <1.5 x background; 1 = <4 x background; 2 = <10 x background; 3 = <100 x background; 4 = <1,000 x background; 5 = <10,000 x background.

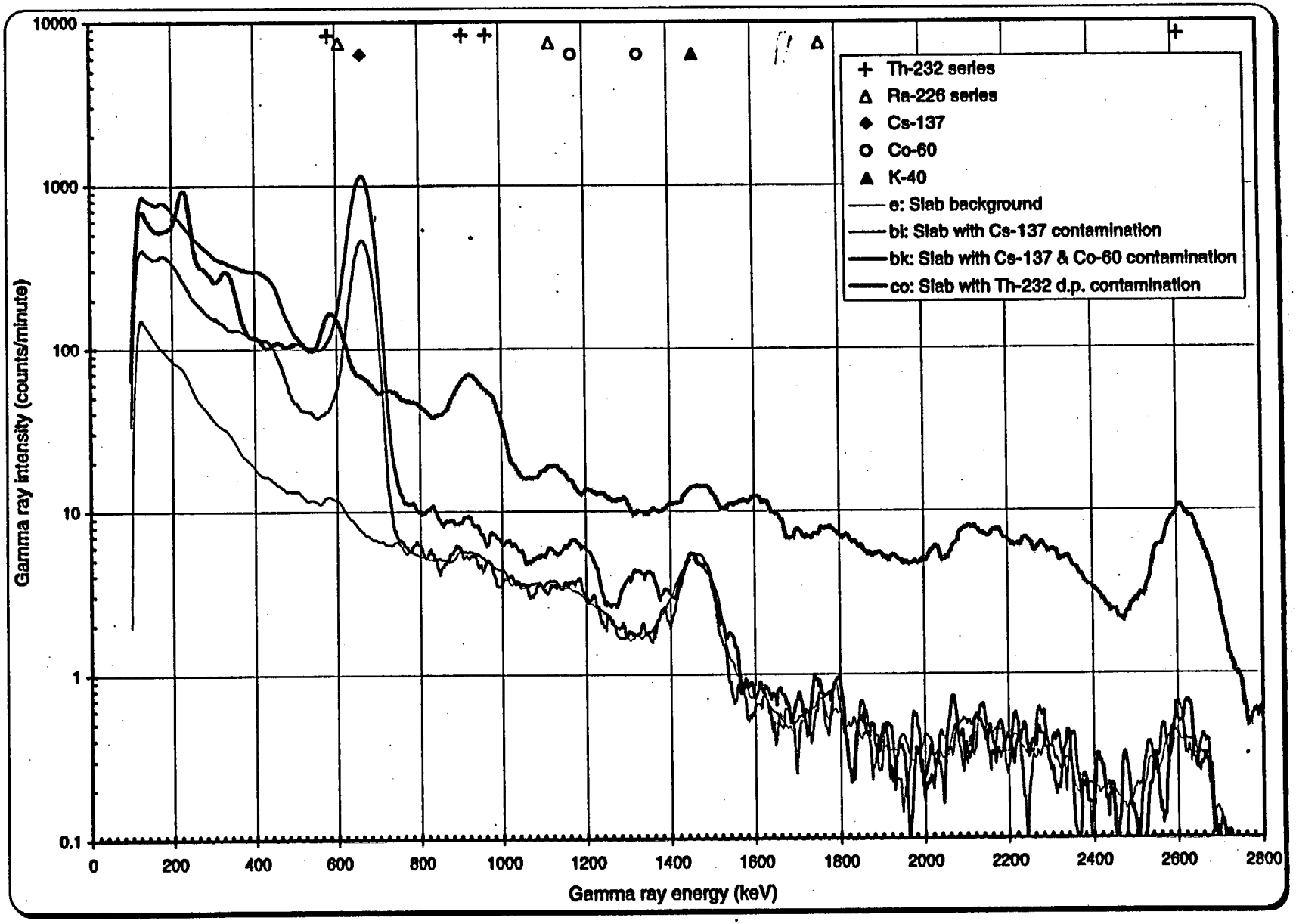


Figure 3-9. Examples of four gamma ray specta showing background, Cs-137, Cs-137 + Co-60, and Th-232 d.p. contamination.

The locations where specific surveys were performed for beta or alpha contamination are shown in Figure 3-10. The results of the surveys are given in Table 3-3. Measurements were taken in the hallway, just outside the offices towards the shop, the alcove to the north of this hallway, selected areas in the Shop, near the electric panels in the northeast area of the shop, and on the asphalt to the east of the Shop. The results in Table 3-3 are based on single measurements of 1 minute duration, with the detector probe stationary.

The survey results for S-3 and S-4 in the hallway outside of the offices (grids 40E:24N and 23E:25N) support the results from field gamma spectra indicating there is residual Cs-137 in this area. The beta results indicate a residual of about 2,700 to 4,000 dpm/100 sq cm, even though the external gamma exposure rate is near background. Field gamma spectra from this area showed low levels of Cs-137. Based on the field gamma spectra results which showed no residual Cs-137 in the alcove by the electric panels at 32E:28N, the measurement at this location (S-5) was used as background, as indicated in Table 3-3.

The beta survey results in the shop range up to over 10,000 dpm/100 sq. cm (S-20 and S-21). Surveys of several areas that were scabbled verify that scabbling reduces the level of residual activity.

The measurements for alpha contamination were limited to the area of the electrical panel in the northeast area of the shop where RCC reportedly performed work with thorium. A sample by the NRC from this area, analyzed by RHB, indicated Th-230 (primarily an alpha emitter) and Th-232. The surveys in this area indicate elevated alpha activity and elevated beta activity. The results for S-24 and S-25 indicate that scabbling reduced both the beta and alpha contamination concentrations. The area of the S-27 sample is apparently on concrete placed by the new owner after the former radioactive materials work. It shows essentially no contamination.

The measurements at S-30 to S-33 were taken on the asphalt to the east of the Shop. S-30 is near the concrete slab where thorium contamination was detected in samples (see Chapter 4). S-31 to 33 are for areas of elevated external gamma exposure rates.

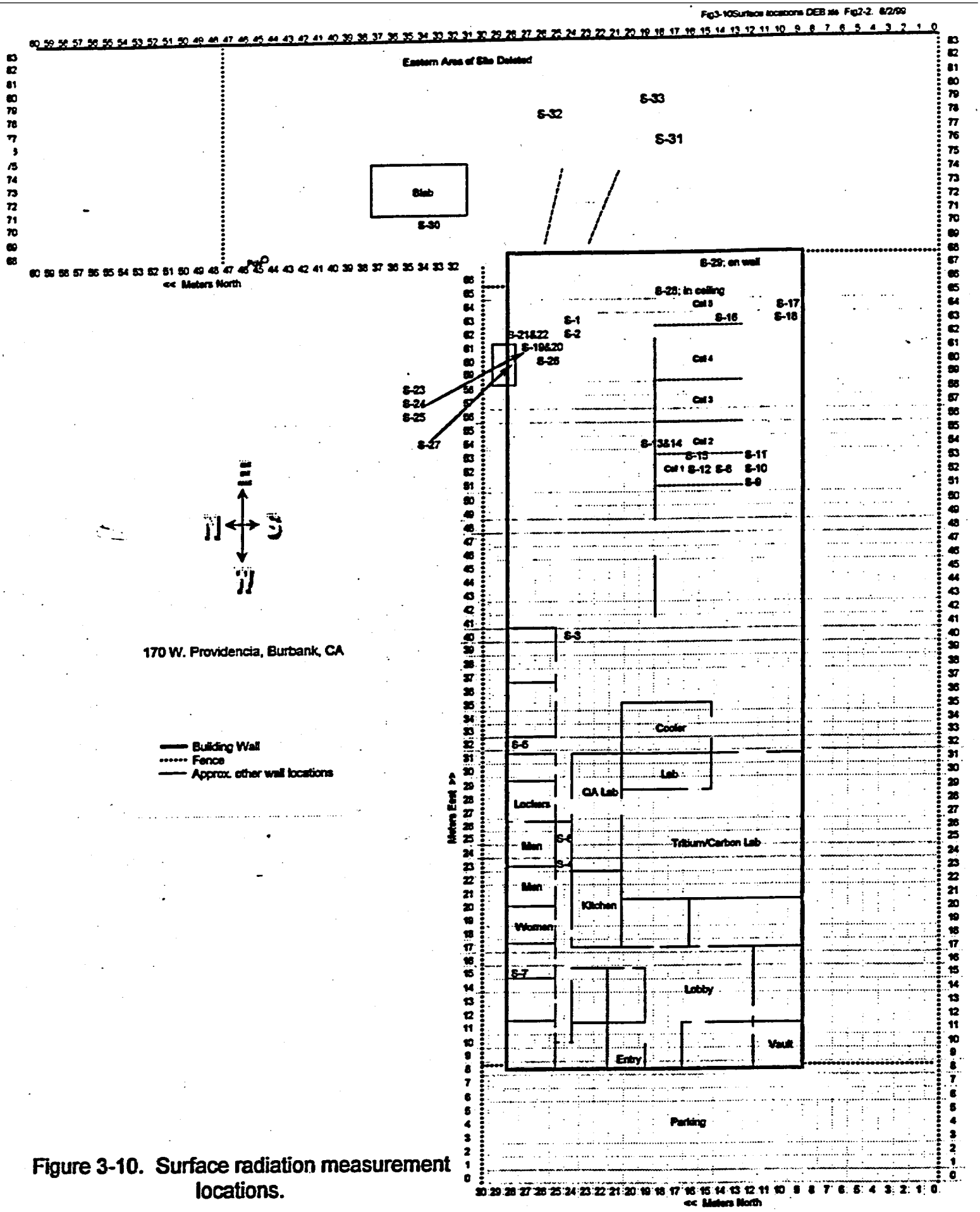


Figure 3-10. Surface radiation measurement locations.

Table 3-3. Measurements of surface contamination, beta and alpha.

Meas.	Grid Location East	Grid Location North	Beta (cpm)	Alpha Cpm)	dpm/100 cm^2 : cpm Beta Cpm)	dpm/100 cm^2 : cpm Alpha Cpm)	Area of Site	
Areas in Shop								
S-1	63	24	183		3967			
S-2	62	24	145		2700			
S-3	40	24	144		2667		Back towards offices	
S-4	23	25	137		2433		Office shop door, indication of Cs-137	
S-5	32	28	64		0		Near office, no indication of Cs-137; near electric panel by office No Cs-137; used as background.	
S-6	25	25	84		667			
S-7	15.3	28	69		167		Utility Room	
S-8	52	14	241		5900		Shop, Hot Lab #1	
S-9	51	12	96		1067		Scabbled Area	
S-10	52	12	109		1500			
S-11	53	12	77		433		Unscabbled Area	
S-12	52	15	122		1933		Unscabbled Area	
S-13	54	18	160		3200		Sr-90 Lab	
S-14	54	17	158		3133			
S-15	53	16	114		1667		Corner of Hot Cells 4 & 5	
S-16	63	14	56		zero			
S-17	64.6	9.5	67		100		New Concrete	
S-18	63	10	75		367			
S-19	61.2	28	450	84	12867	8194	Near Electric Panel, NRC/RHB indication of Th-230 and -232.	
S-20	61.2	27.8	459	36	13167	3455	Near Electric Panel, NRC/RHB indication of Th-230 and -232.	
S-21	62.1	27.7	297	41	7767	3949	Near Electric Panel, NRC/RHB indication of Th-230 and -232.	
S-21	62.1	27.7		40		3850	Near Electric Panel, NRC/RHB indication of Th-230 and -232.	
S-21	62.1	27.7		37		3554	Near Electric Panel, NRC/RHB indication of Th-230 and -232.	
S-22	62.6	28.3	82	8	600	691	Near Electric Panel, NRC/RHB indication of Th-230 and -232.	
S-23	61.6	27.6	241	29	5900	2764	Near Electric Panel, NRC/RHB indication of Th-230 and -232.	
S-24	61.7	27.5	84	1	667	0	Near Electric Panel, NRC/RHB indication of Th-230 and -232.	Area Scabbled
S-25	61.6	27.3		2		99	Near Electric Panel, NRC/RHB indication of Th-230 and -232.	Area Scabbled
S-26	60.6	26.8	46		zero			
S-27	60.8	28.5	95	4	1033	296	Upper level of concrete by Electric Panel, appears to be new concrete	
Area in Ceiling, Former Vent								
S-28	65	18.3	8860		293200		Cs-137, minimal Co-60, purlin	
S-29	67	14-16					Window ledge on East End of Shop	15,000 cpm gamr Bk 4, p. 10
								Could calc beta from surface contam.
Area Out-side; on Asphalt								
S-30	71	3\3.2	759		23167		Area by Concrete Pad, east side	
S-31	76.6	18.4	40000		1331200			
S-32	78.6	25.7	14600		484533		Area generally 1k to 5 k cpm	4 in by 6 in area
S-33	79	18	14000		484533			

Beta error term @ 1000 dpm/100 cm^2	42%	1 sigma
Alpha error term @ 1000 dpm/100 cm&2	35%	1 sigma (normal distribution doen't really apply for this low of counts)

Conversion: cpm to dpm:100 cm^2	Beta	Alpha	ackgrounds	
Ideal Efficiency	35%	34%	Beta	Alpha
Field Equiv % Efficiency	20%	20%	cpm	cpm
Area of Detector (cm^2)	15	5.1		
dpm/100 cm^2: cpm detector	33	99	64	1

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3.4 SUPPLEMENTAL SURVEYS

Radiation surveys were performed for the rain down spouts for the main building and for the storm water catch basin on the southwest corner of the site. These results are summarized in Table 3-4. The locations where measurements were made are shown in Figure 3-11.

There appeared to be no residual contamination associated with the roof down spouts. Some of the gamma survey and beta survey results in Table 3-4 appear to be above background, but assessments by those performing the surveys indicated these values were shine from the surface below. Although the G.M. pancake beta counter responds primarily to beta, it also has some sensitivity to gamma radiation.

The catch basin in the southwest corner of the Site contains residual contamination of over 70 uR/hr. The water and much of the debris were removed from the basin, but all of the debris was not removed. The peak residual contamination may be higher than that indicated. The discharge from the catch basin appears to go into 5-cm diameter pipes which go under the sidewalk, and discharge to the street. However, there are three pipes exiting the basin and only two pipes in the curb in the street. It is possible one of the pipes goes to a sewer. The exposure rate on these pipes, as they exited the basin, are about 10 uR/hr above background, but the exposure rate was background at the curb in the street. The apparent elevated exposure rate in the pipes may be due to shine from the contamination in the catch box.

Table 3-4. Surveys of rain gutters and storm catch basin.

Location	Grids East	North	Gamma Exp Rate uR/hr	Beta dpm per 100 sq cm
Rain Gutters, Main Building				
Measurements on Top of Building				
On North	68	28	1.5	123
On North	36	28	1.5	Bkgd
On North	31	28	Bkgd	Bkgd
On North	21	28	Bkgd	Bkgd
On South	68	9	Bkgd	47
On South	36	9	4.5	Bkgd
On South	18	9	Bkgd	207
On South	13	9	Bkgd	Bkgd
Storm Catch Basin; Southwest Corner of Site				
Bottom of Basin	00	00	53	Not measured
12 cm from surface	00	00	74	Not measured

Note: Values denoted as Bkgd are equal to natural background.

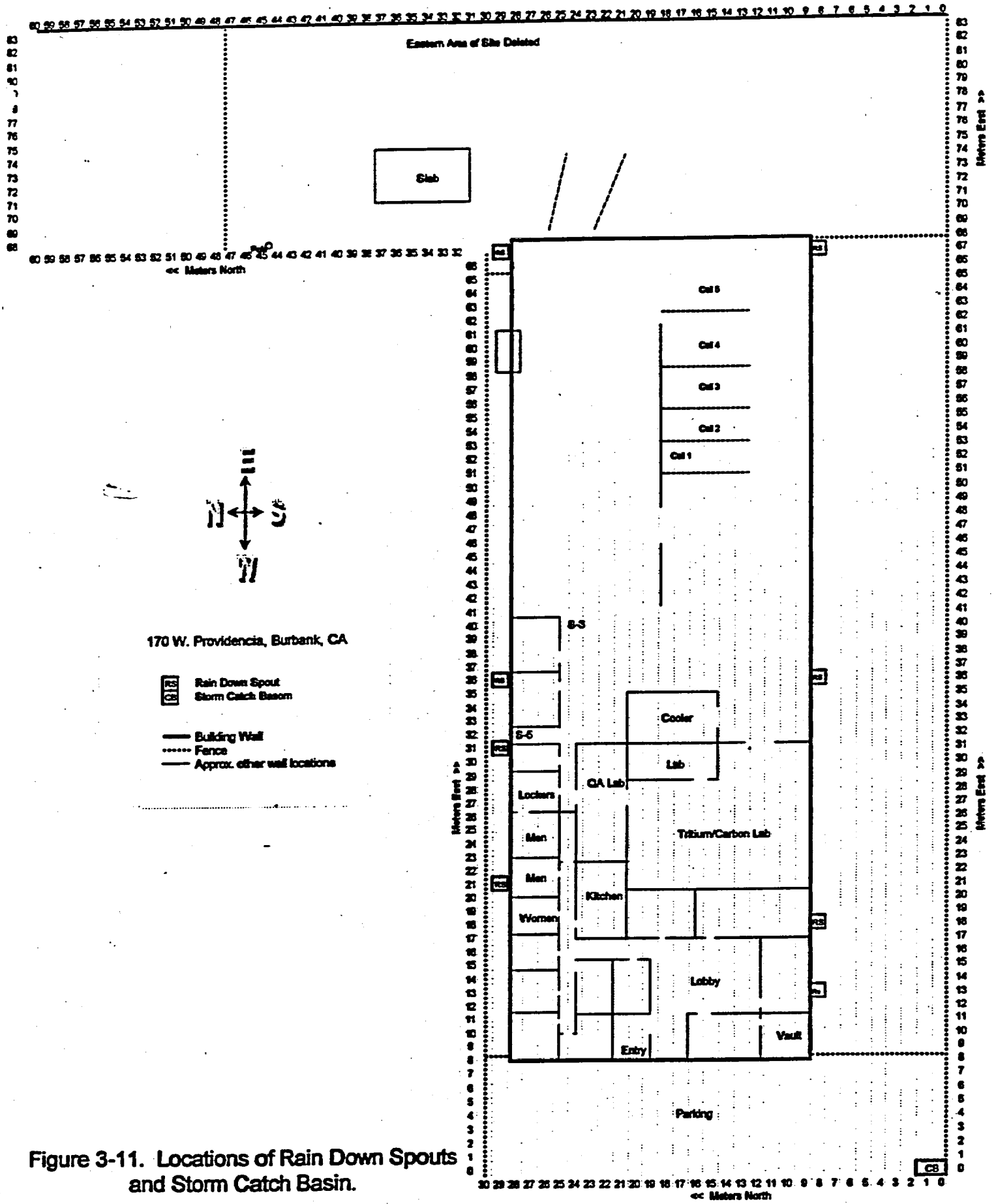

Figure 3-11. Locations of Rain Down Spouts and Storm Catch Basin.

4. SAMPLING AND SUBSURFACE INVESTIGATIONS

Implementation of the SAP included extensive sampling and analysis of samples and performing special investigations to more completely characterize the presence of residual contamination at the Site. This chapter presents the results of these efforts. The principal effort, the drilling of boreholes and related sampling are presented in Section 4.1. The results of gamma logging (placing a detector in the boring and recording the radiation reading) are given in Section 4.2. The results of sampling and analysis for Sr-90 and tritium and C-14 are presented separately in Section 4.3 and Section 4.4. The results for assessments of potential contamination in the sewer are given in Section 4.5. The results for special sampling and analysis to characterize background are given in Section 4.6.

4.1 SURFACE AND SUBSURFACE SAMPLES

The results of radiation surveys and the information from former operations at the site were used to direct much of the drilling of boreholes and collection of samples. However, in addition to the "biased" sampling based on historic information and radiation surveys, about 11 random boreholes were constructed to obtain random subsurface samples. Boreholes were constructed using dry techniques, to ensure that contamination from the surface was not tracked or transported by drilling fluids to the subsurface. The holes through asphalt and concrete were drilled/cut using a jackhammer. Soil samples were taken with bucket augers or trowels.

Many of the biased samples evolved from efforts to clean the surface of concrete in the Shop. As the surface of the concrete in contaminated areas was removed by scabbling or chipping with a jackhammer, the radiation readings sometimes kept increasing until reaching the surface of the soil. In some cases the radiation readings kept going up, even after going into the soil. The holes or boreholes constructed through this process are denoted as biased, because they were constructed based on the known presence of contamination.

In at least three cases in was clear that the samples collected did not reflect the primary source of the radiation exposure–the contamination. Based on radiation instrument readings it was explicitly clear that there was extensive contamination present, but the samples collected did not include material fully characteristic of the source of contamination. In two cases (Co-60 Pool area and a steel lined sump to the north of former Hot Cell #4) field gamma spectra measurements verified that the source of contamination was Cs-137. In the third case, the gamma spectra indicated the presence of elevated levels of Eu-154, a radionuclide not previously identified as being included in operations at the site. The Eu-154 source of contamination is in the "unnamed" bay to the west of Bay A, at the east end of the site. Eu-154 has used for human bone-density work and this contamination might be a sealed source in the quantity of millicuries of activity. The area has been sealed off with a fence and the source left in place for recovery during site decontamination. No samples were taken at this location.

Figure 4-1 shows the locations where samples were collected. The samples included both surface material and subsurface samples. The analytical results for these samples are given in Table 4-1 and Table 4-2. For simplicity and readability, the analytical data in Table 4-1 are limited to the concentrations of the primary radionuclides of concern for characterization of the Site and they are organized into groups for different areas of the Site. Specifically, since the data indicate that the concentrations of the uranium isotopes (U-234, U-238, and U-235) are in the same ratios as natural uranium, only the results for U-238 are given. The same is true for Th-232, where the concentration of Th-228 is not given. Furthermore, the analytical error terms or uncertainties are not given, and where values were less than the detection limit that value is given with a less than sign. The detailed analytical data are given in the appendices in three formats, varying from summarized data to the total data packages provided by the analytical laboratories. Data organized similar to the data sets in Tables 4-1 and 4-2 are given in Appendix B. The summary table provides data for the primary radionuclides and also includes the analytical error terms. A more detailed data compilation is also provided in Appendix B. The laboratory data packages and chain-of-custody sheets are given in Appendix D.

Table 4-1. Analytical results from borings, generally indicating subsurface contamination.

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Match to Fig. 4-1	Sample No.	Hole No.	Location For Samples & Grid E Gd#	N Gd#	Area	Sampling Depth (cm)	U-238 pCi/g	Th-230 pCi/g	Ra-226 pCi/g	Th-232 pCi/g	Ra-228 pCi/g	Cs-137 pCi/g	Co-60 pCi/g	K-40 pCi/g
1 Red	Former C-14/Tritium Lab; residual Cs-137 contamination extends under foundation in SW corner.													
	24-08DB05	1	21.0	9.0	C-14 Lab, SW	25-40			0.2		1.1	65.0	< 0.2	19.0
	24-17KN1	2	24.4	9.8	C-14 Lab	0-15			0.5		< 0.6	< 0.2	< 0.2	18.9
No. #	24-16DB18	8	55.4	18.8	Hot Cell #2				< 0.8		< 0.7	150.0	< 0.3	20.2
2 Red	Area of Hot Cell #4; Borings generally placed based on removal of contamination on surface of floor.													
	24-16DB16	11			Hot Cell #4	0-15			0.5		< 0.8	< 0.3	< 0.2	23.6
	24-16DB17	11	59.3	18.3		15-30			0.5		< 0.4	< 0.1	< 0.1	20.1
	24-16DB08	12	61.8	17.6		0-15			0.6		< 0.6	20.5	1.4	19.1
	24-16DB09	12				15-30			0.4		< 0.7	0.3	2.4	18.3
	24-16DB10	13	62.7	17.1		0-15			< 0.7		< 0.5	117.0	< 0.2	18.2
	24-16DB11	13				15-30			< 1.1		< 0.7	366.0	< 0.2	19.8
3 Red	Area of Former Co-60 Pool; Placed 2 borings													
	24-07KN01	14	66.0	10.0	Co-60 pool	20-26	0.4	0.8	< 1.1	0.9	< 0.8	479.0	< 0.3	20.1
	24-07KN02	14			Co-60 pool	26-45	0.3	0.5	< 1.0	1.0	0.9	610.0	< 0.1	19.0
	24-16DB64	14	66.0	10.0	KN02 Split	26-45			< 1.7		< 0.4	880.0	< 0.1	22.0
	24-08DB01	14	66.0	10.0		51-66	0.3	0.6	< 4.7	0.8	< 1.2	4700.0	< 0.3	19.2
	24-15DB04	15	66.9	10.8	Co-60 pool	10-20			1.2		0.9	11.5	< 0.3	19.5
	24-15DB05	15			Co-60 pool	60-76			0.6		1.0	7.4	< 0.1	20.6
	24-15DB05-D	15			Co-60 pool	60-76			0.3		1.1	6.3	< 0.2	15.9
	24-15DB06	15			Co-60 pool	76-86			0.6		< 0.7	7.1	< 0.3	16.0
4 Red	Samples from the Area of Former Hot Cell #5; show subsurface contamination.													
	24-16DB01	16	66.3	17.1	Hot Cell #5	0-15			< 0.8		1.6	124.0	0.8	20.7
	24-16DB60	16			Dup DB01	0-15			< 0.7		1.1	120.0	0.7	19.0
	24-16DB02	16			East Wall Shp	15-30			0.2		0.9	40.4	0.2	16.9
	24-16DB03	17	67.3	17.0		0-15			0.3	Check	1.5	2.8	< 0.3	24.1
	24-16DB03-D	17				Duplic			0.2		1.4	3.9	< 0.2	25.2
	24-16DB04	17				15-30			0.4		< 0.7	< 0.1	< 0.2	17.7
	24-16DB06	18	68.0	16.2	E Shop Wall	0-15		0.9	< 0.5	0.9	1.5	41.8	0.2	15.7
	24-16DB07	18				15-30		0.7	< 0.9	0.9	1.5	268.0	0.9	18.6
	24-16DB61	18			Dup DB07	15-30		0.9	< 1.1	1.2	0.7	342.0	0.6	16.6
	24-16DB05	19	68.0	17.3	E Shop Wall	15-30	0.3	0.4	< 8.0	0.8	< 2.5	5520.0	2.4	17.6
5 Blue	Area by Electrical Panel, on N Side of Shop													
	24-16DB38	32	69.6	27.3	Near Electric	0-6	0.3	0.4	0.4	0.9	< 0.8	< 0.1	< 0.2	22.7
	24-16DB39	32			Panel where	6-12		1.0	0.2	0.4	1.0	< 0.1	< 0.1	25.8
	24-16DB40	33	67.4	27.4	NRC & State	60-6	0.4	0.5	0.4	0.7	< 0.4	< 0.2	< 0.2	24.1
	24-16DB41	33			had high sample	6-12		0.9	0.2	1.7	< 0.9	< 0.2	< 0.3	27.0
	24-16DB42	34	55.5	27.4		0-6	0.4	0.4	0.4	1.0	1.0	0.1	< 0.2	23.6
	24-16DB42-D	34				0-6			0.5		0.8	< 0.1	< 0.1	19.6
	24-16DB43	34				6-12		0.8	0.5	0.5	1.1	< 0.1	< 0.2	25.3
6 Yellow	Exterior; Area Outside, East of Shop													
	Concrete Pad; re Thorium				Samples on joint around outside of pad.									
	24-08DB02	51	75.0	33.0	East sid Pad	0-8	170.0	3690.0	50.0	470.0	268.0	34.1	< 0.8	40.0
	24-08DB02	51	75.0	33.0	Lab Dup DB02	0-8		4010.0		360.0				
	24-08DB02-D	51	75.0	33.0	Lab Dup DB02	0-8			44.9		242.0	29.6	< 1.0	37.0
	24-16DB-65	51	75.0	33.0	Lab Dup DB65	0-8	155.0							
	24-16DB-65	51	75.0	33.0	RAE Dup DB02	0-8	149.0	3870.0	45.8	420.0	235.0	30.3	< 0.9	36.0
	24-08DB03	51	75.0	33.0	East side Pad	8-10		88.0	15.3	10.8	16.0	0.4	< 0.2	23.4
	24-16DB-66	51	75.0	33.0	Dup DB03	8-10	15.6	177.0	13.8	18.0	25.5	0.6	< 0.2	19.8
	24-15DB01	52	71.0	33.0	West side Pad	0-5	43.0	2240.0	44.4	182.0	171.0	92.0	< 0.6	29.8
	24-15DB02	52	71.0	33.0	West side Pad	5-10	63.0	3960.0	47.7	450.0	236.0	30.2	< 1.0	32.0
	Areas in Asphalt													
	24-08DB04	53	84.0	34.0	Asphalt; Chip				9.0		8.3	10.2	< 0.2	19.3
	24-07JS-1	54	93.0	60.0	rear asphalt				0.6		< 0.8	< 0.2	< 0.3	17.4

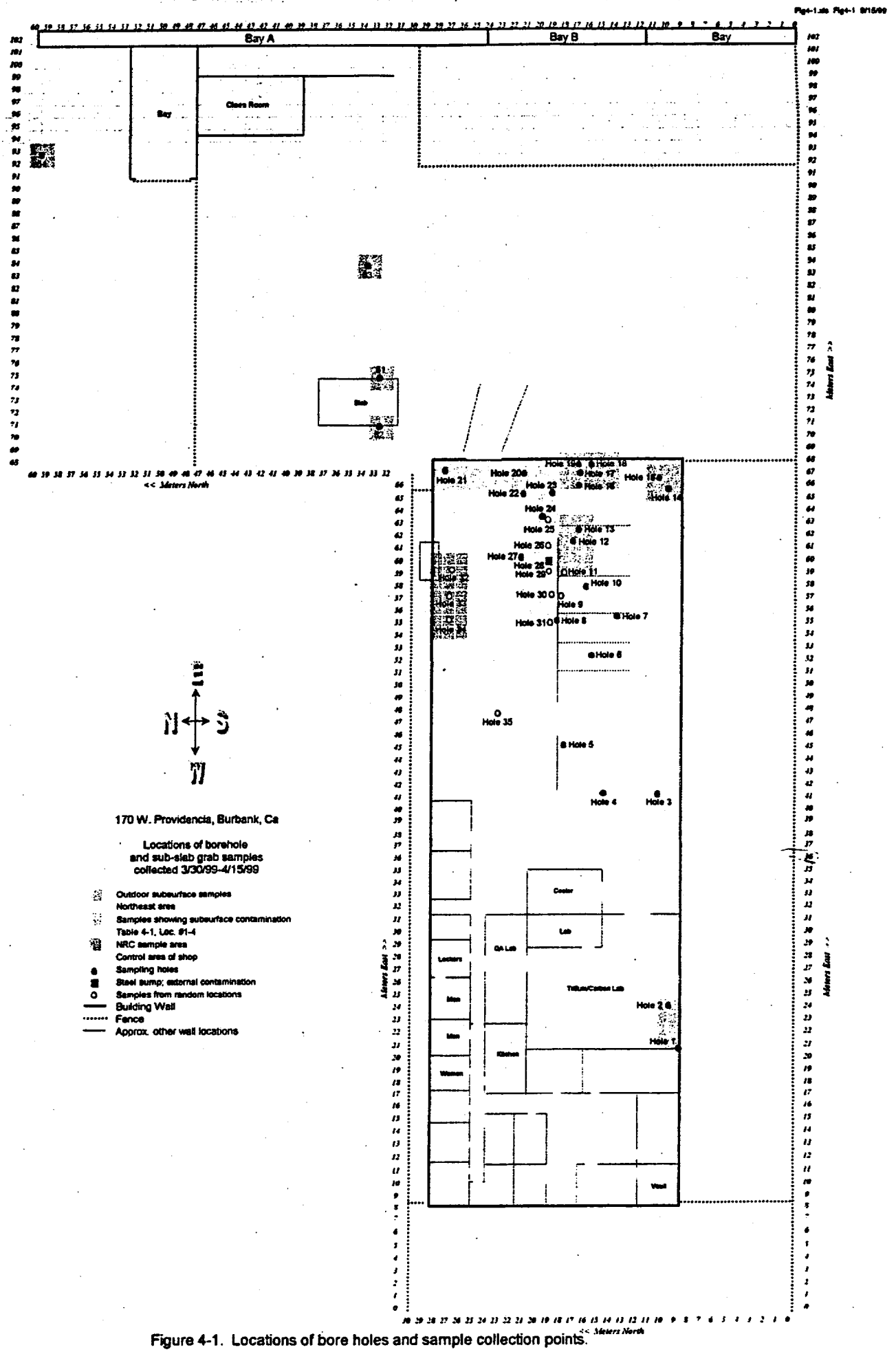

Figure 4-1. Locations of bore holes and sample collection points.

Table 4-2. Results of borings that show essentially no contamination, background samples.

Match to Fig. 4-1	Sample No.	Hole No	Location For Samples & Grid E Grid	N Grid	Area	Sampling Depth (cm)	U-238 pCi/g	Th-230 pCi/g	Ra-226 pCi/g	Th-232 pCi/g	Ra-228 pCi/g	Cs-137 pCi/g	Co-60 pCi/g	K-40 pCi/g
	Borings/holes With Minimal if any Contamination													
No Specific Marking	24-09JS-7	3	52.8	16.0	shop	0-15			0.3		<0.4	3.4		
	24-09JS-8	3			shop	15-30			0.5		<0.6	2.0		
	24-09JS-5	4	55.0	14.0	shop	0-15			0.3		1.1	1.1		
	24-09JS-6	4			shop	15-30			0.6		0.9	1.5		
	24-09JS-6-D	4			shop	15-30			0.3		1.1	1.3		
	24-04DB01	5	45.4	18.2	West shop	0-15			0.6		<0.8	0.2	<0.3	23.4
	24-04DB02	5			West shop	15-25			0.5		1.2	0.3	<0.3	16.4
	24-04DB02-D	5				15-25			0.5		1.0	0.4	<0.2	16.9
	24-09JS-1	6	52.6	16.0	West shop	0-15			0.2		<0.6	0.5		
	24-09JS-2	6			West shop	15-30			0.6		<0.5	<0.1		
	24-09JS-3	7	55.0	14.0	West shop	0-15			0.7		<0.6	0.5		
	24-16DB62	7			Dup of JS03	0-15		1.0	0.4	1.0	1.3	0.5	<0.2	16.5
	24-09JS-4	7				15-30			0.3		<0.5	<0.1		
	24-16DB63	7			Dup of JS04	15-30			8.1		8.5	0.2	<0.1	13.9
	24-16DB14	9	57.4	18.5	Hot Cell #3	0-15			0.2		<0.8	<0.1	<0.3	21.6
	24-16DB15	9			Hot Cell #3	15-30			0.6		<0.6	<0.2	<0.2	21.8
Green	**NE Area of Shop, Borings Show No Significant Contamination**													
	24-16DB32	20	67.3	21.5		0-15	0.5	0.4	0.5	0.7	<0.5	<0.2	<0.2	23.5
	24-16DB32	20			shop	0-15	0.4	0.4		0.7				
	24-16DB33	20			shop	15-30			0.5		<1.0	<0.2	<0.3	17.6
	24-16DB36	21	67.4	27.7	NE corner	0-15		0.5	0.4	0.7	<0.6	<0.1	<0.2	18.5
	24-16DB37	21				15-30			<0.4		<1.0	<0.2	<0.2	19.8
	24-16DB34	22	65.6	21.5	NE Area	0-15			0.3		<0.6	0.2	<0.2	22.2
	24-16DB35	22				15-30			0.4		<0.7	<0.1	<0.2	17.7
	24-16DB30	23	65.7	19.3	NE Area	0-15			<0.4		<1.2	<0.2	<0.3	27.4
	24-16DB31	23				15-30			0.2		0.8	<0.1	<0.1	19.2
	24-16DB29	24	63.8	20.0	Former Boring	0-15	3.4	3.2	2.2	3.0	<1.1	<0.2	<0.2	6.8
	24-16DB29	24			Lab Dup DB29	15-30	3.5	3.8		3.0				
	24-16DB27	25	63.6	19.7	shop	0-15			0.6		0.7	<0.1	<0.1	16.8
	24-16DB28	25			shop	15-30			0.2		1.6	<0.2	<0.2	26.0
	24-16DB28-D	25	63.6	19.7	shop	15-30			0.4		<0.8	<0.2	<0.2	23.0
Orange	**Central Area of Shop, N of Former Hot Cells**													
	24-16DB25	26	61.4	19.5	shop	0-15			0.5		<0.9	<0.2	<0.2	19.1
	24-16DB26	26			shop	15-30			0.3		<0.6	<0.2	<0.2	19.1
	24-16DB23	27	60.6	21.7	shop	0-15		0.7	0.6	1.1	<0.6	<0.1	<0.2	24.0
	24-16DB23	27			Lab dup DB23	0-15		0.9		1.3				
	24-16DB24	27			shop	15-30			0.5		<0.6	<0.2	<0.1	20.8
	24-16DB21	29	59.5	19.5	shop	0-15			0.6		<0.6	<0.2	<0.2	22.7
	24-16DB22	29			shop	15-30			0.3		1.0	<0.2	<0.2	18.3
	24-16DB19	30	57.6	19.3	shop	0-6			0.2		<0.5	<0.1	<0.3	19.9
	24-16DB19-D	30			shop	0-6			0.1		<0.6	<0.2	<0.1	17.8
	24-16DB20	30			shop	6-12			0.5		1.1	<0.1	<0.1	16.8
	24-16DB12	31	55.2	19.4	shop	0-6			0.4		1.3	<0.2	<0.2	22.7
	24-16DB13	31				6-12			0.7		<0.7	<0.2	<0.2	20.2
	24-16DB13-D	31	55.2	19.4		6-12			0.6		0.8	<0.1	<0.1	19.3
	Borings Placed As Random Samples					**Includes repeat of some samples from above areas.**								
Open Circles	24-16DB14	9	57.4	18.5	Hot Cell #3	0-15			0.2		<0.8	<0.1	<0.3	21.6
	24-16DB15	9			Hot Cell #3	15-30			0.6		<0.6	<0.2	<0.2	21.8
	24-16DB17	11	59.3	18.3	Hot Cell #4	0-15			0.5		<0.4	<0.1	<0.1	20.1
	24-16DB16	11				15-30			0.5		<0.8	<0.3	<0.2	23.6
	24-16DB27	25	63.6	19.7	shop	0-15								
	24-16DB28	25	63.6	19.7	shop	15-30			0.2		1.6	<0.2	<0.2	26.0
	24-16DB28-D	25			Lab Dup DB28	15-30			0.4		<0.8	<0.2	<0.2	23.0
	24-16DB25	26	61.4	19.5	shop	0-15			0.5		<0.9	<0.2	<0.2	19.1
	24-16DB26	26			shop	15-30			0.3		<0.6	<0.2	<0.2	19.1
	24-16DB21	29	59.5	19.5	shop	0-15			0.6		<0.6	<0.2	<0.2	22.7
	24-16DB22	29			shop	15-30			0.3		1.0	<0.2	<0.2	18.3
	24-16DB19	30	57.6	19.3	shop	0-15			0.2		<0.5	<0.1	<0.3	19.9
	24-16DB19-D	30			Lab Dup DB19	0-15			0.1		<0.6	<0.2	<0.1	17.8
	24-16DB20	30			shop	15-30			0.5		1.1	<0.1	<0.1	16.8
	24-16DB12	31	55.2	19.4	shop	0-15			0.4		1.3	<0.2	<0.2	22.7
	24-16DB13	31				15-30			0.7		<0.7	<0.2	<0.2	20.2
	24-16DB13-D	31	55.2	19.4	Lab Dup DB13	15-30			0.6		0.8	<0.1	<0.1	19.3
	24-16DB36	32	59.6	27.3	Near Elect Panel	0-15	0.3	0.4	0.4	0.9	<0.8	<0.1	<0.2	22.7
	24-16DB39	32			Near Elect Panel	15-30		1.0	0.2	0.4	1.0	<0.1	<0.1	25.8
	24-16DB40	33	57.4	27.4	Near Elect Panel	0-15	0.4	0.5	0.4	0.7	<0.4	<0.2	<0.2	24.1
	24-16DB41	33			Near Elect Panel	15-30		0.9	0.2	1.7	<0.9	<0.2	<0.3	27.0
	24-16DB42	34	55.5	27.4	Near Elect Panel	0-15	0.4	0.4	0.4	1.0	1.0	0.1	<0.2	23.6
	24-16DB42-D	34			Lab Dup DB42	0-15			0.5		0.8	<0.1	<0.1	19.6
	24-16DB43	34			Near Elect Panel	15-30		0.8	0.5	0.5	1.1	<0.1	<0.2	25.3
	24-16DB44	35	48.0	23.5		0-15			0.5		1.0	<0.2	<0.2	22.6
	24-16DB45	35				15-30			0.4		<0.7	<0.1	<0.2	15.8
					Averages		0.4	0.7	0.4	0.8	0.8	0.2	0.2	21.5
					Standard DeV		0.1	0.2	0.2	0.4	0.3	0.0	0.1	2.9
	Samples of Natural Background, Off Site													
Not On Figure	**Corner of Lake St & Providence; NW site of aqueduct**													
	24-17DB01				Lake & Provid	0-7	0.5	0.6	0.4	1.0	<0.7	<0.1	<0.3	19.7
	24-16DB-70				Dup DB01	0-7	0.6	0.5	<0.3	1.0	<0.7	<0.2	<0.3	16.7
	24-17DB02					0-7	0.6	0.5	0.2	1.0	1.1	<0.1	<0.1	22.4
	24-17DB03					7-15	0.6	0.5	0.6	0.9	0.9	<0.1	<0.2	19.7
	Where Valencia St meets aqueduct, south side of aqueduct													
	24-17DB04				Valen&Aquad		0.5	0.6	0.3	0.9	0.9	<0.1	<0.1	19.7
	24-17DB04-D	Bkgd							0.2		1.0	<0.2	<0.2	15.8
	24-17DB05				Valen&Aquad		0.5	0.6	0.6	1.0	<1.0	<0.2	<0.2	25.5
					Averages		0.6	0.5	0.4	1.0	0.9	0.1	0.2	19.9
					Std Deviation		0.1	0.0	0.2	0.0	0.1	0.0	0.1	3.3
	Samples verifying decontamination of equipment:													
	24-15DB03								<3.0		<5.1	<1.9	<1.6	22.0
	24-09JS-9								<0.9		<1.9	<0.4	<0.5	<3.8

The sample results in Table 4-1 are grouped into categories (generally blocked in table) and tied to color codes in Figure 4-1. Table 4-1 is a summary presentation for the samples where contamination was detected and/or areas where contamination might be expected to occur. Eleven of the boreholes for samples were placed on a random basis to provide the concept of a statistical assessment as to whether contamination was present in subsurface areas other than those that had been identified. The results for these locations, Holes 9, 11, 25, 26, 29, 30, 31, 32, 33, 34, and 35 are given in Table 4-2. The data for off-site background samples, and samples of materials used to decontaminate the sampling equipment are also given in Table 4-2.

The borehole sampling identified four areas with significant subsurface contamination. These areas, identified as areas 1, 2, 3, and 4 in Table 4-1 are color coded red in Figure 4-1. In addition to the four contaminated subsurface areas identified by sampling, radiation monitoring identified the probable presence of significant subsurface contamination beneath a steel lined sump identified as Hole 28 on Figure 4-1.

The sump (Hole 28) had been filled with material and covered with a steel plate at grade, but there was visual evidence of something in the subsurface. There was not a significant radiation anomaly at the surface, but the visual anomaly (square, about 50 cm by 50 cm) was near a sewer vent pipe, and the area was investigated as part of the investigation of sewers. The sump had been filled with rubble, and housed an extensive live roach population. There were three pipes exiting the sump, but the roach population appeared to be limited to the sump. After being exterminated in April, roaches returned in August and September implying a connection with a sewer or other haven for roaches. The material in the sump was not contaminated, but the radiation anomaly in the lower southern area of the sump (about 90 cm deep) was about 5 mR/h. Samples could not be taken without destroying the sump, and the decision was made to not intrude on the area during the site characterization.

The areas with boreholes indicating subsurface contamination in Figure 4-1 are:

1. The southwest corner of the Tritium/C-14 Lab, coordinates about 21E:9N. Efforts to remediate the floor in the southwest corner (Hole 1) evolved into removing about 1 square meter of concrete and a section of the foundation extending out into the driveway on the south. The efforts for remediation

were terminated before all of the material with residual Cs-137 (based on field gamma spectra and the samples) was removed. It is not known how far the area of contamination extends under the driveway or foundation, nor whether the contamination resulted from storage of waste in this area (some historic records indicate there had been a waste storage area at this location) or from leakage from the outside.

No# Hole 8 is not specifically identified as an area of subsurface contamination. This sample was taken from under a wall plate (removed the wall) and is from the area of Hot Cell #2, the Sr-90 Hot Cell. The borehole ended on a footing and did not penetrate to soil. It is not known whether the contamination extends to the soil.

2. Samples from Holes 12 and 13 indicate Cs-137 contamination. The gamma exposure rate in Hole 12 (66,700 cpm with a 1-inch NaI) reflects higher concentrations than indicated by the sample result of 20 pCi/g. The implication is there is more concentrated contamination in adjacent soils than was collected in the sample. Hole 11, for which the result did not indicate contamination, is included in this grouping because of its proximity. This is the former area of Hot Cell #4.

3. Holes 14 and 15 are boreholes that extend into the former Co-60 Pool (i.e., this is predicated on the presumed position of the pool from the SAP). Both boreholes were hand augered to depths of refusal, when it was no longer possible to drive a PVC pipe down within the augered hole. Hole 14 was augered to a depth of about 3 meters, but it was only possible to drive the pipe to about 180 cm and gamma log the hole to 245 cm. The material in Hole 14 was relatively dry in the upper section of the hole and became moist at about 132 cm (52 inches). At about 245 cm material became sandier and drier. The pipe insertion was stopped by something that prevented driving it to greater depths, possibly a wall of the Co-60 Pool.

   Gamma logging Hole 14 indicated high localized radioactivity at 25 cm beneath the surface of the concrete extending to about 30 cm, and remaining very elevated to a depth of about 50 cm. The radioactivity is primarily Cs-137, based on field gamma spectra, and the maximum levels appear to be very localized. The maximum saturated a Ludlum 2221 with a 1-in diameter NaI Ludlum probe at 1 million counts per minute (cpm). The HPS Cypher with a 1-in NaI probe also saturated at 19 million (cpm). Instruments usually show under estimates, versus over estimates when they saturate. The measurements were made through the wall of a 4-inch diameter PVC (schedule 40) pipe. The source seemed to be so localized, that the position of the detector in the pipe affected the measurement. Assessments were also made using a HPS dosimeter with a 200 keV threshold (above 200 keV) and a G.M. pancake detector (using the back of the detector provides a significant reduction in the low photon energy response). Using these the detectors the following estimates of exposure rates are obtained:

Detector	Comment	Energy (keV)	Exposure (mrem/hr)
Cypher NaI	Saturated	>60 kev	About 200 or higher
HPS Dosimeter		>200 kev	6
G.M. Pancake		Low Energy cutoff	5

Field gamma spectra taken in the hole also showed an unusually high low energy component.

The gamma borehole results show a much higher quantity of Cs-137 than is reflected in the sample results. Although the samples show relatively high concentrations of Cs-137, the borehole logging assessments indicated the primary source of contamination was off to the side of the borehole.

The samples and gamma borehole logs from Hole 15 verify the presence of Cs-137, but in smaller quantities than indicated for Hole 14.

4. Holes 16-19, at the east end of the Shop are in the area of former Hot Cell #5, which apparently had subsurface tubes for storing sources. The contamination in these holes is essentially all from Cs-137, with possible traces from Co-60. The results from gamma logging of these holes are reflected by the analytical Cs-137 results. The high Cs-137 concentrations in the holes near the wall indicate the possibility of contamination in or under the foundation of the building.

5. The area of the electric panels, Holes 32-34, is specifically addressed because of the assessments by the NRC and RHB during the initial assessments. A sample of concrete from this area was found to contain elevated concentrations of Th-232, uranium, and Th-230. Much of this area was scabbled before placing the boreholes listed in Table 4-1. There appears to be no subsurface contamination in this area.

H#28 Not sampled, but the location is highlighted because of the indication of subsurface contamination based on radiation measurements in the sump.

6. There are considerable elevations in the gamma exposure rate around the concrete slab located to the northeast of the rear door of the Shop. Field gamma spectra measurements identified the presence of Th-232 (decay products) and Cs-137. The analytical results show elevated concentrations of Th-232, uranium, and Cs-137; and most notably highly elevated concentrations of Th-230. Th-230 is primarily an alpha emitter, with essentially no gamma or beta emissions, and hence is difficult to detect by field monitoring. The samples are from small areas near the edge of the slab. Contamination may extend to greater depths and under the pad.

   The combination of the Th-232 and U-238 equal about 0.5 percent by weight or about 10 times the regulatory threshold definition of source material (0.05 percent, 10 CFR 40).

Holes 53 and 54 are holes dug through the asphalt to assess the depth distribution of contamination. Hole 53 was a small chip (about 100 grams) from an area of high beta contamination. Hole 54 is from a location where the contamination extended down through the asphalt and appears to be in the soil under the asphalt. This hole is discussed in Section 4.2.

The results for samples from the other boreholes in the shop generally indicate natural background concentrations of radionuclides, with minimal impact of residuals from the former facility operations. The results for these samples are given in Table 4-2. The boreholes are grouped according to several areas of the site, to assist in visually relating the results to areas.

The results for 11 boreholes, basically positioned on a random basis, are given in Table 4-2. These holes were positioned in areas where there was not definitive contamination on the floor, and outside of the areas of primary concern in the former Hot Cells or the Co-60 Pool. The results of all of these samples generally reflect natural background concentrations of radionuclides. The average and standard deviation of the results is given at the bottom of the tabulation of these results.

The results for background samples from the two off-site background locations are also given in Table 4-2. The average and standard deviation for these results are given at the bottom of the tabulation.

The analytical results for two sets of sample decontamination materials are given in Table 4-2. These samples were composed of dry and moist paper towels used to decontaminate the sampling equipment. Water was not used for decontamination of sampling equipment so that there would not be liquid effluents or liquid radioactive waste. These samples indicate reasonable decontamination of the equipment with the dry/moist technique.

4.2 ASSESSMENT OF THE ASPHALT AND PROFILE OF CONTAMINATION

The gamma survey results given in Chapter 3 indicate extensive contamination of the asphalt to the rear of the Shop and in the driveway to the south. Assessments were performed

to evaluate the surface distribution of the contamination, the depth profile of the contamination, and the possible options for decontamination. In part, the efforts focused on determining whether the contamination was on the surface, where it could possibly be relatively easily removed, or whether it extended into the asphalt and the soil underneath. Sections 4.2.1 and 4.2.3 provide the results of several case studies.

4.2.1 Surface Distribution of Contamination on the Asphalt in the Rear Lot

Detailed gamma surveys, using a 1-inch NaI detector were performed to evaluate the distribution of the contamination in the area behind the Shop and to the north. Detailed surveys (time efforts of about 5 minutes per 1-m by 1-m grids) indicated that much of the contamination was in the cracks of the asphalt. The exposure rate for the unbroken (uncracked) surface was at times near background, but localized elevations in most of the cracks were greater than twice background, due to contamination in very small areas. The asphalt in this area was very cracked (apparently due to age), and most of the cracks exhibited these localized areas of contamination. The un-named bay to the west of Bay A had similar features. Most of these areas were contaminated with Cs-137, based on field gamma spectra, but the area near the concrete slab (71E:31N) also contains elevated levels of Th-232 and probably Th-230. The excavated areas were filled with concrete to return the surfaces to grade and prevent ponding/infiltration of precipitation.

4.2.2 Area in NE Corner of Site, West of Bay A

Three areas of asphalt on the northeastern part of the Site near Bay A exhibited elevated gamma readings and were investigated. The first area, slightly smaller than 1 m^2, was located at grid 100E:58N, and was about 7 uR/hr above background. The asphalt appeared to be in relatively good condition, but not particularly new. The apparent age may be misleading due to the fact that this area is covered by an overhang from Bay A. Using an electrically powered chipping hammer, about 0.5 cm of asphalt was removed. The grid was then re-surveyed and the gamma readings decreased only slightly. After complete removal

of the 6-7 cm asphalt layer the exposure rate was at background. A survey with a G.M. Pancake for beta contamination also indicated background.

The second area was about 2 m^2 in size and was located at about 93E:60N. The chipping hammer was used to remove a thin layer of asphalt and the area was re-surveyed. The gamma radiation readings were higher after the chipping. Upon further chipping it was determined that a second layer of asphalt existed under the first layer, and it appeared that the excavated hole was at the edge of the lower asphalt layer (see Figure 4-2). Based upon several iterations of chipping, digging, and surveying, it appeared that the contamination was in the lower layer of asphalt, also in the surrounding soil, and possibly beneath the lower layer of asphalt. The upper layer of asphalt appeared to be at background using a gamma probe, but some contamination was observed on the bottom surface of the upper layer when surveyed with a G.M. pancake beta probe. This contamination may have been due to its contact with the contaminated lower layer. The upper layer of asphalt appeared to be fairly new (dark-colored) and was reasonably soft and pliable. The lower layer appeared to be much older (lighter-colored) and was relatively hard and brittle. Decontamination was not completed, so the asphalt pieces were replaced into the excavated area and it was sealed to grade with concrete.

The third area was several square meters in size and was located in and around grid 96E:50N. The area is covered by an outdoor bay, open at both ends, which is attached to Bay A on the west side, near the roll-up door. This area exhibited two spots which were several times background. Further detailed surveys indicated that the contamination around these spots was fairly pervasive and appeared to be located in the cracks of the asphalt. Further investigation of this area was limited to one small spot near the northern wall of the outdoor bay, within grid 53N and 97E. Using hand tools, about one square foot of asphalt was removed. There was only one layer of asphalt and the contamination appeared to be located at the interface of the asphalt and the underlying soil. After removal of the crumbled asphalt and a small amount of soil, the area was remediated to less than twice background.

4.2.3 Case Studies of Contaminated Asphalt in Center of Rear Lot

Two asphalt areas located in about the middle of the back parking lot, exhibited elevated gamma readings. These areas were chosen for further study because they appeared to be relatively isolated hot spots.

The one area was at grid 88E:41N. Using hand tools and the chipping hammer, a thin layer of asphalt was removed. Upon re-survey, the gamma reading was higher. Further asphalt removal, about 0.3 sq meters overall, revealed that their were actually two layers of asphalt. The bottom layer of asphalt appeared to be contaminated along with the underlying soil, while the top layer appeared to be clean. This area was not remediated and the area was backfilled with concrete.

The second area was near the entrance to a below-grade concrete loading dock. The loading dock was about 3.5 meters wide and extended from about 76E, sloping below-grade toward the west, ending butted up against the building. The low area is about 1.5 meters below grade and was full of water. According to the building owner, the loading dock was installed after the use of radioactive materials had ceased at the site. The gamma surveys indicated residual contamination in the joints and area surrounding the loading dock. The asphalt in this area of the parking lot appears to be well-aged with a lot of cracks. The cracks in two areas were investigated, one in front of the entrance (80E:24N) to the loading dock and one on the side (75E:28N). A thin layer of asphalt was removed, along the axis of a crack at both locations. The areas were then re-surveyed and the contamination appeared to be further down in the cracks. Removal of the asphalt by layers was difficult because it was fairly hard and brittle. Further investigation revealed in both cases only one layer of asphalt, about 3 inches thick, which was underlain by soil. The contamination appeared to be located very deep within the asphalt, possibly at the interface with the soil. In addition, the contamination extended perpendicularly away from the axis of the crack. Neither spot was remediated and subsequently both were backfilled to grade with concrete.

4.3 ANALYTICAL RESULTS FROM SR-90 SAMPLES

The results from samples analyzed for Sr-90 are given in Table 4-3 and the sampling locations are shown in Figure 4-2. The selection of sample locations was oriented to the former Sr-90 Hot Cell area and areas where it was perceived there may be Sr-90 contamination. For example, several samples from the boreholes in the area of the former Co-60 pool were analyzed incase material with Sr-90 contamination was used to backfill this area.

The two samples from the area of the former Sr-90 Hot Cell (see Table 4-3 and Figure 4-2) were the only samples with concentrations of 1 pCi/g or greater. The sample from Location #8 (see Figure 4-2), related to the area of the former Hot Cell had a concentration of 3 pCi/g. The background samples (Table 4-3) all have concentrations well below 1 pCi/g, indicating a low level of residual Sr-90 at several of the locations in the Shop, and possibly a very low level residual in the sample of asphalt from the rear lot.

The concentrations of Sr-90 in samples at all of the locations (Table 4-3) are well below the Interim DCGL of 5 pCi/g.

4.4 RESULTS FOR TRITIUM AND C-14

The result of samples analyses for tritium and C-14 are given in Table 4-4. The locations where samples were collected are indicated in Figure 4-3. There was no indication of significant residual contamination from C-14 or tritium.

4.5 ASSESSMENTS OF SEWERS

Table 4-5 lists the sewer connections that were investigated and Figure 4-4 shows the locations of the connections. The assessments included excavating two floor sumps that had

Table 4-3. Sr-90 analytical results.

Sample ID	Borehole #	Location	Sr-90 (pCi/g)	Error Term (pCi/g)
08DB05	01	C-14 Lab SW corner	0.37	0.09
09JS05	04 0-15 cm	Central area of Shop	0.03	0.15
09JS03	07 0-15 cm	Southcentral shop	1.06	0.12
16DB62	07 0-15 cm	Dup of 09JS03	0.80	0.11
16DB63	07 15-30 cm	Southcentral shop	0.08	0.13
16DB18	08	Hot Cell Area	3.12	0.16
07KN01	14 20-25 cm	Co-60 Pool	0.03	0.13
07KN02	14 25-45 cm	Co-60 Pool	0.01	0.11
16DB64	14 45 cm	Co-60 Pool	0.00	0.12
15DB04	15 10-20 cm	Co-60 Pool	0.02	0.12
15DB05	15 60-75 cm	Co-60 Pool	0.07	0.13
15DB06	15 75-85 cm	Co-60 Pool	0.00	0.12
16DB05	19 15-30 cm	East end of Shop	0.17	0.12
08DB03	51 Concrete Pd	Rear Lot	0.01	0.13
08DB04	53	Asphalt, rear lot	0.34	0.08
17DB01	Background	Providencia	0.01	0.07
17DB02	Background	Providencia	0.00	4.08
17DB03	Background	Providencia	0.00	0.12
17DB04	Background	Valencia	0.00	0.25

Values denoted as 0.00 pCi/g were reported as slightly below zero (best estimate).

16DB70	Background	Providencia & Lake	0.00	0.12

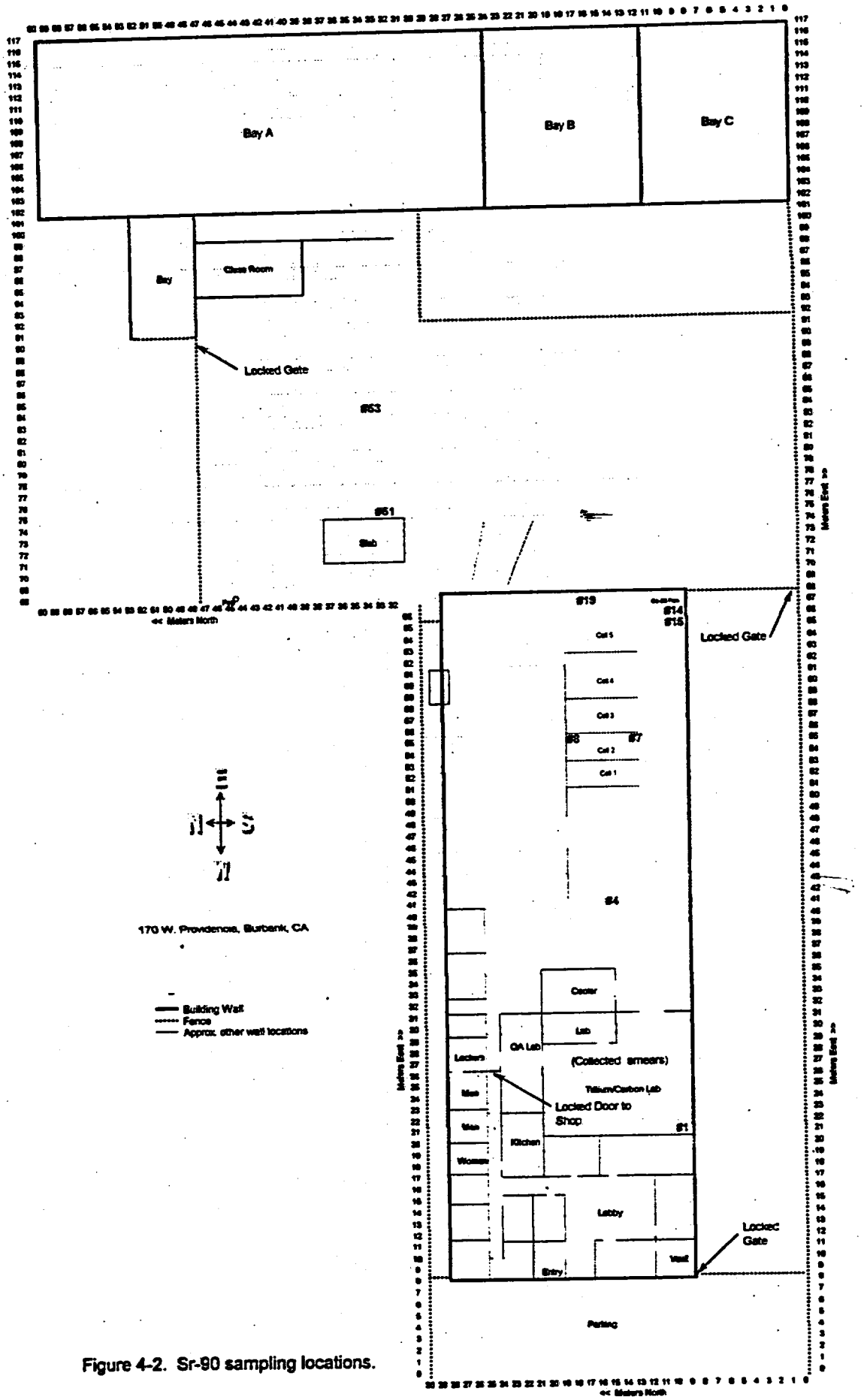

Figure 4-2. Sr-90 sampling locations.

FinalSewers.xls

FinalField sept tom sewer.xls

Table 4-5. Sewer connections that were assessed and checked for contamination.

20-Jul

No.	Basic Location	Coodinates East	Coodinates North	Date	Book	Contaminant	Indication of Sewer Contam.	Comment
1	Shop, N of Hot Labs	60.2	19.5	14-Apr	DEB#5	Cs-137	No explicit link	Lined sump, has connection to near by sewer vent line. Had been backfilled and covered over. High density of roach population. Sump about 50 cm x 50 cm; 90 cm deep. Three pipes going southerly. Source of radiation exposure is outside of sump. About 2 mR/hr.
	Vent connect near above						Background	
2	Bay B, near door	103	24	3/30&31	DEB#5	Thorium	Appears not to extend to sewer.	Area previously identified as one of highest exposure rates by NRC and Calif. RHB surveys. Pre-decontamination exposure rate 350,000 cpm; about 2 mR/hr Excavation indicated it was a floor sump filled with granuler material. After decontamination appears there is no contamination in sewer.
3	NW area of Shop	45.5	27.7	9-Apr	DEB#5	Cs-137	Probably not	Former sump, filled with "plaster of paris or groute," minor gamma elevation. Initial contam. 3600 cpm, after removal of 15 cm of material 6341 cpm (Instr # #3). After removal of material, box 9,000 cpm, drain pipe appears not to be contam.
4	Bay A	30	103				Background	Plugged drain in floor (4-in), just inside of mandoor. Plug seemed to be leaded or solderer in, removed.
5	Men's Locker Rm	28	25	15-Apr	DEB#5	no	Background	Removed toilet to obtain viable access to sewer. Inserted probe about 20 ft. Indicated should have reached main sewer line.
	Men's Locker Rm							
6		23.5	25.8				Inadequate det.	Removed plug from cleanout near sinks. But, material that had been stuffed in pipe prior to placing plug prevented access.
7	Men's Locker Rm	26	25				Inadequate det.	Drain in floor, aligns with toilet drains.
8	Hall in Office	23	25				No indication	Floor drain in hall to shop in office, outside of "Mens Room." Trap prevented access to sewer line.
9	Shop floor, NE area	60	23	14-Apr	DEB#5,p23	Cs-137	Minor indication	Floor drain in shop area, former RCC Area. At 3-ft of entry; exposure increased from 3,400 cpm at surface to 10,000 cpm (Cypher 1-in NaI). Could only get small 1/2-inch detector in about 2 ft.
10	Unitility Room	30	28.5	8-Apr	DEB#5		Background	Utility Room; N of hall, had some type of floor drain
11	Unitility Room	30	28	9-Apr			Background	Sewer connection on side of wall, vent line, plugged.
12	Unitility Room	30	28.5					Sewer connection on side of wall, 4-in metal plug.
	W of Training Room			Multiple connections				Behind temporary building used by Girard for Training, west of Bay A
		100	40-45					Open drains, plugged drains, and vent pipes Appears to Riser for Sewer Vent
		68	28				Riser and drain near NE corner of building.	

Table 4-4. Tritium and C-14 analytical results.

RAE Sample No.	Hole No.	Grid Location East	Grid Location North	Depth (Cm)	Area	C-14 pCi/g or per sample for smears Sample	C-14 Error ±	C-14 mdc	H-3 pCi/g or per sample for smears Sample	H-3 Error ±	H-3 mdc f
24-09DB11	Smears in C-14 Lab				C-14 Lab	4	12	20	7	13	22
24-09DB10	Smears in C-14 Lab				C-14 Lab	-16	12	20	4	13	22
24-19DB20	Smears of Hoods in C-14 Lab				Lab Hoods	-4	12	20	10	13	22
24-08DB05	1	21.0	9.0	0-15	C-14 Lab SW Corner	6.2	5.6	9			
24-17KN1	2	24.4	9.8	0-15	C-14 Lab	4	5.2	8.6			
24-09JS-7	3	41.5	10.7	0-15		1.4	5.2	8.7			
24-09JS-5	4	41.0	15.0	0-15		-0.6	5.1	8.5			
24-07KN01	14	66.0	10.0	20-26	Co-60 Pool	1.3	5.3	8.8	0	0.05	0.08
24-07KN02	14	66.0	10.0	26-45	Co-60 Pool	0.9	5.1	8.6	0.02	0.04	0.07
24-16DB64	14	66.0	10.0	26-45	Dup KN02	3.7	5.3	8.7			
24-16DB64	14	66.0	10.0	26-45	Lab Dup KNO2	2.8	5.2	8.6	0.02	0.04	0.07
24-15DB04	15	66.9	10.8	10-20	Co-60 Pool	-1.2	5.1	8.6			
24-15DB05	15	66.9	10.8	60-76	Co-60 Pool	0.05	5.2	8.6			
24-15DB06	15	66.9	10.8	76-86	Co-60 Pool	1.5	5.3	8.8	-0.01	0.06	0.1

Blanks indicate analysis was not performed.
Minus values are indicative of concentrations near zero and statistical variability.

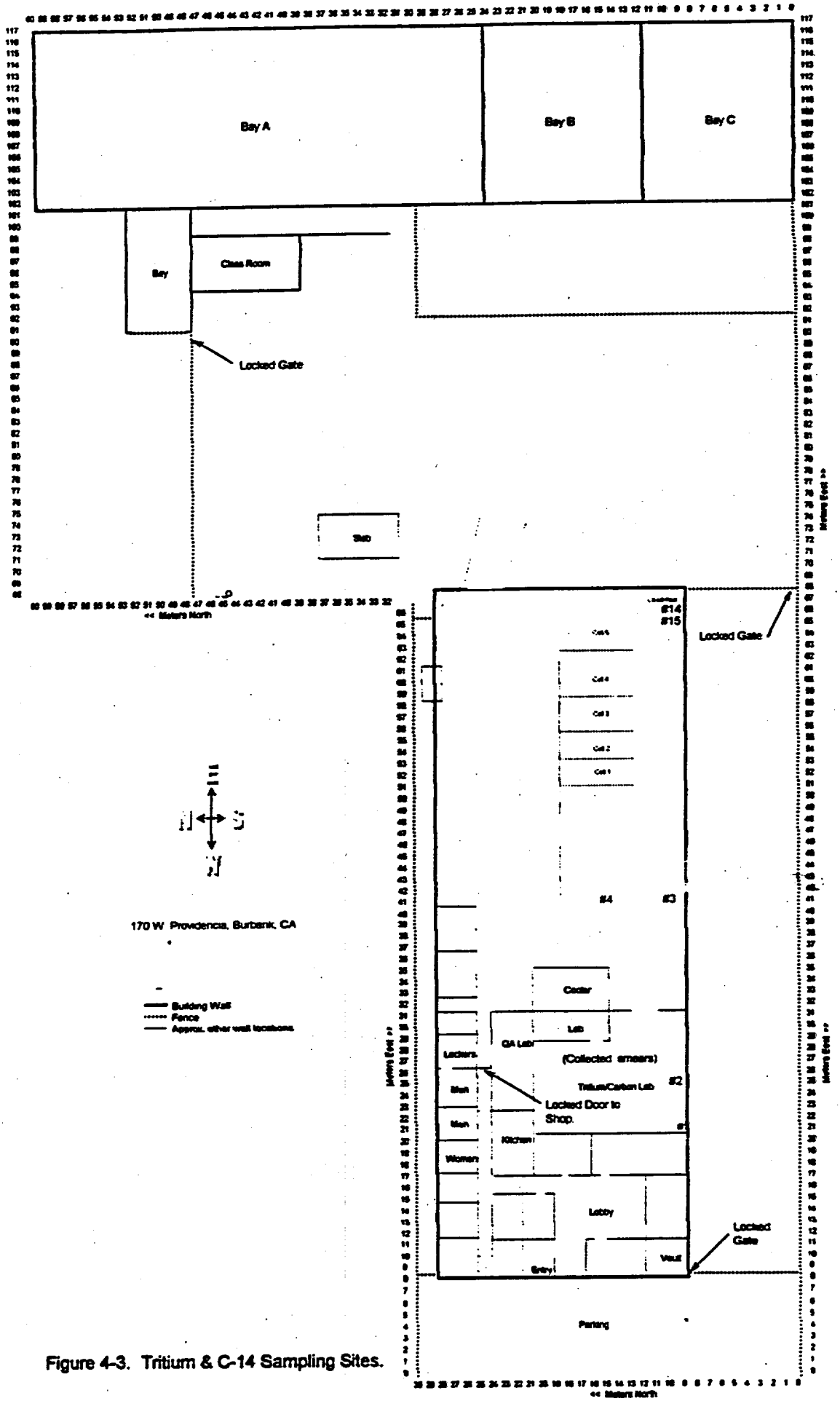

Figure 4-3. Tritium & C-14 Sampling Sites.

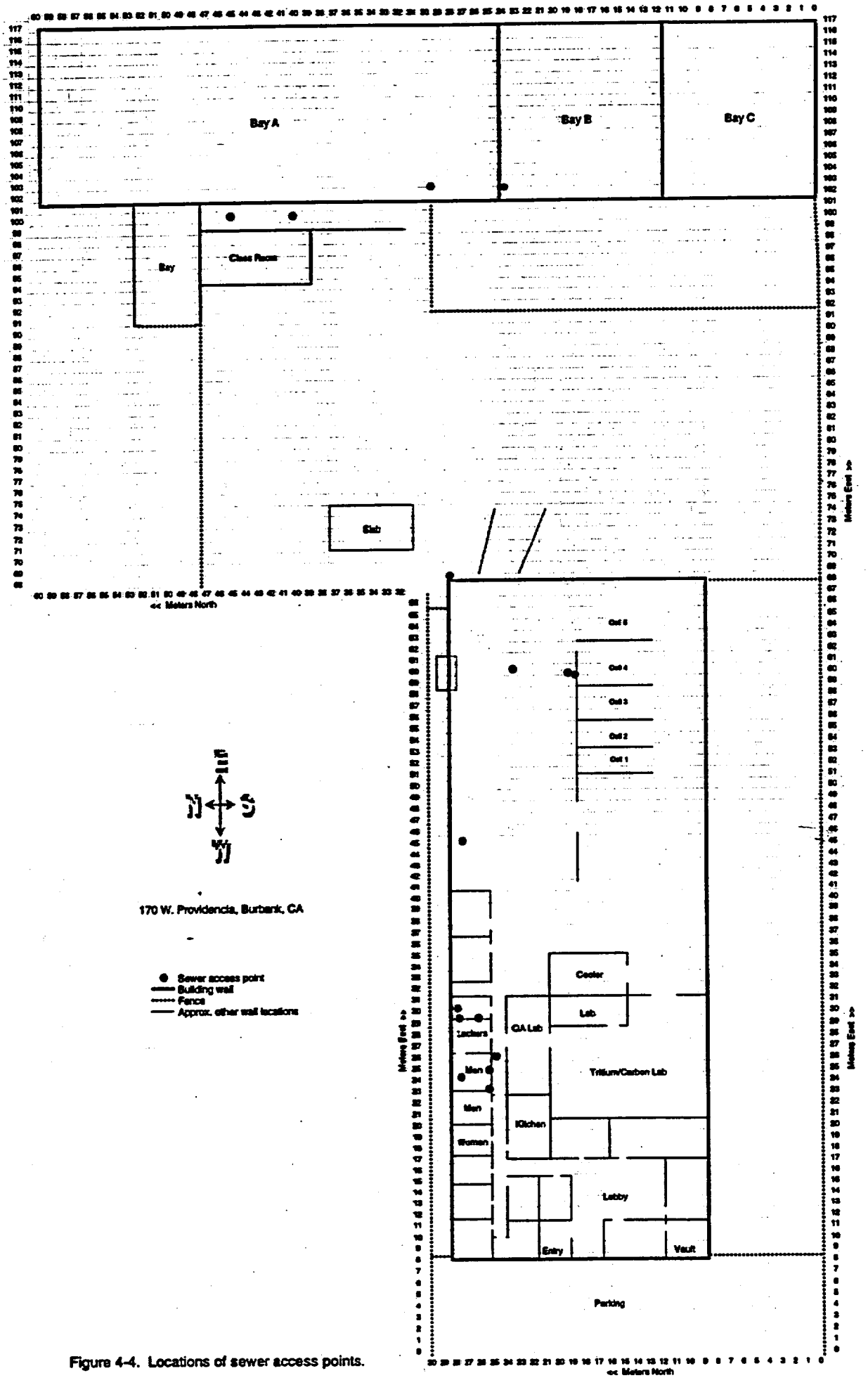

Figure 4-4. Locations of sewer access points.

been filled and sealed, removing a toilet and providing access to the sewer through the toilet connection, and checking many floor drains and vent pipes.

Essentially the only place that good access was attained was through the toilet connection in the men' locker room (grid 25E:27N). Due to traps in the other connections, survey instruments could not be inserted beyond the traps. The only definitive indication of contamination was a measurement of about three times background at about 80 cm into a floor drain in the central area of the northeast quadrant of the Shop (about 60E:23N), indicated to be Cs-137 (field gamma spectrometry). Additional access at this location was not attained. The measurement of 10,000 cpm was about 28 uR/hr above the surface background. The contamination may be from floor washing versus significant contamination due to discharges to the sewer.

In summary, sufficient access to the sewer was not obtained to make definitive measurements to determine whether there is significant contamination in the sewer.

4.6 MEASUREMENTS OF NATURAL BACKGROUND

Natural background is dependent on the materials where measurements are made and the intended application of the measurements. The primary external gamma background values used for the site characterization were taken in front of the facility at grid 04E:19N. Field gamma spectra taken at this location verified that there was not residual Cs-137 or other gamma emitters from the former licensed operations present or impacting the measurements at this location. Off-site gamma background measurements were made in the building to the north of the Site and at locations about one-half block to the southwest and one-half mile to the south. Soil samples for measurements of background were also obtained at these last two off-site locations. The radionuclide concentrations in the samples are given in Table 4-2. These data reflect normal background concentrations.

5. ASSESSMENTS TO SUPPORT USE OF MARSSIM FOR FINAL CLOSEOUT SURVEY

This chapter provides information to support preparation of the final radiation survey for unrestricted use of the Site, based on the concepts of MARSSIM (MARSSIM 1998). Information on the revised classification of areas is provided and appropriate statistical parameters for guidance in developing the final radiation survey for unrestricted use are given. Because of the present extent of contamination on the site it is hard to develop extensive statistical parameter for use in the final survey. The basic parameters presented are for external gamma measurements of natural background ~~and~~ the statistical distributions for concentrations of radionuclides in soil. The statistical distributions are "interim, work in progress" information and may be refined as additional analytical results are obtained and/or based on additional analysis of the existing data.

5.1 CLASSIFICATION OF AREAS: BASED ON MARSSIM IMPACT CLASSES

Figure 5-1 provides the revised classifications for the Site, based on the MARSSIM classifications of impact. The MARSSIM impact classifications are:

Class 1:	Areas of known impact that will probably require decontamination to meet the DCGLs–Derived Concentration Guideline Levels.
Class 2:	Areas of probable impact, but not expected to exceed the DCGLs.
Class 3:	Areas that were impacted, but which have a low probability of containing residual contamination above a low fraction of the DCGLs.
Non-impacted	Areas not impacted by operations.

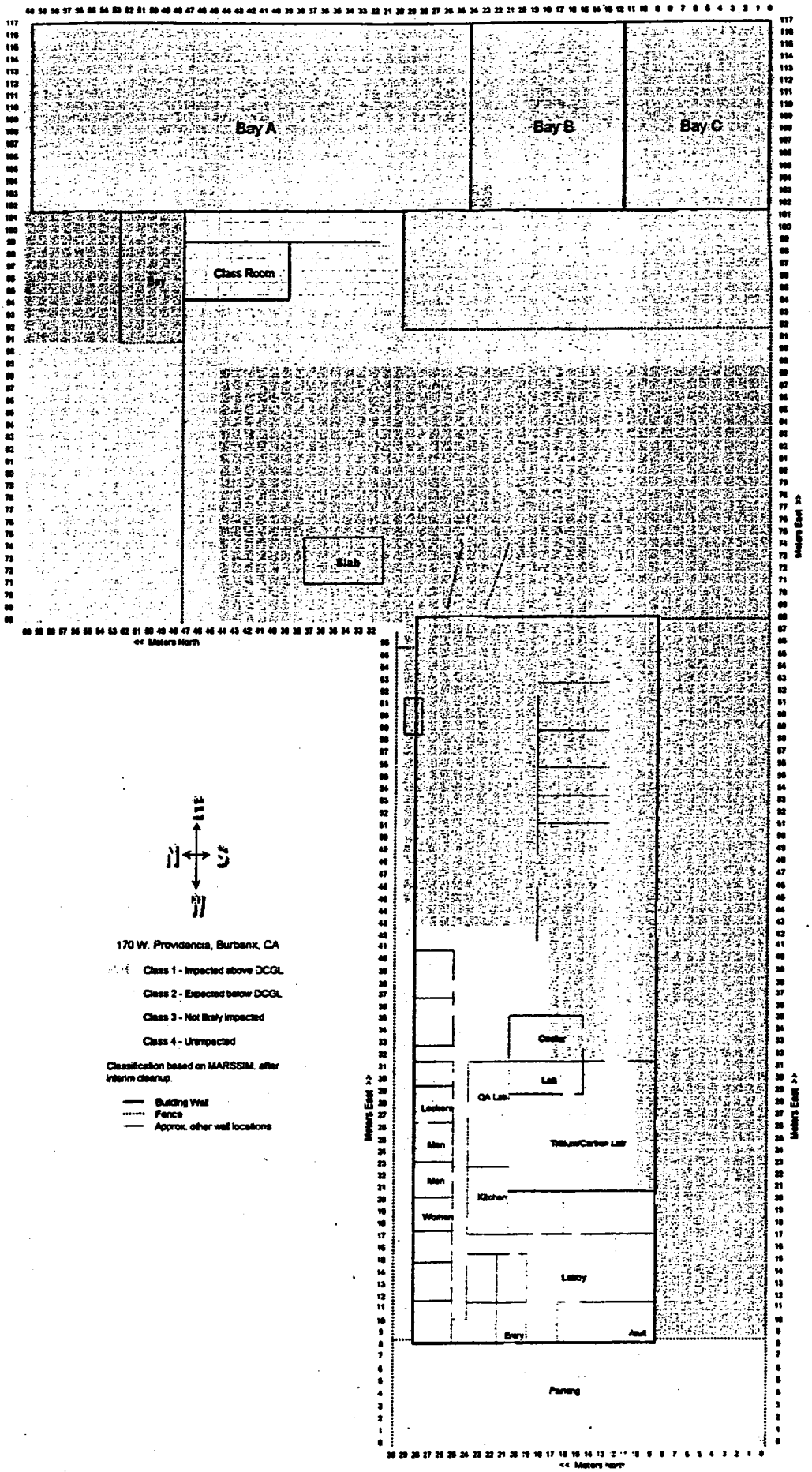

Figure 5-1. Classification of Impact of Areas.

Table 5-1 provides detailed information that supplements the classifications in Figure 5-1. The classifications are similar to the SAP (Bernhardt 1999), with the primary exceptions being identification of contamination from past operations in the northeast area of the site, contamination in the storm catch basin on the southwest corner of the site, localized contamination in the roof of the shop and east wall of the shop, and contamination in the subsurface (Cs-137) of the southwest corner of the former C-14 and Tritium Laboratory. The Class 1 area in Bay B has been extensively reduced.

5.2 INTERIM STATISTICAL ASSESSMENTS OF DATA FOR APPLICATION TO DEVELOPMENT OF CLOSEOUT SURVEY

Information on the statistical distribution of natural background external gamma measurements and concentrations of radionuclides in soil, based on the information from this site characterization, are given in Table 5-2. Table 5-3 provides the results of the soil samples used to develop this data. The external gamma measurements are given in Appendix B.

The averages and standard deviations for some of the radionuclides in Table 5-2 have limited usefulness, since many of the analytical results were below the detection limit.

The standard deviations for the external gamma measurements yield a coefficient of variation of 4 to 8 percent, with an average of about 5 percent.

Table 5-1. Selected areas of concern

Class Number	Identification of Area and Locations
1 Pink	Eastern Area of Shop Refrigerator room in Area of Shop Southern section of former C-14 Tritium Lab Bay B, area of former sealed sump, NW corner of bay. Storm water catch basin, SW corner of Site Walls and Ceilings: – Grid on roof, purlin re former vent; 63E:18N – East wall of Shop, section near window Western portion of rear asphalt area and northeast section; includes "un-named bay west of Bay A Driveway on south, east of locked gate at front of site. Eastern end of corridor on north of main building.
2 Yellow	Area by Training Room, back by bays. Section of shop area excluding northwest portion. Northwest portion of shop
3 Green	Eastern portion of rear parking lot Western end of corridor located to the north of the building Locker room and mens bathroom, northwest end of Shop Area. Remaining Bay areas in Bay B, A, and C & section of asphalt. Former C-14 and Tritium lab-B; excluding Class 1 area. Walls and ceiling of shop area, and roof including roof over office areal other than Class 1 areas.
Non-impacted	Office space Front parking lot

Table 5-1 Marssim class.wpd

Table 5-2. Interim summary of statistical parameters of data for natural background

Type of Data	Description of Data	Number of Values	Units	Measurement or Nuclide	Average	Std Dev.	Coefficient of Variation (Percent)
Soil Samples							
	Random samples, Shop	26 samples					
		11 locations					
	Actual Analysis with detectable values						
		3	pCi/g	U-238	0.4	0.1	23
		6	pCi/g	Th-230	0.7	0.2	35
		25	pCi/g	Ra-226	0.4	0.2	38
		6	pCi/g	Th-232	0.8	0.4	49
		10	pCi/g	Ra-228	0.8	0.3	31
		1	pCi/g	K-40	22	3.0	14
		1	pCi/g	Cs-137	0.2	0.1	22
			pCi/g	Co-60	0.2	0.1	29
	Samples from off-site area	7 samples					
		2 locations					
	Actual Analysis with detectable values						
		6	pCi/g	U-238	0.6	0.1	19
		6	pCi/g	Th-230	0.5	0.1	8
		6	pCi/g	Ra-226	0.4	0.2	44
		6	pCi/g	Th-232	1.0	0.1	4
		4	pCi/g	Ra-228	0.9	0.1	16
		78	pCi/g	K-40	20	3.0	16
		0	pCi/g	Cs-137	0.1	0.1	29
		0	pCi/g	Co-60	0.2	0.1	33
External Gamma Background							
Different Instruments Used at Some Locations			1-inch NaI Detector				
	Site near catch basin						
	Two instruments	18	counts/min	Ext Gamma	2608	92	4
	Std Site Location @ NW						
	Ave Instr #1	15	counts/min	Ext Gamma	2495	104	4
	Ave Instr #2-4	36	counts/min	Ext Gamma	2483	108	4
	Ave all instrument	51	counts/min	Ext Gamma	2460	168	7
	Off-site 156 Providencia	5	counts/min	Ext Gamma	2491	102	4
	Off-site Sample Locations	6	counts/min	Ext Gamma	2125	165	8
			Overall Averages		2444	123	5

Table 5-3. Samples used to calculate standard deviations of concentrations.

lab ID	Sample No.	Hole No.	Location For Samples & Grid E Gd#	N Gd#	Area	Sampling Depth (cm)	U-238 pCi/g	Th-230 pCi/g	Ra-226 pCi/g	Th-232 pCi/g	Ra-228 pCi/g	Cs-137 pCi/g	Co-60 pCi/g	K-40 pCi/g
	Borings Placed As Random Sam Includes repeat of some samples from above areas.													
99-04-226-49	24-16DB14	9	57.4	18.5	Hot Cell #3	0-15			0.2		< 0.6	< 0.1	< 0.3	22
99-04-226-50	24-16DB15	9			Hot Cell #3	15-30			0.6		< 0.6	< 0.2	< 0.2	22
99-04-226-01	24-16DB17	11	59.3	18.3	Hot Cell #4	0-15			0.5		< 0.4	< 0.1	< 0.1	20
99-04-226-51	24-16DB16	11				15-30			0.5		< 0.8	< 0.3	< 0.2	24
99-04-226-11	24-16DB27	25	63.6	19.7	shop	0-15			0.2		1.6	< 0.2	< 0.2	26
99-04-226-12	24-16DB28	25	63.6	19.7	shop	15-30			0.4		< 0.8	< 0.2	< 0.2	23
99-04-226-D2	24-16DB28-D	25			Lab Dup DB28	15-30			0.5		< 0.9	< 0.2	< 0.2	19
99-04-226-09	24-16DB25	26	61.4	19.5	shop	0-15			0.3		< 0.6	< 0.2	< 0.2	19
99-04-226-10	24-16DB26	26			shop	15-30								
99-04-226-05	24-16DB21	29	59.5	19.5	shop	0-15			0.6		< 0.6	< 0.2	< 0.2	23
99-04-226-06	24-16DB22	29			shop	15-30			0.3		1.0	< 0.2	< 0.2	18
99-04-226-03	24-16DB19	30	57.6	19.3	shop	0-15			0.2		< 0.5	< 0.1	< 0.3	20
99-04-226-D1	24-16DB19-D	30			Lab Dup DB19	0-15			0.1		< 0.6	< 0.2	< 0.1	18
99-04-226-04	24-16DB20	30			shop	15-30			0.5		1.1	< 0.1	< 0.1	17
99-04-226-47	24-16DB12	31	55.2	19.4	shop	0-15			0.4		1.3	< 0.2	< 0.2	23
99-04-226-49	24-16DB13	31				15-30			0.7		< 0.7	< 0.2	< 0.2	20
99-04-226-D5	24-16DB13-D	31	55.2	19.4	Lab Dup DB13	15-30			0.6		0.8	< 0.1	< 0.1	19
99-04-226-22	24-16DB38	32	59.6	27.3	Near Elect Panel	0-15	0.3	0.4	0.4	0.9	< 0.8	< 0.1	< 0.2	23
99-04-226-23	24-16DB39	32			Near Elect Panel	15-30		1.0	0.2	0.4	1.0	< 0.1	< 0.1	26
99-04-226-24	24-16DB40	33	57.4	27.4	Near Elect Panel	0-15	0.4	0.5	0.4	0.7	< 0.4	< 0.2	< 0.2	24
99-04-226-25	24-16DB41	33			Near Elect Panel	15-30		0.9	0.2	1.7	< 0.9	< 0.2	< 0.3	27
99-04-226-26	24-16DB42	34	55.5	27.4	Near Elect Panel	0-15	0.4	0.4	0.4	1.0	1.0	0.1	< 0.2	24
99-04-226-D3	24-16DB42-D	34			Lab Dup DB42	0-15			0.5		0.8	< 0.1	< 0.1	20
99-04-226-27	24-16DB43	34			Near Elect Panel	15-30		0.8	0.5	0.5	1.1	< 0.1	< 0.2	25
99-04-226-28	24-16DB44	35	48.0	23.5		0-15			0.5		1.0	< 0.2	< 0.2	23
99-04-226-29	24-16DB45	35				15-30			0.4		< 0.7	< 0.1	< 0.2	16
					Averages		0.4	0.7	0.4	0.8	0.8	0.2	0.2	22
					Standard DeV		0.1	0.2	0.2	0.4	0.3	0.0	0.1	3
					Coeff of Variation as %		23	35	38	49	31	22	29	14
					Less than values excluded from calculations of average, etc.									
	Samples of Natural Background, Off Site													
	Corner of Lake St & Providencia; NW site of aquaduct													
99-04-226-79	24-17DB01				Lake & Provid	0-7	0.5	0.6	0.4	1.0	< 0.7	< 0.1	< 0.3	20
99-04-226-67	24-16DB-70				Dup DB01	0-7	0.6	0.5	< 0.3	1.0	< 0.7	< 0.2	< 0.3	17
99-04-226-80	24-17DB02					0-7	0.6	0.5	0.2	1.0	1.1	< 0.1	< 0.1	22
99-04-226-81	24-17DB03					7-15	0.8	0.5	0.6	0.9	0.9	< 0.1	< 0.2	20
	Where Vaalencia St meets aquaduct, south side of aquaduct													
99-04-226-82	24-17DB04				Valen&Aquad		0.5	0.6	0.3	0.9	0.9	< 0.1	< 0.1	20
99-04-226-D9	24-17DB04-D	Bkgd							0.2		1.0	< 0.2	< 0.2	16
99-04-226-83	24-17DB05				Valen&Aquad		0.5	0.6	0.6	1.0	< 1.0	< 0.2	< 0.2	26
					Averages		0.6	0.5	0.4	1.0	0.9	0.1	0.2	20
					Std Deviation		0.1	0.0	0.2	0.0	0.1	0.0	0.1	3
					Coeff of Variation as %		19	8	44	4	16	29	33	16
					Less than values excluded from calculations of average, etc.									

6. SUMMARY AND CONCLUSIONS

Isotope Specialties Company (IS) manufactured radioactive sealed sources and tracing materials (used in pharmaceutical applications) during the 1950's and early 1960's, in Burbank, California, at 170 West Providencia (denoted as "Site") under a radioactive materials license. Research Chemicals Corporation (RBC) also performed operations at the Site, using thorium/rare earth ores, apparently under a separate license. There were several name changes and changes in corporate identity and ownership during the operations at the site.

The Site has subsequently been used by the present property owner (Joseph Thomson) and leased to others for commercial/industrial operations. Part of the site is vacant; however the rear area is used as an impound lot for Burbank, the front area is rented to adjoining properties for parking, and a tenant/proposed owner uses some of the front offices. The lease for the impound lot was apparently terminated in September 1999, after the site characterization was performed.

In the mid 1990's the U.S. Nuclear Regulatory Agency (NRC) initiated a program to review former sites where radioactive licensing activities had been terminated. Based on the review of the license and records for termination of license for the site, NRC performed a site inspection. The NRC site inspection identified several areas throughout the Site which contain elevated gamma radiation levels. The California Department of Health Services, Radiologic Health Branch (California RHB) participated in the inspection. Based on the inspector's findings, it was concluded that the Site contains radioactive contamination above the NRC's current residual radioactivity criteria for release of such facilities for unrestricted use, and that additional decontamination is necessary.

A Sampling and Analysis Plan (SAP), supplemented in response to requests from the California Radiologic Health Branch (RHB) (Bernhardt 1998, Bernhardt 1999), was prepared to characterize the Site. This site characterization report provides results from implementing the SAP. The RHB required that the SAP be performed under a radioactive materials license,

and. Surface Technology Systems Inc. (STS), a member of the Rogers and Associates Engineering Team for the site characterization, provided the license. The site characterization was performed during March 29 through April 17, 1999. Due to the contamination of radioactivity found on the site, RHB requested that the Site be kept under license and that access to contaminated areas of the Site be controlled. The STS license has been kept active at the site and periodic visits are made to the site to ensure controls are being properly maintained.

Implementation of the SAP included extensive sampling and analysis of samples, comprehensive radiation survey of the site, and performing special investigations to more completely characterize the presence of residual contamination at the Site. The results from the site investigation indicate that residual contamination on the surface and at several subsurface locations exceeds the Interim DCGLs (see Chapter 1) in the SAP (Bernhardt 1999). The primary radionuclide contaminant on the site is Cs-137. However, there are also areas with extensive contamination of Th-230 and Th-232 and its decay products. Limited remediation removed contaminated material above the normal regulatory definition of source material of 0.05 percent of total uranium and thorium by weight (estimated concentration in removed materials was about 1 percent). There is still contamination in at least one area with a source material content of about 0.5 percent by weight. Because of the relatively high levels of radiation exposure found in several subsurface locations, the levels of contamination were not fully characterized in all of the subsurface areas. Specifically, radiation exposure rates in boreholes in the area used to store Co-60 during the former license operations indicated potential exposure rates of about 200 mrem/hr or higher. There was also a steel sump in the area of former hot cells with an exposure rate in the milliroentgen per hour range (mR/hr). Cs-137 concentrations in samples exceeded several thousand picocuries per gram (Interim DCGL is 15 pCi/g) and concentrations of Th-230 in several samples exceeded several thousand picocuries per gram (Interim DCGL of 10 pCi/g of total thorium). Low concentrations of residual Sr-90 (maximum of 3 pCi/g) were found in several locations, but all identified concentrations of Sr-90 were below the Interim DCGL of 5 pCi/g).

The subsurface contamination that was found was generally related to specific areas of the former licensed operations (e.g., Co-60 storage pool or the Hot Cells), or based on surface

radiation anomalies or visual anomalies in the floor. Significant contamination was not found in more that 11 randomly located boreholes.

Numerous potential access points to the sanitary sewer were evaluated and surveyed for residual radioactivity. The only complete access was obtained by removing a toilet and using that connection. Significant contamination was not found in the sewer system, but it is judged that adequate access was not obtained for making final prudent judgement concerning the presence of contamination.

The report contains revisions to the MARSSIM classification map for the site. Estimates of selected statistical parameters related to measurements of natural background for use in developing the final closeout survey after decontamination of the site are also provided.

REFERENCES

Bernhardt 1998	Bernhardt, D.E. and T.K. Rogers, "Sampling and Analysis Plan, 170 W. Providencia Site, Burbank, California," Rogers and Associates Engineering, RAE-9824/1-1 Rev. 2, November 1998.
Bernhardt 1999	Bernhardt, D.E., "170 W. Providencia Street, Burbank Property, Response to Comments of December 16, 1998, and Meeting of January 26, 1999," Rogers and Associates Engineering, TIM-9824/1, February 25, 1999.
EPA 1993	External Exposure to Radionuclides in Air, Water, and Soil, Federal Guidance Report No. 12, U.S. Environmental Protection Agency, authored by K.F. Eckerman and J.C. Ryman, 1993.
Chaney 1996	U.S. Nuclear Regulatory Commission, "Inspection Report 3-90006/96-01," Former licenses 04-00580-03 and 04-00580-07, Isotopes Specialties company, Inspection conducted 2/21 to 23, 1996, report dated 4/8/98.
Leggette87	Leggette, Brashears & Graham, Inc., "Environmental Assessment of the Fiber Resin Property, Burbank, California," Prepared for the H.B. Fuller Company, November 13, 1987.
MARSSIM 1998	U.S. Nuclear Regulatory Agency, Multiagency Radiation Survey and Site Investigation Manual, NUREG-1575, 1998.
Takahashi 1997	Takahashi, Joseph M., CHP, "Letter Report of Radiation Survey of Site," dated January 7, 1997.
Vaden 1998	Vaden, John, "Deposition and Exhibits," former Radiation Safety Officer for the Site, Deposition taken August 5, 1998.

Appendix A

Appendix A

This appendix provides information related to the radioactive materials license. These items include the following:

1. Sections of STS Radioactive materials license.
2. Letter from California authorizing the use of the license for the Thomson property..
3. Letter from California approving temporary unrestricted use of specified sections of the property.
4. Results for TLDs (Table A-2) and summaries of the bioassay results are given after the first pink sheet.
5. The list of instruments and examples of the instrument calibration sheets are given after the yellow sheet.
6. The laboratory data packages from Accu Labs and Thermo NUtech are given after the blue sheet.

TENNESSEE DEPARTMENT OF ENVIRONMENT AND CONSERVATION
DIVISION OF RADIOLOGICAL HEALTH

RADIOACTIVE MATERIAL LICENSE

Pursuant to Tennessee Department of Environment and Conservation Regulations, and in reliance on statements and representations heretofore made by the licensee, a license is hereby issued authorizing the licensee to receive, acquire, possess and transfer radioactive material listed below; and to use such radioactive material for the purpose(s) and at the place(s) designated below. This license is subject to all applicable rules and regulations of the Tennessee Department of Environment and Conservation and orders of the Division of Radiological Health, now or hereafter in effect and to any conditions specified below.

LICENSEE	
1. Name Surface Technology Systems (STS)	3. License number R-01085-I03
	4. Expiration date September 30, 2003
2. Address 105 Brentwood Drive Oak Ridge, TN 37830	5. File no. R-01085

6. Radioactive Material (Element and Mass Number)	8. Chemical and/or physical form	9. Maximum Radioactivity and/or quantity of material which licensee may possess at any one time.
See	Supplementary	Sheets

10. Authorized Use

See Supplementary Sheets

CONDITIONS

11. Unless otherwise specified, the authorized place of use is the licensee's address stated in item 2, above.

See Supplementary Sheets

For the Commissioner
Tennessee Department of Environment and Conservation

Date of Issuance September 24, 1998

By: Charles Arnott
DIVISION OF RADIOLOGICAL HEALTH
Charles Arnott
Health Physicist

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CN-0719 (Rev. 9-92)
Form RHS 6-7

Form RHS 8-7A
(9-92)

TENNESSEE DEPARTMENT OF ENVIRONMENT AND CONSERVATION
DIVISION OF RADIOLOGICAL HEALTH

RADIOACTIVE MATERIAL LICENSE

Supplementary Sheet

License Number R-01085-103

6. Radioactive Material (Element and Mass Number)	8. Chemical and/or Physical Form	9. Maximum Radioactivity and/or Quantity of Material Which Licensee May Possess at Any One Time
A. Uranium – Depleted and Natural	A. Any	A. As necessary for the uses authorized in Item 10.A. Total not to exceed 10 curies.
B. Any radioactive material with atomic number between 1 and 103, except for special nuclear material.	B. Any	B. No single isotope to exceed 1 curie.
C. Uranium 233	C. Any	C. 200 grams *
D. Uranium enriched in the U-235 isotope	D. Any	D. 350 grams * of contained U-235
E. Plutonium	E. Any	E. 200 grams *

* For each kind of special nuclear material determine the ratio between the quantity of that special nuclear material and the quantity specified here for the same kind of special nuclear material. The sums of such ratios for all kinds of special nuclear material in combination shall not exceed "1" (i.e. unity).

Form RHS 8-7A
(9-92)

TENNESSEE DEPARTMENT OF ENVIRONMENT AND CONSERVATION
DIVISION OF RADIOLOGICAL HEALTH

RADIOACTIVE MATERIAL LICENSE

Supplementary Sheet

License Number R-01085-103

10. Authorized Use

A. through E. Possession, storage, packaging, and shipment of radioactive material incident to the surface decontamination of structures, components, and items for the purpose of unrestricted release. Authorized methods of decontamination are the use of the Advanced Recyclable Media System (ARMS), wiping and spraying of components, and the scabbling of concrete. This license also authorizes surveys, characterization, and remediation of radioactively contaminated structures, materials, soils, and soil-like materials. These authorizations shall be in accordance with statements, representations, and procedures contained in application dated July 6, 1998, with attachments, and the references in Condition 19 of this license.

Conditions

12. The licensee shall comply with applicable provisions of 1200-2-4, 1200-2-5, and 1200-2-10 of "State Regulations for Protection Against Radiation."

13. Operations authorized in Item 10. of this license may be conducted at temporary job sites of the licensee, in areas not under exclusive Federal jurisdiction, throughout the State of Tennessee.

Before radioactive materials can be used at a temporary job site at any Federal facility, the jurisdictional status of the job site must be determined. If the jurisdictional status is unknown, the Federal agency should be contacted to determine if the job site is under exclusive Federal jurisdiction. A response should be obtained in writing or a record should be made of the name and title of the person at the Federal agency who provided the determination and the date that it was provided. Authorization for use of radioactive materials at job sites under exclusive Federal jurisdiction shall be obtained either by: (1) filing a NRC Form-241 in accordance with 10 CFR 150.20(b), "Recognition of Agreement State Licenses,"; or (2) by applying for a specific NRC license.

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

14. A. Radioactive material authorized by this license shall be used by, or under the supervision of, Brad Squibb, Stephen V. Prewett, Ph.D., Steven M. Pocock, David Howe, Dell Reuss, or Paul Gillespie.

B. The Radiation Safety Officer for this license is Brad Squibb.

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(9-92)

TENNESSEE DEPARTMENT OF ENVIRONMENT AND CONSERVATION
DIVISION OF RADIOLOGICAL HEALTH

RADIOACTIVE MATERIAL LICENSE

Supplementary Sheet

License Number R-01085-A03

15. The licensee shall submit to the regulatory agency maintaining jurisdiction in accordance with statements, representations, and procedures contained in application dated July 6, 1998, with attachments, a Decontamination and Decommissioning (D&D) Plan for each project to be performed under this license. This D&D Plan shall be submitted prior to the project being performed.

16. The licensee shall maintain complete and accurate records of the receipt and disposal of radioactive material. The licensee shall, for radioactive material no longer useful for any purpose and for any equipment or supplies contaminated with such material for which further use and decontamination is not planned, define those materials as radioactive waste and treat them as such in accordance with the following provisions:

    A. Radioactive waste material shall not be stored with non-radioactive waste.

    B. A written record of all radioactive waste material shall be maintained until it has been determined by a suitable survey or radioassay that it has decayed to background levels or until it has been shipped to an authorized recipient in accordance with all applicable regulations. Accountability of radioactive waste material prepared for shipment but not yet shipped from the licensee's premises shall be maintained by the licensee by an internal record system such that the licensee is constantly aware of the material's location and the proposed time of shipment. Individuals who are involved in the shipping of such material and/or the storage of such material prior to shipment, shall be trained in the precautions necessary for such handling and storage.

    C. For material which has decayed to background levels as determined by radioassay or external level as measured with appropriately calibrated instruments, records shall indicate that the material was determined to be no longer radioactive and will indicate the methods and results of the survey or analysis.

    D. Shipment records of radioactive waste material shall be maintained and the licensee shall require written confirmation from the authorized recipient of such material that this material has been received.

    E. All records and written confirmations required by this condition shall be maintained for inspection by the Department.

    The requirements for this condition are in addition to any other requirements for the handling and/or disposal of radioactive material contained in this license and "State Regulations for Protection Against Radiation."

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(9-92)

TENNESSEE DEPARTMENT OF ENVIRONMENT AND CONSERVATION
DIVISION OF RADIOLOGICAL HEALTH

RADIOACTIVE MATERIAL LICENSE

Supplementary Sheet

License Number R-01085-A03

17. Except for plutonium contained in a medical device designed for individual human application, no plutonium, regardless of form, shall be delivered to a carrier for shipment by air transport or transported in an aircraft by the licensee except in packages the design of which the U. S. NRC has specifically approved for transport of plutonium by air.

18. No provision of this license relieves the licensee from compliance with other Federal, State, and local laws, ordinances, and regulations applicable to the licensee's activities.

19. Except as specifically provided otherwise by this license, the licensee shall possess and use radioactive material described in Items 6, 8, and 9 of this license in accordance with statements, representations, and procedures contained in application dated July 6, 1998, with attachments, and letter received September 18, 1998, with attachments.

STATE OF CALIFORNIA—HEALTH AND HUMAN SERVICES AGENCY GRAY DAVIS, GOVERNOR

DEPARTMENT OF HEALTH SERVICES
714/714 P STREET
P.O. BOX 942732
SACRAMENTO, CA 94234-7320

(916) 445-0931

March 24, 1999

NOTICE OF RECIPROCAL RECOGNITION OF LICENSE FOR USE IN CALIFORNIA

Decontamination/Decommissioning

Mr. Brad Squibb
Radiation Safety Officer
Surface Technology Systems, Ltd.
2920 Byington Solway Road
Knoxville, TN 37931

Dear Mr. Squibb:

REFERENCE: a. Your Request Dated March 22, 1999
b. Tennessee Radioactive Materials License No. R-01085-I03
c. Receipt of Reciprocity Fee of $661.12, Per 30231(e)

In accordance with your request (Reference a.) and pursuant to Title 17, California Code of Regulations (17 CCR) 30225(a), you are hereby authorized to use radioactive materials at temporary job sites in areas not under exclusive Federal jurisdiction throughout the State of California. Such use shall be conducted in accordance with California Code of Regulations (17 CCR) and your Radioactive Materials License (Reference b.) An order form to obtain a copy of the regulations is enclosed.

You are further required to notify our compliance office identified below at least three working days prior to each use of radioactive material in California so that our representative may inspect such use should he choose to do so.

Please see the attached map to determine the proper inspection jurisdiction and notify the individuals listed.

Special Conditions:

1. This authorization expires on December 31, 1999. If you intend to use radioactive materials within California after this date, you must reapply.

2. Radioactive material may not be possessed within California for more than 180 days during this authorization period.

3. A copy of this letter and the California regulations must be carried at all times when radioactive material is used in California under this authorization.

If you have any questions, I can be reached at the phone number above.

For the Department of Health Services

Donald E. Bunn, Chief
Inspection, Compliance & Enforcement
Radiologic Health Branch

Enclosure

cc: RHB-Berkeley
RHB-Los Angeles-North
RHB-Los Angeles-South

Reciprocity Issue No. 99-38

A-8

TE OF CALIFORNIA—HEALTH AND HUMAN SERVICES AGENCY
GRAY DAVIS, Governor
ARTMENT OF HEALTH SERVICES
RADIOLOGIC HEALTH BRANCH
P.O. BOX 942732, MS-178
SACRAMENTO, CA 94234-7320
(916) 323-2759

March 18, 1999

Ms. Martha Sharp
LOEB & LOEB LLP
Attorney At Law
1000 Wilshire Boulevard, Suite 1800
Los Angeles, California 90017-2475

PROPERTY AT 170 WEST PROVIDENCIA STREET, BURBANK, CALIFORNIA

Dear Ms. Sharp:

The Radiologic Health Branch has completed review of the Sampling and Analysis Plan (SAP) and its addendum, Technical Information Memorandum, regarding the characterization and remediation surveys of the property at 170 Providencia, Burbank, California.

Overall, the SAP appears to be an adequate survey plan with the added information and, therefore, it is acceptable under the MARSSIM's guidelines.

If you have any questions concerning this matter, please feel free to call me at the above number or Mr. Stephen Hsu of this office at (916) 322-4797.

Sincerely,

Gerard Wong, Ph.D., Chief
Radioactive Material Licensing Section
Radiologic Health Branch

Cc: Next Page

Edgar Bailey, C.H.P., Chief
Radiologic Health Branch

Donald Bunn, Chief
Inspection, Compliance and Enforcement Section

Mr. Michael Lumbard
Staff Attorney

Mr. Richard L. Bangart, Director
Office of State Programs
U.S. Nuclear Regulatory Commission

Table A-2

Eberline Dosimetry Services
7021 Pan American Fwy NE
Albuquerque, NM 87109
(505) 345-8931 Voice (505) 781-5410 Fax
(888) 343-8537 Toll-Free

NVLAP The dosimetry processor is accredited by NVLAP of the U.S. Department of Commerce as having the competence to perform specified test in accordance with prescribed test methods and accreditation criteria.

Current TLD Occupational Radiation Exposure Report

Customer No. 08992 Charles Lambern

Dosages As Of 06/28/99

Badge Number / Body Location	Work Facility / Work Location	Name / Birthdate	Age	Sex	ID / ID Type	Service 1 / Freq. 2	Date Issued / Date Returned	Dose for Period (mrem): Note 3 / Neutron	Deep / Shallow	Lens / Extremity	Accumulated Dose (mrem) for Calendar Quarter: Deep	Lens	Shallow	Extremity	Accumulated Dose (mrem) for Calendar Year: Deep	Lens	Shallow	Extremity	Perm. Annual Deep (rem) / Accum. Lifetime
01000						T	04/01/99		14		14								5
Control						Q	4/20/99				14								
01001						T	04/01/99		0	0	0	0	0						5
B. Squibb						Q	4/20/99		0		0	0	0						0
01002						T	04/01/99		0	0	0	0	0						5
J. Salsman						Q	4/20/99		0		0	0	0						0
01003						T	04/01/99		0	0	0	0	0						5
M. Healy						Q	4/20/99		0		0	0	0						0
01004						T	04/01/99		0	0	0	0	0						5
A. Rasmussen						Q	4/20/99		0		0	0	0						0
01005						T	04/01/99		0	0	0	0	0						5
K. Nielson						Q	4/20/99		0		0	0	0						0
01006						T	04/01/99		0	0	0	0	0						5
D. Dembardt						Q	4/20/99		0		0	0	0						0
01007						T	04/01/99		0	0	0	0	0						5
T. Marcott						Q	4/20/99		0		0	0	0						0
01009						T	04/01/99		0	0	0	0	0						5
						Q	4/20/99		0		0	0	0						0
01012						T	04/01/99		0	0	0	0	0						5
						I	4/20/99		0		0	0	0						0

1 Service Codes	2 Frequency Codes	3 Note Codes
T,D - Whole Body	W - Weekly	C - Badge damaged
H,R - Ring Badge	B - BiWeekly	E - Reported by telephone or wire
J,L - Ankle Badge	M - Monthly	F - Badge not used
X,W - Wrist Badge	P - BiMonthly	G - Explanation attached
N,E - Neutron	Q - Quarterly	X - Contaminated
A Badge	S - SemiAnnual	Z - Calculated control
	A - Annual	P - Planned exposure
	I - Irregular	

Company SURFACE TECHNOLOGY SYSTEM
Attention DELL REUSS
Address 7857 FREEDOM AVE. N. W
NORTH CANTON, OH 44720

Memo

ROGERS & ASSOCIATES ENGINEERING
A DAMES & MOORE COMPANY

515 East 4500 South
Salt Lake City, UT 84107
801 263-1600 Tel
801 262-1527 Fax

To Steve Pocock

From D. Bernhardt

Date 7/14/99

Subject Bioassay results for Burbank project.

I have enclosed the results for two sets of urine bioassay samples for the Burbank project. The results from Acculabs Inc. are for the samples collected while at the site. The results of the two samples from Therm NUteck are for 1-liter samples collected by K. Nielson, Holly Rasmussen, and myself after return to SLC. The last three samples were collected because of possible concerns for exposure to Sr-90 and/or C-14. I interpret all of the results as showing no significant exposure.

I'll note we also have received the results of the facility characterization for C-14 and tritium. All of the results were essentially background. We saw no evidence of significant concentrations of residual C-14 and tritium.

Dave Bernhardt, CHP

cc. Martha Sharp

ROGERS & ASSOCIATES ENGINEERING
A DAMES & MOORE GROUP COMPANY

515 East 4500 South
Salt Lake City, UT 84107
801-263-1600 Voice
801-262-1527 Fax

Fax Transmittal

To: *Steve Pocock*
Company: *STS*
Fax No.: 330/497-2045

From: David Bernhardt, *CHP*

Date: May 24, 1999

Subject: *Bioassay sample results from April field work at Thomson site in Burbank.*

Pages: 2

The attached tabulation provides the bioassay (urine) results and brief summary statements for the U, tritium, and Sr-89/90 results.

All of the results were similar to or below the analytical detection limit and indicate essentially no adverse exposure at the site.

Larger samples for three RAE people have been submitted to Thermo NUCtech for more definitive analysis for Sr-90 and C-14. Acculabs, who provided the attached results, does not perform C-14 for urine. The results from Thermo NUCtech will not be available till the end of June, or later.

David Bernhardt

cc: Martha Sharp
Bradd Squib

Person	Date of Sample	Sr-90 pCi/L		Trit Oxide pCi/L		U mg/Liter
Bernhardt, Dave	3/29/99	0.90	+/- 8.10	0.70	+/- 0.28	<0.0001
Bernhardt, Dave	4/16/99	9.70	+/- 16.00	0.43	+/- 0.25	0.0001
Healy, Mickey	3/29/99	0.60	+/- 8.50	0.27	+/- 0.24	0.0002
Healy, Mickey	4/16/99	9.10	+/- 10.00	0.19	+/- 0.24	0.0001
Nielson, Kirk	3/29/99	4.10	+/- 15.00	-0.02	+/- 0.23	0.0003
Nielson, Kirk	4/16/99	4.70	+/- 12.00	0.14	+/- 0.23	0.0002
Rasmussen, Holly	3/29/99	-2.20	+/- 28.00			0.0054
Rasmussen, Holly	4/16/99	1.20	+/- 13.00	0.18	+/- 0.23	<0.0001
Salsman, John	3/29/99	11.00	+/- 17.00			0.0003
Salsman, John	4/9/99	1.60	+/- 12.00	0.05	+/- 0.23	<0.0001
Squibb, Brad	3/29/99	-4.10	+/- 9.70	0.04	+/- 0.23	0.0002
Squibb, Brad	4/16/99	0.20	+/- 14.00	0.31	+/- 0.24	<0.0001
Merrit, Tim	4/1/99	1.40	+/- 9.10	0.10	+/- 0.23	<0.0001
Merrit, Tim	4/16/99	0.10	+/- 19.00			0.0003
Guzman, Enrique	4/5/99	2.90	+/- 8.90	0.35	+/- 0.25	0.0001
Guzman, Enrique	4/9/99	-8.00	+/- 32.00			0.0005

Analysis by Acculabs, Lab Job 02990, ROG001,
Golden, CO

Conclusions per review of data, note that samples for Rasmussen, Nielson, and Bernhardt have been sent to Thermo NUCtech for additional Sr-90 and C-14 analysis (expect results end of June).

U U results look normal, the normal MDA is about 3 ug/l. The only result above this criterion is for the initial baseline sample for Rasmussen. No further assessment needed.

The closeout sample for Enrique was taken at the end of the day. It is below 3 ug/l and also it would have short half-life material from the work day.

Tritium All results are similar to present natural background; and given that the results are below or similar to the detection level (error term similar to most results) they indicate there was no significant exposure.

Sr-89 & 90: The results are generally well below the error term, analytical MDA.

David E. Bernhardt, CHP
5/24/99

Table A-1. Instruments used for site characterization.

Instrument/Model No.		Serial No.	Detector/Model No.		Det serial No	type Detector
Ludlum	2221	144863	Ludlum	44-2	151603	1-in NaI
	2221	117366		44-2	92439	1-in NaI
	2221	97833		44-2	94982	1-in NaI
	2221	117363		44-2	95313	1-in NaI
Ludlum	2220	46601		44-9	DB RAE#1	1-in NaI
	2220	46601		43-2		Zn S Alpha
	2220	50055		44-2	152398	1-in NaI
	2220	50055		44-9		GM Pancake
	12	146055		44-9		GM Pancake
	3			44-9	37926	GM Pancake
Bicron Surveyor M		A170Z	Bicron	G1/SN	B241M	NaI
			Ludlum	44-9	42780	GM Pancake
HP Inst	Cypher	501109	HP Inst		7500120	1-in NaI

INSTRUMENT CALIBRATION

CAL# 7731
Prev. 7556

health physics instruments
330 D South Kellogg Ave. Goleta, CA 93117 Tel 805.967.8422 Fax 805.964.3162 Division of Far West Technology, Inc.

INSTRUMENT OWNED BY: Rogers & Associates		DATE: 8 October 1998
MFG.: Ludlum	MODEL: 2221	TYPE / RADIATION DETECTED: Scintillator
SERIAL NUMBER: 144863	BATTERIES: Four D Cells	PROBE SN/TYPE: 44-2 151603

CALIBRATION SOURCE DATA :

Source	Type	Cal Constant	Source	Type	Cal Constant
CS2:	CS137	mR/h @ 1 Meter	CS1-2:	CS137	mR/h @ 1 Meter
CS1:	CS137	mR/h @ 1 Meter	S:	Ra-226	1.929 mR/h @ 1 Meter
CS1-1:	CS137	mR/h @ 1 Meter	W:	Ra-226	0.128 mR/h @ 1 Meter
CS1-3	CS137	mR/h @ 1 Meter	N:	Cf252	mrem/h@ 1 Meter

Source	Distance cm	Exposure µR/h	Scale Readings (cpm) X1000	X 100	X 10	X 1	scaler 1 min *1	cpm/µr/h *2
W	30.2	14000	220,000					157
	65.3	300	50,000					162
	94.3	140		30,000				205
	111.3	100		22,000				220
	160.0	50		13,000			11882	213
	178.9	40		10,000			10080	221
	206.6	30		8,000			8209	233
	253.8	20		6,000			6099	243
	357.8	10			4000		4121	289
	506.0	5			3000		3255	404
		background			1200	OS	1234	

Pulsar	cpm	Log	x 1K	X 100	X 10	X 1	Scaler	Time
	400K	350K	400K				1	399997
	400K	350K	400K				.5	199973
	40K			40,000			.1	3999
	4000				4000		10	39995
	400					400		

BAROMETER mmHg:	TEMPERATURE °C	EFFICIENCY % C14	EFFICIENCY % TC99	EFFICIENCY % SR90
761	21°			

COMMENTS: Window out Threshold ~~499~~ 2a9 HV=1c5
*1 Background not subtracted from reading
*2 Calculated on 1 min scaler minus Background where appl.

CPM ranges set electronically. Background ***NOT*** subtracted from all readings. ( ) indicates reading before calibration. Gamma calibrations from the side of all GM tubes. Calibrations traceable to the National Institute Of Standards And Technology.

☑ Instrument OK

CALIBRATION BY: JOHN S. HANDLOSER, JR. John S. Handloser Jr

CHECKED BY: JOHN S. HANDLOSER, JR. JSH

INSTRUMENT CALIBRATION

CAL# 7904
Prev.

health physics instruments
330 D South Kellogg Ave. Goleta, CA 93117 Tel 805.967.8422 Fax 805.964.3162 Division of Far West Technology, Inc.

INSTRUMENT OWNED BY:		DATE:
GTS Duratek		26 March 1999
MFG.: Ludlum	MODEL: 2221	TYPE / RADIATION DETECTED: Scintillator
SERIAL NUMBER: A2 117366	BATTERIES: Four D Cells	PROBE SN/TYPE: 44-2 092439

CALIBRATION SOURCE DATA :

Source	Type	Cal Constant	Source	Type	Cal Constant
CS2:	CS137	mR/h @ 1 Meter	CS1-2:	CS137	mR/h @ 1 Meter
CS1:	CS137	mR/h @ 1 Meter	S:	Ra-226	1.929 mR/h @ 1 Meter
CS1-1:	CS137	mR/h @ 1 Meter	W:	Ra-226	0.128 mR/h @ 1 Meter
CS1-3	CS137	mR/h @ 1 Meter	N:	Cf252	mrem/h@ 1 Meter

Source	Distance	Exposure	Scale Readings (cpm)					
	cm	µR/h	X1000	X 100	X 10	X 1	scaler 1 min *1	cpm/µR/h *2
W	30.2	1400	200,000					142
	65.3	300	50,000					166
	94.3	140		27,000				192
	111.3	100		20,000			19937	190
	160.0	50		10,000			10951	200
	178.9	40		9,000			9503	214
	206.6	30		8,000			7300	213
	253.8	20		5,000			5580	233
	357.8	10		3500			3489	256
	506.0	5		3000			2705	
		background			1000	OS	925	

Pulsar	cpm	Log	x 1K	X 100	X 10	X 1	Scaler	Time
	400K	400K	400K				1	399935
	400K						.5	199967
	40K	60K		40K			.1	4000
	4000	4000			4000		10	39993
	400							

BAROMETER mmHg:	TEMPERATURE °C	EFFICIENCY % C14	EFFICIENCY % TC99	EFFICIENCY % SR90
760	23			

COMMENTS: Window out Threshold 200 HV 900 Am 241 OK
*1 Background not subtracted from reading
*2 Calculated on 1 min scaler minus Background where appl.

CPM ranges set electronically. Background ***NOT*** subtracted from all readings. ( ) indicates reading before calibration. Gamma calibrations from the side of all GM tubes. Calibrations traceable to the National Institute Of Standards And Technology.

☒ Instrument OK

CALIBRATION BY: JOHN S. HANDLOSER, JR. CHECKED BY: JOHN S. HANDLOSER, JR.

HP FORM CALFORM 2/96

INSTRUMENT CALIBRATION

CAL# 7902
Prev.

health physics instruments
330 D South Kellogg Ave, Goleta, CA 93117 Tel 805.967.8422 Fax 805.964.3162 Division of Far West Technology, Inc.

INSTRUMENT OWNED BY: GTS Duratek		DATE: 26 March 1999
MFG.: Ludlum	MODEL: 2221	TYPE / RADIATION DETECTED: Scintillator
SERIAL NUMBER: 97833	BATTERIES: Four D Cells	PROBE SN/TYPE: 44-2 094982

#3

CALIBRATION SOURCE DATA :

Source	Type	Cal Constant	Source	Type	Cal Constant
CS2:	CS137	mR/h @ 1 Meter	CS1-2:	CS137	mR/h @ 1 Meter
CS1:	CS137	mR/h @ 1 Meter	S:	Ra-226	1.929 mR/h @ 1 Meter
CS1-1:	CS137	mR/h @ 1 Meter	W:	Ra-226	0.128 mR/h @ 1 Meter
CS1-3	CS137	mR/h @ 1 Meter	N:	Cf252	mrem/h@ 1 Meter

Source	Distance	Exposure	Scale Readings (cpm)					
	cm	µR/h	X1000	X 100	X 10	X 1	scaler 1 min *1	cpm/µr/h *2
W	30.2	1400	220,000					157
	65.3	300	50,000					166
	94.3	140		25,000				178
	111.3	100		20,000			19005	181
	160.0	50		10,000			10511	192
	178.9	40		8,000			8863	199
	206.6	30		7,000			7274	212
	253.8	20		5,000			5201	215
	357.8	10			3500		3331	243
	506.0	5			2500		2552	330
		background			1000	OS	901	

Pulsar	cpm	Log	x 1K	X 100	X 10	X 1	Scaler	Time
	400K	350K	400K				1	400040
	400K						.5	200019
	40K	40K		40K			.1	4000
	4000	4000			4000		10	40004
	400	400				400		

BAROMETER mmHg:	TEMPERATURE °C	EFFICIENCY % C14	EFFICIENCY % TC99	EFFICIENCY % SR90
760	23			

COMMENTS: Window out Threshold 200 HV 900 Am 241 OK
*1 Background not subtracted from reading
*2 Calculated on 1 min scaler minus Background where appl.

CPM ranges set electronically. Background ***NOT*** subtracted from all readings. ( ) indicates reading before calibration. Gamma calibrations from the side of all GM tubes. Calibrations traceable to the National Institute Of Standards And Technology.

☒ Instrument OK

CALIBRATION BY: JOHN S. HANDLOSER, JR. CHECKED BY: JOHN S. HANDLOSER, JR.

NPI-FORM CALFORM 2/96

08

INSTRUMENT CALIBRATION

CAL# 7903
Prev.

health physics instruments
330 D South Kellogg Ave. Goleta, CA 93117 Tel 805.967.8422 Fax 805.964.3162 Division of Far West Technology, Inc.

INSTRUMENT OWNED BY: GTS Duratek		DATE: 26 March 1999
MFG.: Ludlum	MODEL: 2221	TYPE / RADIATION DETECTED: Scintillator
SERIAL NUMBER: 117363	BATTERIES: Four D Cells	PROBE SN/TYPE: 44-2 095313

34

CALIBRATION SOURCE DATA :

Source	Type	Cal Constant	Source	Type	Cal Constant
CS2:	CS137	mR/h @ 1 Meter	CS1-2:	CS137	mR/h @ 1 Meter
CS1:	CS137	mR/h @ 1 Meter	S:	Ra-226	1.929 mR/h @ 1 Meter
CS1-1:	CS137	mR/h @ 1 Meter	W:	Ra-226	0.128 mR/h @ 1 Meter
CS1-3	CS137	mR/h @ 1 Meter	N:	Cf252	mrem/h@ 1 Meter

Source	Distance	Exposure	Scale Readings (cpm)					
	cm	µR/h	X1000	X 100	X 10	X 1	scaler 1 min *1	cpm/µr/h *2
W	30.2	1400	320,000					228
	65.3	300	55,000					183
	94.3	140		29,000				207
	111.3	100		21,000			19841	188
	160.0	50		11,000			11190	203
	178.9	40		9,000			9379	209
	206.6	30		5,000			7587	219
	253.8	20		4,000			5627	230
	357.8	10			3200		3358	233
	506.0	5			3000		2674	330
		background			1000	OS	1023	

Pulsar	cpm	Log	x 1K	X 100	X 10	X 1	Scaler	Time
	400K	400K	400K				1	399931
	400K						.5	199966
	40K	40K		40K			.1	3999
	4000	4500			4000		10	39993
	400							

BAROMETER mmHg:	TEMPERATURE °C	EFFICIENCY % C14	EFFICIENCY % TC99	EFFICIENCY % SR90
760	23			

COMMENTS: Window out Threshold 200 HV 900 Am 241 OK
*1 Background not subtracted from reading
*2 Calculated on 1 min scaler minus Background where appl.

CPM ranges set electronically. Background *NOT* subtracted from all readings. ( ) indicates reading before calibration. Gamma calibrations from the side of all GM tubes. Calibrations traceable to the National Institute Of Standards And Technology.

☒ Instrument OK

CALIBRATION BY: JOHN S. HANDLOSER, JR. CHECKED BY: JOHN S. HANDLOSER, JR.

John S. Handloser JSH

HPI FORM CALFORM 2/96

INSTRUMENT CALIBRATION

CAL# 7733
Prev. 7284

health physics instruments
330 D South Kellogg Ave. Goleta, CA 93117 Tel 805.967.8422 Fax 805.964.3162 Division of Far West Technology, Inc.

INSTRUMENT OWNED BY: Rogers & Associates		DATE: 8 October 1998
MFG.: Bicron	MODEL: Surveyor M	TYPE / RADIATION DETECTED: Gamma
SERIAL NUMBER: A170Z	BATTERIES: one 9 volt	PROBE SN/TYPE: Bicron G1/SN = B241M

CALIBRATION SOURCE DATA :

Source	Type	Cal Constant	Source	Type	Cal Constant
CS2:	CS137	mR/h @ 1 Meter	CS1-2:	CS137	mR/h @ 1 Meter
CS1:	CS137	mR/h @ 1 Meter	S:	Ra-226	1.929 mR/h @ 1 Meter
CS1-1:	CS137	mR/h @ 1 Meter	W:	Ra-226	0.128 mR/h @ 1 Meter
CS1-3	CS137	mR/h @ 1 Meter	N:	Cf252	mrem/h@ 1 Meter

Source	Distance	Exposure	Scale Readings					
	cm	µR/h	X 1000	X 100	X10	X 1	scaler *1	cpm/µr/h *2
W	27.4	1700	230,000					135
	56.6	400	60,000					147
	86.8	170		34,000				192
	160.0	50		12,000			11269	200
	178.8	40		10,000			9130	197
	206.5	30		8000			7412	205
	253.0	20		6000			5673	220
	357.8	10			3500		3595	233
	506.0	5			3000		2834	314
		Background			1200		1262	
Pulser								
		400K	400K				399606	
		40K		40,000				
		4000			4000			
		400				400		

BAROMETER mmHg:	TEMPERATURE °C	EFFICIENCY % TC99	EFFICIENCY % SR90
761	23°		

COMMENTS: HV: 900
*1 Background not subtracted from readings.
*2 Calculated on 1 min scaler minus background where appl.

CPM ranges set electronically. Background ***NOT*** subtracted from all readings. ( ) indicates reading before calibration. Gamma calibrations from the side of all GM tubes. Calibrations traceable to the National Institute Of Standards And Technology.

☒ Instrument OK

CALIBRATION BY: JOHN S. HANDLOSER, JR. John S. Handloser

CHECKED BY: JOHN S. HANDLOSER, JR. JSH

HPI FORM CALFORM 2/96

INSTRUMENT CALIBRATION

CAL# 7730
Prev. 7601

health physics instruments
330 D South Kellogg Ave. Goleta. CA 93117 Tel 805.967.8422 Fax 805.964.3162 Division of Far West Technology, Inc.

INSTRUMENT OWNED BY: Rogers & Associates Eng. Corp.		DATE: 8 October 1998
MFG.: Ludlum	MODEL: 2220	TYPE / RADIATION DETECTED: Scintillator
SERIAL NUMBER: 46601	BATTERIES: Four D cell	PROBE SN/TYPE: RAE #1

CALIBRATION SOURCE DATA :

Source	Type	Cal Constant	Source	Type	Cal Constant
CS2:	CS137	mR/h @ 1 Meter	CS1-2:	CS137	mR/h @ 1 Meter
CS1:	CS137	mR/h @ 1 Meter	S:	Ra-226	1.929 mR/h @ 1 Meter
CS1-1:	CS137	mR/h @ 1 Meter	W:	Ra-226	0.128 mR/h @ 1 Meter
CS1-3	CS137	mR/h @ 1 Meter	N:	Cf252	mrem/h@ 1 Meter

Source	Distance	Exposure	Scale Readings (cpm)					
	cm	µR/h	X 1000	X 100	X 10	X 1	scaler 1 min *1	cpm/µr/h *2
W	31.4	1300	220,000					170
	65.3	300	70,000					233
	99.2	130		27,000				207
	111.3	100		22,000				207
	160.0	50		13,000			12482	223
	178.9	40		11,000			10308	224
	206.6	30		10,000			8456	238
	253.0	20		8,000			6479	258
	357.8	10			4200		4090	277
	506.0	5			3000		3267	390
		Background			1300		1317	
Pulser	**cpm**	**LOG**	**X1000**	**X100**	**X10**	**X1**	**scaler**	**time**
	400K	400K	400K				399742	1
	400K	400K	400K				199886	.5
	40K	35K		40000			3993	.1
	4000	4K			4000			
	400	400				400		

BAROMETER mmHg:	TEMPERATURE °C	EFFICIENCY % TC99	EFFICIENCY % SR90
761	23°		

COMMENTS: Window out Threshold 200 - HV = 900
*1 Background not subtracted from reading
*2 Calculated on 1 min scaler minus Background where appl.

CPM ranges set electronically. Background ***NOT*** subtracted from reading. ( ) indicates reading before calibration. Gamma calibrations from the side of all GM tubes. Calibrations traceable to the National Institute Of Standards And Technology.

☒ Instrument OK

CALIBRATION BY: JOHN S. HANDLOSER, JR. CHECKED BY: JOHN S. HANDLOSER, JR.

HPI FORM CALFORM 2/96

INSTRUMENT CALIBRATION

CAL# 7601
Prev. 7555

health physics instruments
330 D South Kellogg Ave. Goleta. CA 93117 Tel 805 967.8422 Fax 805.964 3162 Division of Far West Technology. Inc.

INSTRUMENT OWNED BY:		DATE.
Rogers & Associates Eng. Corp.		8 June 1998
MFG..	MODEL:	TYPE / RADIATION DETECTED
Ludlum	2220	Scintillator
SERIAL NUMBER:	BATTERIES:	PROBE SN/TYPE.
46601	Four D cell	PR 10540 /44-2

HS

CALIBRATION SOURCE DATA :

Source	Type	Cal Constant	Source	Type	Cal Constant
CS2:	CS137	mR/h @ 1 Meter	CS1-2:	CS137	mR/h @ 1 Meter
CS1:	CS137	mR/h @ 1 Meter	S:	Ra-226	1.929 mR/h @ 1 Meter
CS1-1:	CS137	mR/h @ 1 Meter	W:	Ra-226	0.128 mR/h @ 1 Meter
CS1-3	CS137	mR/h @ 1 Meter	N:	Cf252	mrem/h@ 1 Meter

Source	Distance	Exposure	Scale Readings (cpm)					
	cm	microR/h	X 1000	X 100	X 10	X 1		cpm/µR/hr
W	31.4	1300	260,000					200
	65.3	300	80,000					266
	99.2	130		33,000				253
	206.6	30		10,000				333
	357.7	10			2500			250
	653.2	3			1000			333
		Background			1700	OS		

Pulsar	cpm	Log	X 1000	X 100	X 10	X 1	Scaler	Time
	400,000	350,000	400,000				400,177	1 min.
	400,000						200,064	.5 min.
	400,000						39,991	.1 min.
	40,000	35,000		40,000				
	4,000	3500			4000			
	400	380				400		

BAROMETER mmHg:	TEMPERATURE °C	EFFICIENCY % TC99	EFFICIENCY % SR90
764	24°		

COMMENTS:
HV 900 THR 200 WIN -

CPM ranges set electronically. Background subtracted from all readings. ( ) indicates reading before calibration. Gamma calibrations from the side of all GM tubes. Calibrations traceable to the National Institute Of Standards And Technology.

☑ Instrument OK

CALIBRATION BY: CHARLES P. REID

CHECKED BY: JOHN S. HANDLOSER, JR.

HPI FORM CALFORM 2/96

INSTRUMENT CALIBRATION

CAL# 7945
Prev# 7729

health physics instruments
330 D South Kellogg Ave, Goleta, CA 93117 Tel 805.967.8422 Fax 805.964.3162 Division of Far West Technology, Inc.

INSTRUMENT OWNED BY: Rogers & Associates		DATE: 13 May 1999
MFG.: HPI	MODEL: 5000	TYPE / RADIATION DETECTED: Scintillator
SERIAL NUMBER: 501109	BATTERIES: Six AA	PROBE SN/TYPE: 7500120

CALIBRATION SOURCE DATA :

Source	Type	Cal Constant	Source	Type	Cal Constant
CS2:	CS137	mR/h @ 1 Meter	CS1-2:	CS137	mR/h @ 1 Meter
CS1:	CS137	mR/h @ 1 Meter	S:	Ra-226	1.929 mR/h @ 1 Meter
CS1-1:	CS137	mR/h @ 1 Meter	W:	Ra-226	0.128 mR/h @ 1 Meter
CS1-3	CS137	mR/h @ 1 Meter	N:	Cf252	mrem/h@ 1 Meter

Source	Distance	Exposure	Detector 1	Scale Readings				
	cm	µR/h	µR/h	mR/h	cpm		scaler 1 min *1	cpm/ µr/h *2
W:	11.3	10,000		OS	940K			
	35.7	1000	800		132,000			
	113.1	100	84		18000			
	160.0	50	47		10000		9982	185
	178.8	40	38		8100		8197	186
	253.0	20	21		4600		4766	201
	357.6	10	8		2800		2826	208
	506.0	5	6		2200		2270	306
		Background	4				740	
Scaler	CPM							
	1000				1000		1000	

BAROMETER mmHg:	TEMPERATURE °C	EFFICIENCY % TC99	EFFICIENCY % SR90
762	23		

COMMENTS: Rate Cal 4.70E-3 DT 95
Setting for Detector 1
*1 Background not subtracted from reading.
*2 Calculated on 1 minute minus background where appl.
ADDED QUICK COUNTER TO SOFTWARE Software VS 1.20

CPM ranges set electronically. Background NOT subtracted from all readings. ( ) indicates reading before calibration. Gamma calibrations from the side of all GM tubes. Calibrations traceable to the National Institute Of Standards And Technology.

☒ Instrument OK

CALIBRATION BY: JOHN S. HANDLOSER, JR. CHECKED BY: JOHN S. HANDLOSER, JR.

HPI FORM CALFORM 2/96

Thermo NUtec:
2030 Wright Aven
P.O. Box 4[illegible]
Richmond CA 94804-[illegible]
[illegible] • FAX (510) 235-[illegible]

July 6, 1999

Mr. Dave Bernhardt
Rogers & Associates Engineering
515 East 4500 South
Salt Lake City, UT 84107

Dear Mr. Bernhardt:

Enclosed is the data report from the analysis of three urine samples received at Thermo Nutech on May 3, 1999. The samples were analyzed for carbon-14 and strontium-90. No problems were encountered with the analyses.

Please call me if you have any questions regarding the data.

Sincerely,

N. Joseph Verville
Senior Program Manager

/njv

Enclosure: Report

A subsidiary of Thermo Remediation, a Thermo Electron Company

h

XGERS ASSO
324
RINE

MDA	Evaluation
1.26	<MDA
0.490	<MDA

ified by
rt Date 07/06/99
e 2

Thermo NUtech

ANALYSIS RESULTS

Client ROGERS ASSO
Contract 9824
Matrix URINE

ected	Analyzed	Nuclide	Results ± 2σ	Units	MDA
6/99	06/27/99	C14	-9.00 ± 39	pCi/L	66.0
	06/10/99	Sr 90	0.060 ± 0.096	pCi/L	0.656
8/99	06/27/99	C14	-16.0 ± 36	pCi/L	61.0
	06/10/99	Sr 90	0.054 ± 0.085	pCi/L	0.572
7/99	06/27/99	C14	-24.0 ± 36	pCi/L	61.0
	06/10/99	Sr 90	0.082 ± 0.13	pCi/L	0.901

Certified by
Report Date 07/06/99
Page 1

Thermo NUtech

QC RESULTS

SDG 5134
Work Order N905014-01
Received Date 05/03/99

Client ROGERS ASSO
Contract 9824
Matrix URINE

Lab Sample ID	Nuclide	Results	Units	Amount Added	MDA	Evaluation
BLANK						
5134-004	C14	-0.264 ± 0.75	pCi/Smpl	NA	1.26	<MDA
	Sr 90	0.009 ± 0.062	pCi/Smpl	NA	0.490	<MDA

Certified by [signature]
Report Date 07/06/99
Page 2

D. BURNHART

Rogers & Associates Engineering Corporation
515 East 4500 South
Salt Lake City, UT 84107 (801) 263-1600 FAX (801) 262-1527

CHAIN OF CUSTODY RECORD - RAE

PROJ. NO.: 9824

PROJECT NAME: BURBANK

SAMPLERS: (SIGNATURES) D Burnhart

SAMPLE NUMBER	DATE M/D/Y	TIME	STATION LOCATION	NUMBER OF CONTAINERS	TYPE OF CONTAINERS	Sr-90	C-14					REMARKS
24-30-DB01			BERNHARDT, URINE BIOASS	1	BOTTLE	↓	↓					Urine, BIOASSAY 4/26-29
↓ 02			NIELSON ↓	↓	↓	↓	↓					4/28
↓ 03			HOLYRAS									4/26-4/29
												COLLECTED 4/26-4/30

RELINQUISHED BY: (SIG.)	DATE/TIME	RECEIVED BY: (SIG)	RELINQUISHED BY: (SIG)	DATE/TIME	RECEIVED BY: (SIG)
D Burnhart	4/30/99	UPS	UPS	5/03/99 11:30	M. Goldenberg 5/03/99 11:30
RELINQUISHED BY: (SIG.)	DATE/TIME	RECEIVED BY: (SIG)	RELINQUISHED BY: (SIG)	DATE/TIME	RECEIVED BY: (SIG)

RELINQUISHED BY: (SIG.)	DATE/TIME	RECEIVED FOR LABORATORY BY: (SIG)	DATE/TIME	REMARKS:

A-27

Tritium Distillation	[illegible]	5/ [illegible]		
Strontium-89+90, total	0.48 pCi/mL	5/ 4/99	14:49	
Tritium (Oxide)	0.0001 mg/L			
Uranium (KPA), total				

QA/QC Report for Acculabs Job Number 029990

Acculabs Inc.

PARAMETER	DETECTION LIMIT	DATE OF ANALYSIS	TIME OF ANALYSIS	ANALYST	METHOD
Lab Sample Number: 99-A7333					
Client Sample ID: DAVE BERNHARDT					
Tritium Distillation	NA	5/ 4/99	12:00	JS	References 1, 3, 4, 6, 8
Strontium-89+90, total	3.8 pCi/L	4/27/99	13:02	JD	References 1, 2, 3, 4, 6, 8, 9
Tritium (Oxide)	0.50 pCi/mL	5/ 7/99	12:00	JS	References 1, 3, 4, 6, 8, 9
Uranium (KPA), total	0.0001 mg/L	5/ 4/99	14:49	JBS	Reference 16
Lab Sample Number: 99-A7334					
Client Sample ID: MICKEY HEALY					
Tritium Distillation	NA	5/ 4/99	12:00	JS	References 1, 3, 4, 6, 8
Strontium-89+90, total	4.1 pCi/L	4/27/99	13:02	JD	References 1, 2, 3, 4, 6, 8, 9
Tritium (Oxide)	0.49 pCi/mL	5/ 7/99	12:00	JS	References 1, 3, 4, 6, 8, 9
Uranium (KPA), total	0.0001 mg/L	5/ 4/99	14:49	JBS	Reference 16
Lab Sample Number: 99-A7335					
Client Sample ID: KIRK NIELSON					
Tritium Distillation	NA	5/ 4/99	12:00	JS	References 1, 3, 4, 6, 8
Strontium-89+90, total	8.4 pCi/L	4/27/99	13:02	JD	References 1, 2, 3, 4, 6, 8, 9
Tritium (Oxide)	0.48 pCi/mL	5/ 7/99	12:00	JS	References 1, 3, 4, 6, 8, 9
Uranium (KPA), total	0.0001 mg/L	5/ 4/99	14:49	JBS	Reference 16
Lab Sample Number: 99-A7336					
Client Sample ID: HOLLY RASMUSSEN					
Strontium-89+90, total	14 pCi/L	4/27/99	13:02	JD	References 1, 3, 4, 6, 8
Uranium (KPA), total	0.0001 mg/L	5/ 4/99	14:49	JBS	References 1, 2, 3, 4, 6, 8, 9
					Reference 16
Lab Sample Number: 99-A7337					
Client Sample ID: JOHN SALSMAN					
Strontium-89+90, total	8.0 pCi/L	4/27/99	13:02	JD	References 1, 2, 3, 4, 6, 8, 9
Uranium (KPA), total	0.0001 mg/L	5/ 4/99	14:49	JBS	Reference 16

Acculabs Inc.

QA/QC Report for Acculabs Job Number 029990

PARAMETER	DETECTION LIMIT	DATE OF ANALYSIS	TIME OF ANALYSIS	ANALYST	METHOD
Lab Sample Number: 99-A7338					
Client Sample ID: BRAD SQUIBB					
Tritium Distillation	NA	5/ 4/99	12:00	JS	References 1, 3, 4, 6, 8
Strontium-89+90, total	4.8 pCi/L	4/27/99	13:02	JD	References 1, 2, 3, 4, 6, 8, 9
Tritium (Oxide)	0.48 pCi/mL	5/ 7/99	12:00	JS	References 1, 3, 4, 6, 8, 9
Uranium (KPA), total	0.0001 mg/L	5/ 4/99	14:49	JBS	Reference 16
Lab Sample Number: 99-A7339					
Client Sample ID: TIM MERRIT					
Tritium Distillation	NA	5/ 4/99	12:00	JS	References 1, 3, 4, 6, 8
Strontium-89+90, total	4.4 pCi/L	4/27/99	13:02	JD	References 1, 2, 3, 4, 6, 8, 9
Tritium (Oxide)	0.48 pCi/mL	5/ 7/99	12:00	JS	References 1, 3, 4, 6, 8, 9
Uranium (KPA), total	0.0001 mg/L	5/ 4/99	14:49	JBS	Reference 16
Lab Sample Number: 99-A7340					
Client Sample ID: ENRIQUE					
Tritium Distillation	NA	5/ 4/99	12:00	JS	References 1, 3, 4, 6, 8
Strontium-89+90, total	4.4 pCi/L	4/27/99	13:02	JD	References 1, 2, 3, 4, 6, 8, 9
Tritium (Oxide)	0.49 pCi/mL	5/ 7/99	12:00	JS	References 1, 3, 4, 6, 8, 9
Uranium (KPA), total	0.0001 mg/L	5/ 4/99	14:49	JBS	Reference 16
Lab Sample Number: 99-A7341					
Client Sample ID: ENRIQUE GUZMAN					
Strontium-89+90, total	18 pCi/L	4/27/99	13:02	JD	References 1, 2, 3, 4, 6, 8, 9
Uranium (KPA), total	0.0001 mg/L	5/ 4/99	14:49	JBS	Reference 16
Lab Sample Number: 99-A7342					
Client Sample ID: JOHN SALSMAN					
Tritium Distillation	NA	5/ 4/99	12:00	JS	References 1, 3, 4, 6, 8
Strontium-89+90, total	6.4 pCi/L	4/27/99	13:02	JD	References 1, 2, 3, 4, 6, 8, 9
Tritium (Oxide)	0.48 pCi/mL	5/ 7/99	12:00	JS	References 1, 3, 4, 6, 8, 9
Uranium (KPA), total	0.0001 mg/L	5/ 4/99	14:49	JBS	Reference 16

Acculabs Inc.

QA/QC Report for Acculabs Job Number 029990

PARAMETER	DETECTION LIMIT	DATE OF ANALYSIS	TIME OF ANALYSIS	ANALYST	METHOD
Lab Sample Number: 99-A7343					
Client Sample ID: D. BERNHARDT					
Tritium Distillation	NA	5/ 4/99	12:00	JS	References 1, 3, 4, 6, 8
Strontium-89+90, total	8.2 pCi/L	5/ 5/99	14:06	JD	References 1, 2, 3, 4, 6, 8, 9
Tritium (Oxide)	0.49 pCi/mL	5/ 7/99	12:00	JS	References 1, 3, 4, 6, 8, 9
Uranium (KPA), total	0.0001 mg/L	5/ 4/99	14:49	JBS	Reference 16
Lab Sample Number: 99-A7344					
Client Sample ID: M. HEALY					
Tritium Distillation	NA	5/ 4/99	12:00	JS	References 1, 3, 4, 6, 8
Strontium-89+90, total	5.4 pCi/L	5/ 5/99	14:06	JD	References 1, 2, 3, 4, 6, 8, 9
Tritium (Oxide)	0.48 pCi/mL	5/ 7/99	12:00	JS	References 1, 3, 4, 6, 8, 9
Uranium (KPA), total	0.0001 mg/L	5/ 4/99	14:49	JBS	Reference 16
Lab Sample Number: 99-A7345					
Client Sample ID: K. NIELSON					
Tritium Distillation	NA	5/ 4/99	12:00	JS	References 1, 3, 4, 6, 8
Strontium-89+90, total	5.6 pCi/L	5/ 5/99	14:06	JD	References 1, 2, 3, 4, 6, 8, 9
Tritium (Oxide)	0.48 pCi/mL	5/ 7/99	12:00	JS	References 1, 3, 4, 6, 8, 9
Uranium (KPA), total	0.0001 mg/L	5/ 4/99	14:49	JBS	Reference 16
Lab Sample Number: 99-A7346					
Client Sample ID: H. RASMUSSEN					
Tritium Distillation	NA	5/ 4/99	12:00	JS	References 1, 3, 4, 6, 8
Strontium-89+90, total	6.2 pCi/L	5/ 5/99	14:06	JD	References 1, 2, 3, 4, 6, 8, 9
Tritium (Oxide)	0.48 pCi/mL	5/ 7/99	12:00	JS	References 1, 3, 4, 6, 8, 9
Uranium (KPA), total	0.0001 mg/L	5/ 4/99	14:49	JBS	Reference 16
Lab Sample Number: 99-A7347					
Client Sample ID: B. SQUIBB					
Tritium Distillation	NA	5/ 4/99	12:00	JS	References 1, 3, 4, 6, 8
Strontium-89+90, total	7.5 pCi/L	5/ 5/99	14:06	JD	References 1, 2, 3, 4, 6, 8, 9
Tritium (Oxide)	0.49 pCi/mL	5/ 7/99	12:00	JS	References 1, 3, 4, 6, 8, 9

Acculabs Inc.

QA/QC Report for Acculabs Job Number 029990

PARAMETER	DETECTION LIMIT	DATE OF ANALYSIS	TIME OF ANALYSIS	ANALYST	METHOD
Lab Sample Number: 99-A7347					
Client Sample ID: B. SQUIBB					
Uranium (KPA), total	0.0001 mg/L	5/ 4/99	14:49	JBS	Reference 16
Lab Sample Number: 99-A7348					
Client Sample ID: T. MERRITT					
Strontium-89+90, total	9.6 pCi/L	5/ 5/99	14:06	JD	References 1, 2, 3, 4, 6, 8, 9
Uranium (KPA), total	0.0001 mg/L	5/ 4/99	14:49	JBS	Reference 16

The reference summary for the Radiochemistry Methods is attached.

Approved by : [illegible] Date : 5/13/99

A-31

Acculabs Inc.
Golden 4663 Table Mountain Drive, Golden CO 80403 ■ 303-277-9514 ■ Fax 277-9512

Date: 05/13/99
Page 1 - A

CASE NARRATIVE

Mr David E Bernhardt
Rogers & Associates Engineering Cor
POB 330
Salt Lake City, UT 84110-0330

Lab Job Number: 029990 ROG001
Date Samples Received: 04/23/99

The following samples were received at the laboratory:

99-A7333	Urine
99-A7334	Urine
99-A7335	Urine
99-A7336	Urine
99-A7337	Urine
99-A7338	Urine
99-A7339	Urine
99-A7340	Urine
99-A7341	Urine
99-A7342	Urine
99-A7343	Urine
99-A7344	Urine
99-A7345	Urine
99-A7346	Urine
99-A7347	Urine
99-A7348	Urine

The samples were received within EPA recommended holding times and in good condition. The radioactivity screen was performed at sample login, if required, and all results were within acceptable limits. If required, a pH screen confirmed that all samples were preserved to acceptable pH levels. Samples were analyzed within holding times as prescribed by the analytical method. Exceptions to these statements, additional information and any analytical anomalies are noted below.

Because each sample was less than 100mls, aliquot sizes for the analyses were much smaller than recommended for the method. This resulted in higher uncertainty values and detection limits.
No replicates were analyzed due to the limited sample volume.
Sample 99a7335 had a Sr90 chemical recovery of 49%. The minimum acceptable is 50%, however there was not enough sample to reanalyze it. A variance was approved by the Quality Assurance Department.

Acculabs Inc.

Date: 05/13/99
Page 2 - A

CASE NARRATIVE

Mr David E Bernhardt
Rogers & Associates Engineering Cor

Lab Job Number: 029990 ROG001
Date Samples Received: 04/23/99

Sections A, B and C of this report contain a total of 12 pages.

Trudy L Scott

Trudy L. Scott
Laboratory Manager

Acculabs Inc.

Date: 05/13/99
Page 1 - B

REPORT OF ANALYSIS

Mr David E Bernhardt
Rogers & Associates Engineering Cor
POB 330
Salt Lake City, UT 84110-0330

Lab Job Number: 029990 ROG001
Date Samples Received: 04/23/99

Acculabs Designation:	99-A7333
Client Designation:	DAVE BERNHARDT
Sample Location:	03/29/99
Location II:	
Date/Time Collected	03/29/99

Radiochemistry (results in pCi/L unless noted):

Uranium, total (mg/L)	< 0.0001
Tritium (Oxide) (pCi/mL)	0.70 +/- 0.28
Strontium-89+90, total	0.9 +/- 8.1

Acculabs Designation:	99-A7334
Client Designation:	MICKEY HEALY
Sample Location:	03/29/99
Location II:	
Date/Time Collected	03/29/99

Radiochemistry (results in pCi/L unless noted):

Uranium, total (mg/L)	0.0002
Tritium (Oxide) (pCi/mL)	0.27 +/- 0.24
Strontium-89+90, total	0.6 +/- 8.5

Acculabs Designation:	99-A7335
Client Designation:	KIRK NIELSON
Sample Location:	03/29/99
Location II:	
Date/Time Collected	03/29/99

Radiochemistry (results in pCi/L unless noted):

Uranium, total (mg/L)	0.0003
Tritium (Oxide) (pCi/mL)	-0.02 +/- 0.23
Strontium-89+90, total	4.1 +/- 15

Acculabs Inc.

Date: 05/13/99
Page 2 - B

REPORT OF ANALYSIS

Mr David E Bernhardt
Rogers & Associates Engineering Cor

Lab Job Number: 029990 ROG001
Date Samples Received: 04/23/99

Acculabs Designation:	99-A7336
Client Designation:	HOLLY RASMUSSEN
Sample Location:	545-85-6970
Location II:	3/29/99
Date/Time Collected	03/29/99

Radiochemistry (results in pCi/L unless noted):

Uranium, total (mg/L)	0.0054
Strontium-89+90, total	-2.2 +/- 28

Acculabs Designation:	99-A7337
Client Designation:	JOHN SALSMAN
Sample Location:	454-37-6733
Location II:	3/29/99
Date/Time Collected	03/29/99

Radiochemistry (results in pCi/L unless noted):

Uranium, total (mg/L)	0.0003
Strontium-89+90, total	11 +/- 17

Acculabs Designation:	99-A7338
Client Designation:	BRAD SQUIBB
Sample Location:	03/29/99
Location II:	
Date/Time Collected	03/29/99

Radiochemistry (results in pCi/L unless noted):

Uranium, total (mg/L)	0.0002
Tritium (Oxide) (pCi/mL)	0.04 +/- 0.23
Strontium-89+90, total	-4.1 +/- 9.7

Acculabs Designation:	99-A7339
Client Designation:	TIM MERRIT
Sample Location:	04/01/99
Location II:	
Date/Time Collected	04/01/99

Radiochemistry (results in pCi/L unless noted):

Uranium, total (mg/L)	< 0.0001

Acculabs Inc.

Date: 05/13/99
Page 3 - B

REPORT OF ANALYSIS

Mr David E Bernhardt
Rogers & Associates Engineering Cor

Lab Job Number: 029990 ROG001
Date Samples Received: 04/23/99

Acculabs Designation:	99-A7339
Client Designation:	TIM MERRIT
Sample Location:	04/01/99
Location II:	
Date/Time Collected	04/01/99
Tritium (Oxide) (pCi/mL)	0.10 +/- 0.23
Strontium-89+90, total	1.4 +/- 9.1

Acculabs Designation:	99-A7340
Client Designation:	ENRIQUE
Sample Location:	04/05/99
Location II:	
Date/Time Collected	04/05/99

Radiochemistry (results in pCi/L unless noted):

Uranium, total (mg/L)	0.0001
Tritium (Oxide) (pCi/mL)	0.35 +/- 0.25
Strontium-89+90, total	2.9 +/- 8.9

Acculabs Designation:	99-A7341
Client Designation:	ENRIQUE GUZMAN
Sample Location:	04/09/99
Location II:	
Date/Time Collected	04/09/99

Radiochemistry (results in pCi/L unless noted):

Uranium, total (mg/L)	0.0005
Strontium-89+90, total	-8.0 +/- 32

Acculabs Designation:	99-A7342
Client Designation:	JOHN SALSMAN
Sample Location:	454-37-6733
Location II:	04/09/99
Date/Time Collected	04/09/99

Radiochemistry (results in pCi/L unless noted):

Uranium, total (mg/L)	< 0.0001
Tritium (Oxide) (pCi/mL)	0.05 +/- 0.23

Acculabs Inc.

REPORT OF ANALYSIS

Mr David E Bernhardt
Rogers & Associates Engineering Cor

Lab Job Number: 029990 ROG001
Date Samples Received: 04/23/99

Acculabs Designation:	99-A7342
Client Designation:	JOHN SALSMAN
Sample Location:	454-37-6733
Location II:	04/09/99
Date/Time Collected	04/09/99
Strontium-89+90, total	1.6 +/- 12

Acculabs Designation:	99-A7343
Client Designation:	D. BERNHARDT
Sample Location:	04/16/99
Location II:	
Date/Time Collected	04/16/99

Radiochemistry (results in pCi/L unless noted):

Uranium, total (mg/L)	0.0001
Tritium (Oxide) (pCi/mL)	0.43 +/- 0.25
Strontium-89+90, total	9.7 +/- 16

Acculabs Designation:	99-A7344
Client Designation:	M. HEALY
Sample Location:	04/16/99
Location II:	
Date/Time Collected	04/16/99

Radiochemistry (results in pCi/L unless noted):

Uranium, total (mg/L)	0.0001
Tritium (Oxide) (pCi/mL)	0.19 +/- 0.24
Strontium-89+90, total	9.1 +/- 10

Acculabs Designation:	99-A7345
Client Designation:	K. NIELSON
Sample Location:	04/16/99
Location II:	
Date/Time Collected	04/16/99

Radiochemistry (results in pCi/L unless noted):

Uranium, total (mg/L)	0.0002
Tritium (Oxide) (pCi/mL)	0.14 +/- 0.23

Acculabs Inc.

REPORT OF ANALYSIS

Mr David E Bernhardt
Rogers & Associates Engineering Cor

Lab Job Number: 029990 ROG001
Date Samples Received: 04/23/99

Acculabs Designation:	99-A7345
Client Designation:	K. NIELSON
Sample Location:	04/16/99
Location II:	
Date/Time Collected	04/16/99
Strontium-89+90, total	4.7 +/- 12

Acculabs Designation:	99-A7346
Client Designation:	H. RASMUSSEN
Sample Location:	04/16/99
Location II:	
Date/Time Collected	04/16/99

Radiochemistry (results in pCi/L unless noted):

Uranium, total (mg/L)	< 0.0001
Tritium (Oxide) (pCi/mL)	0.18 +/- 0.23
Strontium-89+90, total	1.2 +/- 13

Acculabs Designation:	99-A7347
Client Designation:	B. SQUIBB
Sample Location:	04/16/99
Location II:	
Date/Time Collected	04/16/99

Radiochemistry (results in pCi/L unless noted):

Uranium, total (mg/L)	< 0.0001
Tritium (Oxide) (pCi/mL)	0.31 +/- 0.24
Strontium-89+90, total	0.2 +/- 14

Acculabs Designation:	99-A7348
Client Designation:	T. MERRITT
Sample Location:	04/16/99
Location II:	
Date/Time Collected	04/16/99

Radiochemistry (results in pCi/L unless noted):

Uranium, total (mg/L)	0.0003
Strontium-89+90, total	0.1 +/- 19

Acculabs Inc.

Date: 05/13/99
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REPORT OF ANALYSIS

Mr David E Bernhardt
Rogers & Associates Engineering Cor

Lab Job Number: 029990 ROG001
Date Samples Received: 04/23/99

Acculabs Designation:	99-A7348
Client Designation:	T. MERRITT
Sample Location:	04/16/99
Location II:	
Date/Time Collected	04/16/99

NOTES:

Variability of the radioactive disintegration process (counting error) at the 95% confidence level is 1.96 sigma and the level of significance may exceed that of the reported analytical result.

Scheduled sample disposal/return date: June 12, 1999.

Trudy L. Scott
Laboratory Manager

Acculabs Inc.

QA/QC Report for Acculabs Job Number 029990

PARAMETER	DETECTION LIMIT	DATE OF ANALYSIS	TIME OF ANALYSIS	ANALYST	METHOD
Lab Sample Number: 99-A7338					
Client Sample ID: BRAD SQUIBB					
Tritium Distillation	NA	5/ 4/99	12:00	JS	References 1, 3, 4, 6, 8
Strontium-89+90, total	4.8 pCi/L	4/27/99	13:02	JD	References 1, 2, 3, 4, 6, 8, 9
Tritium (Oxide)	0.48 pCi/mL	5/ 7/99	12:00	JS	References 1, 3, 4, 6, 8, 9
Uranium (KPA), total	0.0001 mg/L	5/ 4/99	14:49	JBS	Reference 16
Lab Sample Number: 99-A7339					
Client Sample ID: TIM MERRIT					
Tritium Distillation	NA	5/ 4/99	12:00	JS	References 1, 3, 4, 6, 8
Strontium-89+90, total	4.4 pCi/L	4/27/99	13:02	JD	References 1, 2, 3, 4, 6, 8, 9
Tritium (Oxide)	0.48 pCi/mL	5/ 7/99	12:00	JS	References 1, 3, 4, 6, 8, 9
Uranium (KPA), total	0.0001 mg/L	5/ 4/99	14:49	JBS	Reference 16
Lab Sample Number: 99-A7340					
Client Sample ID: ENRIQUE					
Tritium Distillation	NA	5/ 4/99	12:00	JS	References 1, 3, 4, 6, 8
Strontium-89+90, total	4.4 pCi/L	4/27/99	13:02	JD	References 1, 2, 3, 4, 6, 8, 9
Tritium (Oxide)	0.49 pCi/mL	5/ 7/99	12:00	JS	References 1, 3, 4, 6, 8, 9
Uranium (KPA), total	0.0001 mg/L	5/ 4/99	14:49	JBS	Reference 16
Lab Sample Number: 99-A7341					
Client Sample ID: ENRIQUE GUZMAN					
Strontium-89+90, total	18 pCi/L	4/27/99	13:02	JD	References 1, 2, 3, 4, 6, 8, 9
Uranium (KPA), total	0.0001 mg/L	5/ 4/99	14:49	JBS	Reference 16
Lab Sample Number: 99-A7342					
Client Sample ID: JOHN SALSMAN					
Tritium Distillation	NA	5/ 4/99	12:00	JS	References 1, 3, 4, 6, 8
Strontium-89+90, total	6.4 pCi/L	4/27/99	13:02	JD	References 1, 2, 3, 4, 6, 8, 9
Tritium (Oxide)	0.48 pCi/mL	5/ 7/99	12:00	JS	References 1, 3, 4, 6, 8, 9
Uranium (KPA), total	0.0001 mg/L	5/ 4/99	14:49	JBS	Reference 16

Acculabs Inc.

QA/QC Report for Acculabs Job Number 029990

PARAMETER	DETECTION LIMIT	DATE OF ANALYSIS	TIME OF ANALYSIS	ANALYST	METHOD
Lab Sample Number: 99-A7343					
Client Sample ID: D. BERNHARDT					
Tritium Distillation	NA	5/ 4/99	12:00	JS	References 1, 3, 4, 6, 8
Strontium-89+90, total	8.2 pCi/L	5/ 5/99	14:06	JD	References 1, 2, 3, 4, 6, 8, 9
Tritium (Oxide)	0.49 pCi/mL	5/ 7/99	12:00	JS	References 1, 3, 4, 6, 8, 9
Uranium (KPA), total	0.0001 mg/L	5/ 4/99	14:49	JBS	Reference 16
Lab Sample Number: 99-A7344					
Client Sample ID: M. HEALY					
Tritium Distillation	NA	5/ 4/99	12:00	JS	References 1, 3, 4, 6, 8
Strontium-89+90, total	5.4 pCi/L	5/ 5/99	14:06	JD	References 1, 2, 3, 4, 6, 8, 9
Tritium (Oxide)	0.48 pCi/mL	5/ 7/99	12:00	JS	References 1, 3, 4, 6, 8, 9
Uranium (KPA), total	0.0001 mg/L	5/ 4/99	14:49	JBS	Reference 16
Lab Sample Number: 99-A7345					
Client Sample ID: K. NIELSON					
Tritium Distillation	NA	5/ 4/99	12:00	JS	References 1, 3, 4, 6, 8
Strontium-89+90, total	5.6 pCi/L	5/ 5/99	14:06	JD	References 1, 2, 3, 4, 6, 8, 9
Tritium (Oxide)	0.48 pCi/mL	5/ 7/99	12:00	JS	References 1, 3, 4, 6, 8, 9
Uranium (KPA), total	0.0001 mg/L	5/ 4/99	14:49	JBS	Reference 16
Lab Sample Number: 99-A7346					
Client Sample ID: H. RASMUSSEN					
Tritium Distillation	NA	5/ 4/99	12:00	JS	References 1, 3, 4, 6, 8
Strontium-89+90, total	6.2 pCi/L	5/ 5/99	14:06	JD	References 1, 2, 3, 4, 6, 8, 9
Tritium (Oxide)	0.48 pCi/mL	5/ 7/99	12:00	JS	References 1, 3, 4, 6, 8, 9
Uranium (KPA), total	0.0001 mg/L	5/ 4/99	14:49	JBS	Reference 16
Lab Sample Number: 99-A7347					
Client Sample ID: B. SQUIBB					
Tritium Distillation	NA	5/ 4/99	12:00	JS	References 1, 3, 4, 6, 8
Strontium-89+90, total	7.5 pCi/L	5/ 5/99	14:06	JD	References 1, 2, 3, 4, 6, 8, 9
Tritium (Oxide)	0.49 pCi/mL	5/ 7/99	12:00	JS	References 1, 3, 4, 6, 8, 9

Acculabs Inc.

QA/QC Report for Acculabs Job Number 029990

PARAMETER	DETECTION LIMIT	DATE OF ANALYSIS	TIME OF ANALYSIS	ANALYST	METHOD
Lab Sample Number: 99-A7347					
Client Sample ID: B. SQUIBB					
Uranium (KPA), total	0.0001 mg/L	5/ 4/99	14:49	JBS	Reference 16
Lab Sample Number: 99-A7348					
Client Sample ID: T. MERRITT					
Strontium-89+90, total	9.6 pCi/L	5/ 5/99	14:06	JD	References 1, 2, 3, 4, 6, 8, 9
Uranium (KPA), total	0.0001 mg/L	5/ 4/99	14:49	JBS	Reference 16

The reference summary for the Radiochemistry Methods is attached.

Approved by : [illegible] Date : 5/13/99

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RADIOCHEMISTRY DEPARTMENT
METHOD REFERENCES UTILIZED BY ACCULABS INC.

1. U.S. Environmental Protection Agency, 1979, "Radiochemical Analytical Procedures for Analysis of Environmental Samples", Report No. EMSL-LV-0539-1, Las Vegas, NV.

2. American Public Health Association, American Water Works Association, Water Pollution Control Federation, 1989, "Standard Methods for the Examination of Water and Wastewater", 17th ed., Washington, D.C., Am. Public Health Association.

3. U.S. Environmental Protection Agency, 1976, "Interim Radiochemical Methodology for Drinking Water", Report No. EPA-600/4-75-008, Cincinnati, OH.

4. U.S. Environmental Protection Agency, Eastern Environmental Radiation Facility, "Radiochemistry Procedures Manual", EPA 520/5-84-006, Aug. 1984.

5. Misaqi, Fazlelleh L., "Monitoring Radon-222 Content of Mine Waters Informational Report 1026", U.S. Department of Interior, Mining Enforcement and Safety Administration, Denver, Colorado, 1975.

6. "Radioassay Procedures for Environmental Samples", 1967, USDHEW, Sec. 7.2.3.

7. "Handbook of Analytical Procedures", USAEC, Grand Junction Lab, 1970, p. 196.

8. "Prescribed Procedures for Measurement of Radioactivity in Drinking Water", EPA600/4-80-032, August 1980, Environmental Monitoring and Support Laboratory, Office of Research and Development, U.S. Environmental Protection Agency, Cincinnati, Ohio 45268.

9. "Methods for Determination of Radioactive Substances in Water and Fluvial Sediments", U.S.G.S. Book 5, Chapter A5, 1977.

10. "Acid Dissolution Method for the Analysis of Plutonium in Soil", EPA-600/7-79-081, March 1979, U.S. EPA Environmental Monitoring and Support Laboratory, Las Vegas, Nevada, 1979.

11. "Procedures for the Isolation of Alpha Spectrometrically Pure Plutonium, Uranium and Americium", by E.H. Essington and E.J. Drennon, Los Alamos National Lab, private communication.

12. "Isolation of Americium from Urine Samples", Rocky Flats Plant, Health Safety and Environmental Laboratories, Laboratory Procedure, HS and EL-7, revised 01/21/83.

13. Volchok, H.L., ed., 1982, "EML Procedures Manual", HASL-300-Ed. 25 (DE 83010805); Environmental Measurements Laboratory, U.S. D.O.E., 376 Hudson Street, New York NY 10014.

METHOD REFERENCES
CONTINUED

14. "Tritium by Vacuum Sublimination", Health Protection Department/Savannah River Plant, S.C., DPSOPREF-271-5-257, Approved 10/24/68.

5. "The Environmental Survey Manual, Appendix D", US DOE, DOE/EH-0053, Vol. 3 or 4, August 1987, pg. D-722.

5. "1992 Annual Book of ASTM Standards Vol. 11.01 & Vol. 11.02 Water", ASTM, Philadelphia, PA 19103-1187.

Volchok, H.L., and dePlanque G., "Radiochemical Determination of Technetium-99", EML Procedures Manual, 25th Edition, 1982 E-Tc-01-01.

Walker, C.R., Short, B.W. and Spring, H.S., "The Determination of Technetium-99 by Liquid Scintillation Counting," Radioelement Analysis Progress and Problems, October 9-11, 1979, p. 101-110.

Sullivan, T., Nelson, D. and Thompson E., "Determination of Technetium-99 in Borehold Waters using an Extraction Chromatographic Resin (1), " Workshop on Extraction Chromatography, 37th Annual Conference on Bioassay, Analytical and Environmental Radiochemistry, 7(1991) 1-4.

Reese, T., "Sequential Separation of Thorium, Uranium, Neptunium, Plutonium, Americium and Curium", Thesis, Colorado School of Mines, 1983.

Cleveland, J.M., "The Chemistry of Plutonium", Americium Nuclear Society, 1979, p. 142-158.

JS EPA, Office of Research & Development, Environmental Monitoring Systems .aboratory - Las Vegas, Las Vegas, NV 89193-3478.

PA Method 913.0. "The Determination of Radon in Drinking Water by Liquid cintillation Counting", Draft Version, May 1991.

nerican Public Health Association, American Water Works Association, Water llution Control Federation, 1995, "Standard Methods for the Examination of Water f Wastewater", 19th ed., Washington, D.C., American Public Health Association.

'94 Annual Book of ASTM Standards, Vol. 1 1.01 and Vol. 11.02 Water", ASTM, adelphia, PA 19103-1187.

lth and Environmental Chemistry: Analytical Techniques, Data Management, Quality Assurance", LA-10300-M, Vols. 1, 11, 111, IV Manual, Margaret A. er, ed., Los Alamos National Laboratory, Los Alamos, NM 87545.

METHOD REFERENCES
CONTINUED

27. " 1983 Annual Book of ASTM Standards", ASTM, Philadelphia, PA 19103-1187, Method #3357.

28. "Collected Radiochemical Procedures (Radiochemistry Group CNC- 1 1) ", LA- 1721, 4th Ed., UC-4, Chemistry, April, 1975, Jacob Klienberg and Helen Smith, ed., Los Alamos Scientific Laboratory, Los Alamos, NM 87545.

29. "Procedures for radiochemical Analysis of Nuclear Reactor Aqueous Solutions", PB-222 154, May 1973, H.L. Krieger and S. Gold, National Environmental Research Center, Office of Research and Development, U.S. Environmental Protection Agency, Cincinnatti, OH 45268.

30. "EML Procedures Manual", 27th ed., 1990, N.L. Chieco; D.C. Bogen, E.O. Knutson, ed.; Environmental Measurements Laboratory, U.S. D.O.E., 376 Hudson Street, New York, NY 10014.

Acculabs Inc.

QA/QC Report for Acculabs Job Number 029990

PARAMETER	DETECTION LIMIT	DATE OF ANALYSIS	TIME OF ANALYSIS	ANALYST	METHOD
Lab Sample Number: 99-A7333					
Client Sample ID: DAVE BERNHARDT					
Tritium Distillation	NA	5/ 4/99	12:00	JS	References 1, 3, 4, 6, 8
Strontium-89+90, total	3.8 pCi/L	4/27/99	13:02	JD	References 1, 2, 3, 4, 6, 8, 9
Tritium (Oxide)	0.50 pCi/mL	5/ 7/99	12:00	JS	References 1, 3, 4, 6, 8, 9
Uranium (KPA), total	0.0001 mg/L	5/ 4/99	14:49	JBS	Reference 16
Lab Sample Number: 99-A7334					
Client Sample ID: MICKEY HEALY					
Tritium Distillation	NA	5/ 4/99	12:00	JS	References 1, 3, 4, 6, 8
Strontium-89+90, total	4.1 pCi/L	4/27/99	13:02	JD	References 1, 2, 3, 4, 6, 8, 9
Tritium (Oxide)	0.49 pCi/mL	5/ 7/99	12:00	JS	References 1, 3, 4, 6, 8, 9
Uranium (KPA), total	0.0001 mg/L	5/ 4/99	14:49	JBS	Reference 16
Lab Sample Number: 99-A7335					
Client Sample ID: KIRK NIELSON					
Tritium Distillation	NA	5/ 4/99	12:00	JS	References 1, 3, 4, 6, 8
Strontium-89+90, total	8.4 pCi/L	4/27/99	13:02	JD	References 1, 2, 3, 4, 6, 8, 9
Tritium (Oxide)	0.48 pCi/mL	5/ 7/99	12:00	JS	References 1, 3, 4, 6, 8, 9
Uranium (KPA), total	0.0001 mg/L	5/ 4/99	14:49	JBS	Reference 16
Lab Sample Number: 99-A7336					
Client Sample ID: HOLLY RASMUSSEN					
Strontium-89+90, total	14 pCi/L	4/27/99	13:02	JD	References 1, 2, 3, 4, 6, 8, 9
Uranium (KPA), total	0.0001 mg/L	5/ 4/99	14:49	JBS	Reference 16
Lab Sample Number: 99-A7337					
Client Sample ID: JOHN SALSMAN					
Strontium-89+90, total	8.0 pCi/L	4/27/99	13:02	JD	References 1, 2, 3, 4, 6, 8, 9
Uranium (KPA), total	0.0001 mg/L	5/ 4/99	14:49	JBS	Reference 16

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Appendix B

Appendix B

Summary of Analytical Data From Paragon Analytics

This a appendix provides three tables that provide summaries of the analytical data from Paragon Labs. The data from Thermo NUteck was only for Sr-90 and the complete data set is given in Chapter 4.

Table B-1, two pages provides the primary data used in Tables 4-1and 4-2, and includes all of the isotopes of uranium and thorium. The analytical error terms for the data is also given.

Table B-2a provides the data for many other radionuclides reported by the laboratory.

Table B-2b provides the data for laboratory control samples.

The data reported in these tables was taken from an electronic file provided by the laboratory.

The detailed laboratory reports are given in Appendix D.

Table B-1
Laboratory Analytical Rresults
page 1 of 2

Lab ID	Sample No.	Hole No.	Area	U-238 pCi/g	±	U-234 pCi/g	±	U-235 pCi/g	±	Th-230 pCi/g	±	Ra-226 pCi/g	±	Th-232 pCi/g	±	Ra-228 pCi/g	±	Cs-137 pCi/g	±	Co-60 pCi/g	±	K-40 pCi/g	±
99-04-226-77	24-08DB05	1	C-14 lab									< 0.6				1.1	± 0.5	65	± 11	< 0.2		19	± 5
99-04-226-84	24-17KN1	2	C-14 lab									0.5	± 0.3			< 0.6		< 0.2		< 0.3		19	± 5
99-04-226-02	24-16DB18	8	shop									< 0.8				< 0.7		150	± 25	< 0.3		20	± 5
99-04-226-51	24-16DB16	11	shop									0.5	± 0.4			< 0.8		< 0.3		< 0.2		24	± 6
99-04-226-01	24-16DB17	11	shop									0.5	± 0.2			< 0.4		< 0.1		< 0.1		20	± 4
99-04-226-43	24-16DB08	12										0.6	± 0.4			< 0.6		21	± 3	1.4	± 0.3	19	± 4
99-04-226-44	24-16DB09	12										0.4	± 0.2			< 0.7		0.3	± 0.2	2.4	± 0.5	18	± 4
99-04-226-45	24-16DB10	13										< 0.7				< 0.5		117	± 19	< 0.2		18	± 5
99-04-226-46	24-16DB11	13										< 1.1				< 0.7		366	± 61	< 0.2		20	± 5
99-04-226-30	24-07KN01	14	Co-60 pool	0.4	± 0.1	0.4	± 0.1	< 0.05		0.8	± 0.2	< 1.1		0.9	± 0.2	< 0.8		479	± 79	< 0.3		20	± 5
99-04-226-31	24-07KN02	14	Co-60 pool	0.3	± 0.1	0.3	± 0.1	< 0.05		0.5	± 0.1	< 1.0		1.0	± 0.2	0.9	± 0.4	610	± 100	< 0.1		19	± 4
99-04-226-32	24-16DB64	14										< 1.7				< 0.4		880	± 150	< 0.1		22	± 5
99-04-226-34	24-08DB01	14		0.3	± 0.1	0.4	± 0.1	< 0.06		0.6	± 0.1	< 4.7		0.8	± 0.1	< 1.2		4700	± 770	< 0.3		21	± 5
99-04-226-73	24-15DB04	15	Co-60 pool									1.2	± 0.4			0.9	± 0.6	12	± 2	< 0.3		20	± 5
99-04-226-74	24-15DB05	15	Co-60 pool									0.6	± 0.3			1.0	± 0.3	7.4	± 1.3	< 0.1		21	± 4
99-04-226-D6	24-15DB05-D	15	Co-60 pool									0.6	± 0.3			1.1	± 0.5	6.3	± 1.2	< 0.2		16	± 5
99-04-226-78	24-15DB06	15	Co-60 pool									0.6	± 0.3			< 0.7		7.1	± 1.3	< 0.3		16	± 4
99-04-226-36	24-16DB01	16										< 0.8				1.6	± 0.8	124	± 21	0.8	± 0.3	21	± 6
99-04-226-62	24-16DB60	16										< 0.7				1.1	± 0.7	120	± 20	0.7	± 0.3	19	± 6
99-04-226-37	24-16DB02	16										< 0.4				0.9	± 0.4	40	± 7	0.2	± 0.1	17	± 4
99-04-226-38	24-16DB03	17										0.3	± 0.2			1.5	± 0.6	2.8	± 0.6	< 0.3		24	± 6
99-04-226-D4	24-16DB03-D	17										< 0.3				1.4	± 0.6	3.9	± 0.8	< 0.2		25	± 6
99-04-226-39	24-16DB04	17										0.4	± 0.3			< 0.7		< 0.1		< 0.2		18	± 4
99-04-226-41	24-16DB06	18								0.9	± 0.3	< 0.5		0.9	± 0.3	1.5	± 0.6	42	± 7	0.2	± 0.1	16	± 4
99-04-226-42	24-16DB07	18								0.7	± 0.3	< 0.9		0.9	± 0.3	1.5	± 0.7	268	± 44	0.9	± 0.2	19	± 5
99-04-226-63	24-16DB61	18								0.9	± 0.3	< 1.1		1.2	± 0.3	0.7	± 0.6	342	± 56	0.6	± 0.2	17	± 4
99-04-226-40	24-16DB05	19		0.3	± 0.1	0.4	± 0.1	< 0.06		0.4	± 0.1	< 8.0		0.8	± 0.1	< 2.5		5520	± 910	2.4	± 0.6	18	± 6
99-04-226-59	24-09JS-7	3	shop									0.5	± 0.3			< 0.4		3.4	± 0.7	< 0.2		19	± 5
99-04-226-60	24-09JS-8	3	shop									0.5	± 0.3			< 0.6		2.0	± 0.4	< 0.2		20	± 5
99-04-226-57	24-09JS-5	4	shop									0.5	± 0.3			1.1	± 0.5	1.1	± 0.3	< 0.3		19	± 5
99-04-226-58	24-09JS-6	4	shop									0.6	± 0.3			0.9	± 0.4	1.5	± 0.3	< 0.1		22	± 5
99-04-226-D6	24-09JS-6-D	4	shop									0.7	± 0.3			1.1	± 0.5	1.3	± 0.4	< 0.2		24	± 6
99-04-226-90	24-04DB01	5										0.6	± 0.4			< 0.8		0.2	± 0.2	< 0.3		23	± 6
99-04-226-91	24-04DB02	5										0.5	± 0.3			1.2	± 0.6	0.3	± 0.2	< 0.3		16	± 4
99-04-226-DN	24-04DB02-D	5										0.5	± 0.3			1.0	± 0.5	0.4	± 0.2	< 0.2		19	± 5
99-04-226-53	24-09JS-1	6	shop									< 0.3				< 0.6		0.5	± 0.2	< 0.2		19	± 5
99-04-226-54	24-09JS-2	6	shop									0.6	± 0.2			< 0.5		< 0.1		< 0.1		19	± 4
99-04-226-55	24-09JS-3	7	shop									0.7	± 0.4			< 0.6		0.5	± 0.2	< 0.2		25	± 6
99-04-226-92	24-16DB62	7								1.0	± 0.3	0.4	± 0.3	1.0	± 0.3	1.3	± 0.5	0.5	± 0.2	< 0.2		17	± 5
99-04-226-56	24-09JS-4	7	shop									0.5	± 0.3			< 0.5		< 0.1		< 0.2		16	± 4
99-04-226-64	24-16DB63	7										8.1	± 1.6			9.5	± 1.7	0.2	± 0.2	< 0.1		14	± 3
99-04-226-49	24-16DB14	9	shop									< 0.2				< 0.8		< 0.1		< 0.3		22	± 6
99-04-226-50	24-16DB15	9	shop									0.6	± 0.3			< 0.6		< 0.2		< 0.2		22	± 5
99-04-226-16	24-16DB32	20	shop	0.5	± 0.1	0.4	± 0.1	< 0.03		0.4	± 0.1	0.5	± 0.3	0.7	± 0.1	< 0.5		< 0.2		< 0.2		24	± 5
9904226-16-D1	24-16DB32	20	shop	0.4	± 0.1	0.4	± 0.1	< 0.03		0.4	± 0.1			0.7	± 0.1								
99-04-226-17	24-16DB33	20	shop									0.5	± 0.3			< 1.0		< 0.2		< 0.3		18	± 6
99-04-226-20	24-16DB36	21	shop							0.5	± 0.2	0.7	± 0.3	0.7	± 0.2	< 0.6		< 0.1		< 0.2		19	± 5
99-04-226-21	24-16DB37	21	shop									< 0.4				< 1.0		< 0.2		< 0.2		20	± 6
99-04-226-18	24-16DB34	22	shop									0.3	± 0.3			< 0.8		< 0.2		< 0.2		22	± 6
99-04-226-19	24-16DB35	22	shop									0.4	± 0.3			< 0.7		< 0.1		< 0.2		18	± 4
99-04-226-14	24-16DB30	23	shop									< 0.4				< 1.2		< 0.2		< 0.3		27	± 7
99-04-226-15	24-16DB31	23	shop									< 0.2				0.8	± 0.3	< 0.1		< 0.1		19	± 4
99-04-226-13	24-16DB29	24	shop	3.4	± 0.5	2.8	± 0.4	0.20	± 0.06	3.2	± 0.5	2.2	± 0.6	3.0	± 0.4	< 1.1		< 0.2		< 0.2		6	± 4
9904226-13-D1	24-16DB29	24	shop	3.5	± 0.5	2.9	± 0.4	0.22	± 0.07	3.8	± 0.5			3.0	± 0.4								
99-04-226-11	24-16DB27	25	shop									0.6	± 0.2			0.7	± 0.4	< 0.1		< 0.1		17	± 4
99-04-226-12	24-16DB28	25	shop									< 0.3				1.6	± 0.7	< 0.2		< 0.2		26	± 6
99-04-226-D2	24-16DB28-D	25	shop									0.7	± 0.3			< 0.8		< 0.2		< 0.2		23	± 6
99-04-226-09	24-16DB25	26	shop									0.5	± 0.3			< 0.9		< 0.2		< 0.2		19	± 5
99-04-226-10	24-16DB26	26	shop									0.5	± 0.2			< 0.6		< 0.2		< 0.2		19	± 5
99-04-226-07	24-16DB23	27	shop							0.7	± 0.3	0.6	± 0.3	1.1	± 0.3	< 0.6		< 0.1		< 0.2		24	± 5
9904226-7-D1	24-16DB23	27	shop							0.9	± 0.3			1.3	± 0.4								
99-04-226-08	24-16DB24	27	shop									0.5	± 0.3			< 0.6		< 0.2		< 0.1		21	± 5
99-04-226-05	24-16DB21	29	shop									0.6	± 0.3			< 0.6		< 0.2		< 0.2		23	± 5
99-04-226-06	24-16DB22	29	shop									0.6	± 0.3			1.0	± 0.4	< 0.2		< 0.2		16	± 5
99-04-226-03	24-16DB19	30	shop									0.4	± 0.2			< 0.5		< 0.1		< 0.3		20	± 5
99-04-226-D1	24-16DB19-D	30	shop									< 0.2				< 0.6		< 0.2		< 0.1		18	± 5
99-04-226-04	24-16DB20	30	shop									0.5	± 0.2			1.1	± 0.4	< 0.1		< 0.1		17	± 4
99-04-226-47	24-16DB12	31	shop									0.7	± 0.3			1.3	± 0.5	< 0.2		< 0.2		23	± 5
99-04-226-48	24-16DB13	31										0.7	± 0.3			< 0.7		< 0.2		< 0.2		20	± 5
99-04-226-D5	24-16DB13-D	31										0.8	± 0.2			0.8	± 0.3	< 0.1		< 0.1		19	± 4

Table B-1
Laboratory Analytical Results
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Lab ID	Sample No.	Hole No.	Area	U-238 pCi/g	±	U-234 pCi/g	±	U-235 pCi/g	±	Th-230 pCi/g	±	Ra-226 pCi/g	±	Th-232 pCi/g	±	Ra-228 pCi/g	±	Cs-137 pCi/g	±	Co-60 pCi/g	±	K-40 pCi/g	±
99-04-226-22	24-16DB38	32	shop	0.3	± 0.1	0.3	± 0.1	< 0.06		0.4	± 0.1	0.4	± 0.3	0.9	± 0.2	< 0.8		< 0.1		< 0.2		23	± 6
99-04-226-23	24-16DB39	32	shop							1.0	± 0.3	< 0.2		0.4	± 0.2	1.0	± 0.4	< 0.1		< 0.1		26	± 5
99-04-226-24	24-16DB40	33	shop	0.4	± 0.1	0.5	± 0.1	< 0.04		0.5	± 0.1	0.4	± 0.3	0.7	± 0.1	< 0.4		< 0.2		< 0.2		24	± 5
99-04-226-25	24-16DB41	33	shop							0.9	± 0.3	< 0.3		1.7	± 0.4	< 0.9		< 0.2		< 0.3		27	± 6
99-04-226-26	24-16DB42	34	shop	0.4	± 0.1	0.4	± 0.1	< 0.06		0.4	± 0.1	0.4	± 0.3	1.0	± 0.2	1.0	± 0.5	< 0.1		< 0.2		24	± 6
99-04-226-D3	24-16DB42-D	34	shop									0.5	± 0.2			0.8	± 0.3	< 0.1		< 0.1		20	± 4
99-04-226-27	24-16DB43	34	shop							0.8	± 0.3	0.5	± 0.3	0.5	± 0.2	1.1	± 0.5	< 0.1		< 0.2		25	± 5
99-04-226-49	24-16DB14	9	shop									< 0.2				< 0.8		< 0.1		< 0.3		22	± 6
99-04-226-50	24-16DB15	9	shop									0.6	± 0.3			< 0.6		< 0.2		< 0.2		22	± 5
99-04-226-01	24-16DB17	11	shop									0.5	± 0.2			< 0.4		< 0.1		< 0.1		20	± 4
99-04-226-51	24-16DB16	11	shop									0.5	± 0.4			< 0.8		< 0.3		< 0.2		24	± 6
99-04-226-11	24-16DB27	25	shop									0.6	± 0.2			0.7	± 0.4	< 0.1		< 0.1		17	± 4
99-04-226-12	24-16DB28	25	shop									< 0.3				1.6	± 0.7	< 0.2		< 0.2		26	± 6
99-04-226-D2	24-16DB28-D	25	shop									0.7	± 0.3			< 0.8		< 0.2		< 0.2		23	± 6
99-04-226-09	24-16DB25	26	shop									0.5	± 0.3			< 0.9		< 0.2		< 0.2		19	± 5
99-04-226-10	24-16DB26	26	shop									0.5	± 0.2			< 0.6		< 0.2		< 0.2		19	± 5
99-04-226-05	24-16DB21	29	shop									0.6	± 0.3			< 0.6		< 0.2		< 0.2		23	± 5
99-04-226-06	24-16DB22	29	shop									0.6	± 0.3			1.0	± 0.4	< 0.2		< 0.2		18	± 5
99-04-226-03	24-16DB19	30	shop									0.4	± 0.2			< 0.5		< 0.1		< 0.3		20	± 5
99-04-226-D1	24-16DB19-D	30	shop									< 0.2				< 0.6		< 0.2		< 0.1		18	± 5
99-04-226-04	24-16DB20	30	shop									0.5	± 0.2			1.1	± 0.4	< 0.1		< 0.1		17	± 4
99-04-226-47	24-16DB12	31	shop									0.7	± 0.3			1.3	± 0.5	< 0.2		< 0.2		23	± 5
99-04-226-48	24-16DB13	31										0.7	± 0.3			< 0.7		< 0.2		< 0.2		20	± 5
99-04-226-D5	24-16DB13-D	31										0.6	± 0.2			0.8	± 0.3	< 0.1		< 0.1		19	± 4
99-04-226-22	24-16DB38	32	shop	0.3	± 0.1	0.3	± 0.1	< 0.06		0.4	± 0.1	0.4	± 0.3	0.9	± 0.2	< 0.8		< 0.1		< 0.2		23	± 6
99-04-226-23	24-16DB39	32	shop							1.0	± 0.3	< 0.2		0.4	± 0.2	1.0	± 0.4	< 0.1		< 0.1		26	± 5
99-04-226-24	24-16DB40	33	shop	0.4	± 0.1	0.5	± 0.1	< 0.04		0.5	± 0.1	0.4	± 0.3	0.7	± 0.1	< 0.4		< 0.2		< 0.2		24	± 5
99-04-226-25	24-16DB41	33	shop							0.9	± 0.3	< 0.3		1.7	± 0.4	< 0.9		< 0.2		< 0.3		27	± 6
99-04-226-26	24-16DB42	34	shop	0.4	± 0.1	0.4	± 0.1	< 0.06		0.4	± 0.1	0.4	± 0.3	1.0	± 0.2	1.0	± 0.5	< 0.1		< 0.2		24	± 6
99-04-226-D3	24-16DB42-D	34	shop									0.5	± 0.2			0.8	± 0.3	< 0.1		< 0.1		20	± 4
99-04-226-27	24-16DB43	34	shop							0.8	± 0.3	0.5	± 0.3	0.5	± 0.2	1.1	± 0.5	< 0.1		< 0.2		25	± 5
99-04-226-28	24-16DB44	35	neighbor									0.5	± 0.3			1.0	± 0.4	< 0.2		< 0.2		23	± 5
99-04-226-29	24-16DB45	35	neighbor									0.4	± 0.3			< 0.7		< 0.1		< 0.2		16	± 4
99-04-226-66	24-08DB02			170	± 41	183	± 43	< 23.		3690	± 550	50	± 9	470	± 140	258	± 44	34	± 6	< 0.8		40	± 11
9904226-66-D1	24-08DB02									4010	± 570			360	± 110								
99-04-226-D7	24-08DB02-D											45	± 8			242	± 40	30	± 5	< 1.0		37	± 10
9904226-68-D1	24-16DB-65			155	± 33	141	± 31	< 9.5															
99-04-226-68	24-16DB-65			149	± 29	131	± 27	10.3	± 6.2	3870	± 560	46	± 8	420	± 120	235	± 39	30	± 5	< 0.9		36	± 12
99-04-226-65	24-08DB03									88	± 11	15	± 3	11	± 2	16	± 3	0.4	± 0.3	< 0.2		23	± 5
99-04-226-69	24-16DB-66			16	± 4	16	± 4	< 2.0		177	± 72	14	± 2	< 45		26	± 4	0.6	± 0.2	< 0.2		20	± 4
99-04-226-70	24-15DB01			43	± 14	37	± 13	< 9.4		2240	± 360	44	± 8	182	± 80	171	± 28	92	± 15	< 0.6		30	± 9
99-04-226-71	24-15DB02			63	± 19	58	± 16	< 8.8		3960	± 570	48	± 8	450	± 130	236	± 39	30	± 5	< 1.0		32	± 11
99-04-226-76	24-08DB04											8.0	± 1.6			8.3	± 1.5	10	± 2	< 0.2		19	± 4
99-04-226-52	24-07JS-1		rear asphalt									0.6	± 0.4			< 0.8		< 0.2		< 0.3		17	± 5
99-04-226-79	24-17DB01			0.5	± 0.1	0.8	± 0.2	0.29	± 0.08	0.6	± 0.1	0.4	± 0.3	1.0	± 0.2	< 0.7		< 0.1		< 0.3		20	± 5
99-04-226-67	24-16DB-70			0.6	± 0.1	0.8	± 0.2	0.31	± 0.08	0.5	± 0.1	< 0.3		1.0	± 0.2	< 0.7		< 0.2		< 0.3		17	± 5
99-04-226-80	24-17DB02			0.6	± 0.1	0.6	± 0.1	0.12	± 0.06	0.5	± 0.1	0.5	± 0.3	1.0	± 0.2	1.1	± 0.4	< 0.1		< 0.1		22	± 5
99-04-226-81	24-17DB03		–	0.8	± 0.2	0.7	± 0.1	< 0.06		0.5	± 0.1	0.6	± 0.3	0.9	± 0.2	0.9	± 0.4	< 0.1		< 0.2		20	± 5
99-04-226-82	24-17DB04			0.5	± 0.1	0.3	± 0.1	< 0.08		0.6	± 0.1	0.3	± 0.2	0.9	± 0.2	0.9	± 0.3	< 0.1		< 0.1		20	± 4
99-04-226-D9	24-17DB04-D											< 0.3				1.0	± 0.5	< 0.2		< 0.2		16	± 4
99-04-226-83	24-17DB05			0.5	± 0.1	0.5	± 0.1	< 0.05		0.6	± 0.1	0.6	± 0.4	1.0	± 0.2	< 1.0		< 0.2		< 0.2		26	± 6
99-04-226-85	24-16DB50											< 0.6				< 0.5		131	± 22	< 0.2		14	± 4
99-04-226-72	24-15DB03											< 3.0				< 5.1		< 1.9		< 1.6		22	± 21
99-04-226-61	24-09JS-9											< 0.9				< 1.6		< 0.4		< 0.5		< 4	

Table B-2a. Complete listing of laboratory analytical results: samples

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lab ID	Sample No.	Hole	Area	Sample	Count	Ac-228				Ag-110m				Am-241				Be-7				Bi-212				Bi-214				Ce-139				Ce-144				
		No.		Date	Date	pCi/g	±	mdc	f	pCi/g	±	mdc	f	pCi/g	±	mdc	f	pCi/g	±	mdc	f	pCi/g	±	mdc	f	pCi/g	±	mdc	f	pCi/g	±	mdc	f	pCi/g	±	mdc	f	pCi/g
99-04-226-01	24-16DB17	11	shop	4/16/99	6/22/99			0.4	U			0.1	U			0.5	U			1.6	U			1.2	U	0.5	0.3					0.1	U			0.6	U	
99-04-226-02	24-16DB18	8	shop	4/16/99	6/22/99			0.7	U			1.1	U			1.2	U			12.0	U			1.8	U			0.6	U			0.3	U			1.8	U	
99-04-226-03	24-16DB19	30	shop	4/16/99	6/22/99			0.5	U			0.2	U			0.2	U			2.7	U			2.0	U			0.3	U			0.1	U			0.5	U	
99-04-226-04	24-16DB20	30	shop	4/16/99	6/22/99	1.1	0.4					0.1	U			0.6	U			1.6	U			1.3	U	0.4	0.3					0.1	U			0.6	U	
99-04-226-05	24-16DB21	29	shop	4/16/99	6/22/99			0.6	U			0.2	U			0.8	U			3.0	U			2.0	U	0.5	0.4					0.1	U			0.7	U	
99-04-226-06	24-16DB22	29	shop	4/16/99	6/22/99	1.0	0.4					0.2	U			0.5	U			2.2	U			2.5	U			0.4	U			0.1	U			0.5	U	
99-04-226-07	24-16DB23	27	shop	4/16/99	6/22/99			0.6	U			0.2	U			0.7	U			2.5	U	3.0	1.7			0.6	0.3					0.1	U			0.8	U	
9904226-7-D1	24-16DB23	27	shop	4/16/99	6/18/99																																	
99-04-226-08	24-16DB24	27	shop	4/16/99	6/22/99			0.6	U			0.2	U			0.6	U			2.1	U			1.7	U	0.4	0.3					0.1	U			0.6	U	
99-04-226-09	24-16DB25	26	shop	4/16/99	6/22/99			0.9	U			0.2	U			0.6	U			2.8	U			1.7	U	0.8	0.4					0.1	U			0.6	U	
99-04-226-10	24-16DB26	26	shop	4/16/99	6/22/99			0.6	U			0.2	U			0.5	U			2.4	U	2.1	1.7					0.3	U			0.1	U			0.6	U	
99-04-226-11	24-16DB27	25	shop	4/16/99	6/22/99	0.7	0.4					0.1	U			0.6	U			1.6	U			1.4	U	0.5	0.2					0.1	U			0.5	U	
99-04-226-12	24-16DB28	25	shop	4/16/99	6/22/99	1.6	0.7					0.3	U			1.0	U			2.5	U	2.2	2.2		U	0.4	0.5		U			0.1	U			0.8	U	
99-04-226-13	24-16DB29	24	shop	4/16/99	6/22/99			1.1	U			0.2	U			0.9	U			3.3	U			3.8	U	1.9	0.7					0.2	U			0.9	U	
9904226-13-D1	24-16DB29	24	shop	4/16/99	6/26/99																																	
99-04-226-14	24-16DB30	23	shop	4/16/99	6/22/99			1.2	U			0.2	U			0.3	U			4.1	U			3.5	U			0.3	U			0.1	U			0.7	U	
99-04-226-15	24-16DB31	23	shop	4/16/99	6/22/99	0.8	0.3					0.1	U			0.5	U			1.4	U	1.3	1.2			0.3	0.3					0.1	U			0.6	U	
99-04-226-16	24-16DB32	20	shop	4/16/99	6/22/99			0.5	U			0.2	U			0.7	U			2.3	U			1.5	U	0.4	0.3					0.1	U			0.6	U	
9904226-16-D1	24-16DB32	20	shop	4/16/99	6/26/99																																	
99-04-226-17	24-16DB33	20	shop	4/16/99	6/22/99			1.0	U			0.2	U			0.6	U			3.2	U			3.3	U	0.5	0.4					0.1	U			0.8	U	
99-04-226-18	24-16DB34	22	shop	4/16/99	6/22/99			0.8	U			0.1	U			0.2	U			2.3	U			1.7	U	0.3	0.3		U			0.1	U			0.5	U	
99-04-226-19	24-16DB35	22	shop	4/16/99	6/22/99			0.7	U			0.2	U			0.5	U			2.8	U			2.3	U	0.3	0.3					0.1	U			0.6	U	
99-04-226-20	24-16DB36	21	shop	4/16/99	6/22/99			0.8	U			0.2	U			0.6	U			1.8	U			1.8	U	0.7	0.3					0.1	U			0.7	U	
99-04-226-21	24-16DB37	21	shop	4/16/99	6/22/99			1.0	U			0.2	U			0.6	U			2.9	U			3.2	U			0.4	U			0.1	U			0.8	U	
99-04-226-22	24-16DB38	32	shop	4/16/99	6/22/99			0.8	U			0.2	U			0.2	U			2.4	U			1.8	U	0.3	0.3		U			0.1	U			0.5	U	
99-04-226-23	24-16DB39	32	shop	4/16/99	6/22/99	1.0	0.4					0.1	U			0.7	U			2.2	U	2.1	1.3			0.4	0.3					0.1	U			0.7	U	
99-04-226-24	24-16DB40	33	shop	4/16/99	6/22/99			0.4	U			0.2	U			0.6	U			2.0	U			1.9	U	0.3	0.3		U			0.1	U			0.6	U	
99-04-226-25	24-16DB41	33	shop	4/16/99	6/22/99			0.9	U			0.2	U			0.6	U			2.9	U			2.5	U	0.5	0.4					0.1	U			0.6	U	
99-04-226-26	24-16DB42	34	shop	4/16/99	6/22/99	1.0	0.5					0.1	U			0.2	U			2.8	U			1.5	U	0.3	0.4		U			0.1	U			0.5	U	
99-04-226-27	24-16DB43	34	shop	4/16/99	6/22/99	1.1	0.5					0.2	U			0.8	U			1.9	U	1.5	1.5			0.4	0.3					0.1	U			0.8	U	
99-04-226-28	24-16DB44	35	neighbor	4/16/99	6/22/99	1.0	0.4					0.1	U			0.6	U			2.1	U	2.4	1.6			0.5	0.3					0.1	U			0.6	U	
99-04-226-29	24-16DB45	35	neighbor	4/16/99	6/22/99			0.7	U			0.1	U			0.4	U			2.4	U			2.0	U	0.5	0.3					0.1	U			0.6	U	
99-04-226-30	24-07KN01	14	Co-60 pool	4/7/99	6/22/99			0.8	U			1.1	U			0.7	U			23.0	U			2.4	U			1.0	U			0.4	U			2.3	U	
99-04-226-31	24-07KN02	14	Co-60 pool	4/7/99	6/22/99	0.9	0.4					2.4	U			2.5	U			15.0	U			1.5	U			0.9	U			0.5	U			3.0	U	
99-04-226-32	24-16DB64			4/16/99	6/22/99			0.4	U			2.4	U			4.2	U			24.0	U	1.7	1.7					1.3	U			0.7	U			4.2	U	
99-04-226-34	24-08DB01			4/8/99	6/22/99			1.2	U			6.8	U			6.9	U			85.0	U			4.5	U			3.9	U			1.8	U			11.0	U	
99-04-226-36	24-16DB01	16		4/16/99	6/22/99	1.6	0.8					0.7	U			0.5	U			12.0	U			3.0	U			0.7	U			0.3	U			1.5	U	
99-04-226-37	24-16DB02	16		4/16/99	6/22/99	0.9	0.4					0.6	U			0.8	U			4.2	U			1.4	U	0.4	0.3					0.2	U			1.0	U	
99-04-226-38	24-16DB03	17		4/16/99	6/22/99	1.5	0.6					0.3	U			0.9	U			3.4	U			2.2	U	0.6	0.4					0.1	U			0.8	U	
99-04-226-39	24-16DB04	17		4/16/99	6/22/99			0.7	U			0.2	U			0.5	U			2.8	U			2.3	U	0.3	0.3					0.1	U			0.6	U	
99-04-226-40	24-16DB05	19		4/16/99	7/8/99			2.5	U			12.0	U			12.0	U			160.0	U			6.5	U			6.7	U			3.3	U			19.0	U	
99-04-226-41	24-16DB06	18		4/16/99	7/12/99	1.5	0.6					0.5	U			1.1	U			7.5	U			1.5	U			0.4	U			0.2	U			1.2	U	
99-04-226-42	24-16DB07	18		4/16/99	6/22/99	1.5	0.7					0.8	U			0.5	U			15.0	U			2.5	U			0.7	U			0.3	U			1.7	U	
99-04-226-43	24-16DB08	12		4/16/99	6/22/99			0.6	U			0.5	U			0.9	U			3.5	U			1.6	U	0.5	0.4					0.2	U			1.0	U	
99-04-226-44	24-16DB09	12		4/16/99	6/22/99			0.7	U			0.2	U			0.8	U			2.5	U			2.2	U	0.8	0.3					0.1	U			0.7	U	
99-04-226-45	24-16DB10	13		4/16/99	6/22/99			0.5	U			0.7	U			1.7	U			9.3	U			2.1	U			0.7	U			0.3	U			1.7	U	
99-04-226-46	24-16DB11	13		4/16/99	6/22/99			0.7	U			0.9	U			0.6	U			17.0	U			2.4	U			0.9	U			0.4	U			2.1	U	
99-04-226-47	24-16DB12	31	shop	4/16/99	6/23/99	1.3	0.5					0.2	U			0.8	U			2.4	U			1.8	U	0.7	0.3					0.1	U			0.9	U	
99-04-226-48	24-16DB13			4/16/99	6/23/99			0.7	U			0.2	U			0.7	U			2.2	U			2.3	U	0.6	0.3					0.1	U			0.7	U	
99-04-226-49	24-16DB14	9	shop	4/16/99	6/23/99			0.8	U			0.2	U			0.2	U			2.1	U			2.2	U	0.3	0.3		U			0.1	U			0.4	U	
99-04-226-50	24-16DB15	9	shop	4/16/99	6/23/99			0.6	U			0.1	U			0.9	U			2.2	U			2.0	U	0.5	0.4					0.1	U			0.8	U	
99-04-226-51	24-16DB16	11	shop	4/16/99	6/23/99			0.8	U			0.2	U			0.9	U			2.8	U			2.5	U	0.5	0.4					0.1	U			0.8	U	
99-04-226-52	24-07JS-1		rear asphalt	4/7/99	6/23/99			0.8	U			0.2	U			0.6	U			3.4	U			3.0	U	0.7	0.4					0.1	U			0.8	U	
99-04-226-53	24-09JS-1	6	shop	4/9/99	6/23/99			0.6	U			0.2	U			0.2	U			3.0	U			1.9	U	0.3	0.3					0.1	U			0.5	U	

Table B-2a. Complete listing of laboratory analytical results: samples

lab ID	Sample No.	Hole No.	Area	Sample Date	Count Date	Ac-228				Ag-110m				Am-241				Be-7				Bi-212				Bi-214				Co-139				Co-144				
						pCi/g	±	mdc	f*	pCi/g	±	mdc	f	pCi/g	±	mdc	f	pCi/g	±	mdc	f	pCi/g	±	mdc	f	pCi/g	±	mdc	f	pCi/g	±	mdc	f	pCi/g	±	mdc	f	pCi/g
99-04-226-54	24-09JS-2	6	shop	4/9/99	6/23/99			0.5	U			0.1	U			0.7	U			2.1	U			1.5	U	0.6	0.3					0.1	U			0.7	U	
99-04-226-55	24-09JS-3	7	shop	4/9/99	6/23/99			0.6	U			0.1	U			0.9	U			2.7	U			2.6	U	0.6	0.4					0.1	U			0.8	U	
99-04-226-56	24-09JS-4	7	shop	4/9/99	6/23/99			0.5	U			0.1	U			0.5	U			2.5	U			1.9	U	0.5	0.3					0.1	U			0.6	U	
99-04-226-57	24-09JS-5	4	shop	4/9/99	6/23/99	1.1	0.5					0.2	U			0.2	U			2.2	U			1.9	U	0.5	0.3					0.1	U			0.5	U	
99-04-226-58	24-09JS-6	4	shop	4/9/99	6/23/99	0.9	0.4					0.2	U			0.7	U			2.2	U	2.0	1.5			0.7	0.3					0.1	U			0.7	U	
99-04-226-59	24-09JS-7	3	shop	4/9/99	6/23/99			0.4	U			0.2	U			0.7	U			3.2	U			2.1	U			0.3	U			0.1	U			0.7	U	
99-04-226-60	24-09JS-8	3	shop	4/9/99	6/23/99			0.6	U			0.2	U			0.4	U			2.6	U			2.1	U	0.4	0.3					0.1	U			0.6	U	
99-04-226-61	24-09JS-9			4/9/99	6/23/99			1.6	U			0.5	U			1.6	U			7.2	U			4.4	U			1.0	U			0.4	U			2.3	U	
99-04-226-62	24-16DB60			4/16/99	6/23/99	1.1	0.7					0.7	U			0.5	U			12.0	U			3.0	U			0.7	U			0.3	U			1.3	U	
99-04-226-63	24-16DB61			4/16/99	6/23/99	0.7	0.6		TI			1.6	U			1.7	U			18.0	U			2.3	U			1.0	U			0.4	U			2.5	U	
99-04-226-64	24-16DB63			4/16/99	6/23/99	9.5	1.7					0.2	U			1.0	U			2.7	U	12.6	2.9			8.6	1.5					0.2	U			1.1	U	
99-04-226-65	24-08DB03			4/8/99	6/23/99	16.0	2.8					0.3	U			1.7	U			5.0	U	21.3	4.9			14.4	2.5					0.3	U			1.9	U	
99-04-226-66	24-08DB02			4/8/99	6/23/99	268.0	44.0					1.2	U			6.1	U			18.0	U	272.0	48.0			48.3	8.3					0.9	U			5.7	U	
9904226-66-D1	24-08DB02			4/8/99	6/26/99																																	
99-04-226-67	24-16DB-70			4/16/99	6/23/99			0.7	U			0.2	U			0.5	U			3.1	U			2.0	U			0.3	U			0.1	U			0.6	U	
99-04-226-68	24-16DB-65			4/16/99	6/23/99	235.0	39.0					1.0	U			1.4	U			16.0	U	234.0	42.0			45.9	7.9					0.6	U			3.7	U	
9904226-68-D1	24-16DB-65			4/16/99	6/26/99																																	
99-04-226-69	24-16DB-66			4/16/99	6/23/99	25.5	4.3					0.3	U			1.5	U			3.6	U	25.5	5.4			13.1	2.2					0.3	U			1.7	U	
99-04-226-70	24-15DB01			4/15/99	6/23/99	171.0	26.0					1.2	U			4.9	U			15.0	U	179.0	32.0			43.2	7.4					0.7	U			4.4	U	
99-04-226-71	24-15DB02			4/15/99	6/23/99	236.0	39.0					1.3	U			4.2	U			21.0	U	244.0	44.0			45.9	7.9					0.9	U			5.4	U	
99-04-226-72	24-15DB03			4/15/99	6/23/99			5.1	U			2.1	U			8.2	U			27.0	U			23.0	U			3.1	U			1.2	U			7.4	U	
99-04-226-73	24-15DB04	15	Co-60 pool	4/15/99	6/23/99	0.9	0.6					0.3	U			0.2	U			4.3	U			2.2	U	1.2	0.4					0.1	U			0.5	U	
99-04-226-74	24-15DB05	15	Co-60 pool	4/15/99	6/23/99	1.0	0.3					0.3	U			0.6	U			2.4	U	1.9	1.4			0.6	0.3					0.1	U			0.7	U	
99-04-226-76	24-08DB04			4/8/99	6/24/99	8.3	1.5					0.2	U			0.5	U			3.0	U	7.6	2.6			8.7	1.5					0.1	U			0.6	U	
99-04-226-77	24-08DB05			4/8/99	6/23/99	1.1	0.5					0.5	U			1.3	U			7.7	U			2.0	U	0.5	0.5		U			0.2	U			1.3	U	
99-04-226-78	24-15DB06	15	Co-60 pool	4/15/99	6/23/99			0.7	U			0.3	U			0.5	U			4.1	U			2.2	U	0.4	0.4					0.1	U			0.8	U	
99-04-226-79	24-17DB01			4/17/99	6/23/99			0.7	U			0.2	U			0.2	U			2.4	U			2.9	U	0.4	0.4					0.1	U			0.5	U	
99-04-226-80	24-17DB02			4/17/99	6/23/99	1.1	0.4					0.1	U			0.6	U			2.2	U			1.5	U	0.5	0.3					0.1	U			0.7	U	
99-04-226-81	24-17DB03			4/17/99	6/23/99	0.9	0.4					0.2	U			0.7	U			2.0	U			1.2	U	0.4	0.3					0.1	U			0.7	U	
99-04-226-82	24-17DB04			4/17/99	6/23/99	0.9	0.3					0.1	U			0.6	U			1.5	U			1.7	U	0.3	0.3					0.1	U			0.6	U	
99-04-226-83	24-17DB05			4/17/99	6/23/99			1.0	U			0.2	U			0.9	U			3.7	U			3.1	U	0.5	0.5					0.1	U			0.8	U	
99-04-226-84	24-17KN1	2	C-14 lab	4/17/99	6/23/99			0.6	U			0.2	U			0.4	U			2.2	U			2.5	U	0.6	0.3					0.1	U			0.6	U	
99-04-226-85	24-16DB50			4/16/99	6/23/99			0.5	U			0.5	U			0.4	U			10.0	U			2.0	U			0.6	U			0.2	U			1.3	U	
99-04-226-90	24-04DB01			4/4/99	6/23/99			0.8	U			0.2	U			0.9	U			3.3	U	4.5	2.5			0.6	0.5					0.2	U			0.9	U	
99-04-226-91	24-04DB02			4/4/99	6/23/99	1.2	0.6					0.2	U			0.5	U			2.6	U	1.9	1.9		U	0.4	0.3					0.1	U			0.6	U	
99-04-226-92	24-16DB62			4/16/99	6/23/99	1.3	0.5					0.1	U			0.2	U			2.8	U			2.6	U	0.5	0.3					0.1	U			0.4	U	
99-04-226-B1	Blank			5/18/99	6/22/99			0.5	U			0.1	U			0.2	U			1.6	U			2.0	U			0.3	U			0.1	U			0.3	U	
99-04-226-B2	Blank			5/18/99	6/22/99			0.5	U			0.2	U			0.5	U			1.4	U			1.5	U			0.2	U			0.1	U			0.5	U	
99-04-226-B3	Blank			5/18/99	6/22/99			0.5	U			0.1	U			0.1	U			1.2	U			2.2	U			0.3	U			0.1	U			0.4	U	
99-04-226-B4	Blank			5/18/99	6/23/99			0.6	U			0.1	U			0.6	U			1.5	U			1.7	U			0.3	U			0.1	U			0.6	U	
99-04-226-B5	Blank			5/18/99	6/24/99			0.8	U			0.2	U			0.6	U			1.5	U			1.8	U			0.4	U			0.1	U			0.6	U	
99-04-226-B6	Blank			5/18/99	6/23/99			0.4	U			0.1	U			0.5	U			1.0	U			1.1	U			0.3	U			0.1	U			0.5	U	
99-04-226-B7	Blank			5/18/99	7/6/99			0.3	U			0.1	U			0.5	U			1.1	U			1.4	U			0.2	U			0.1	U			0.5	U	
99-04-226-D1	24-16DB19-D	30	shop	4/16/99	6/22/99			0.6	U			0.2	U			0.5	U			2.0	U			2.3	U	0.3	0.3		U			0.1	U			0.6	U	
99-04-226-D2	24-16DB28-D	25	shop	4/16/99	6/22/99			0.8	U			0.3	U			0.2	U			3.1	U	2.3	2.2					0.4	U			0.1	U			0.6	U	
99-04-226-D3	24-16DB42-D	34	shop	4/16/99	6/22/99	0.8	0.3					0.1	U			0.6	U			1.6	U	1.8	1.2			0.6	0.3					0.1	U			0.6	U	
99-04-226-D4	24-16DB03-D	17		4/16/99	6/22/99	1.4	0.6					0.3	U			0.9	U			4.0	U			1.6	U	0.3	0.4		U			0.1	U			0.9	U	
99-04-226-D5	24-16DB13-D			4/16/99	6/23/99	0.8	0.3					0.1	U			0.5	U			1.4	U	1.9	1.4			0.6	0.3					0.1	U			0.6	U	
99-04-226-D6	24-09JS-6-D	4	shop	4/9/99	6/23/99	1.1	0.5					0.2	U			0.9	U			3.3	U	1.8	1.9		U			0.4	U			0.1	U			0.8	U	
99-04-226-D7	24-08DB02-D			4/8/99	6/23/99	242.0	40.0					1.2	U			3.6	U			20.0	U	250.0	45.0			43.5	7.5					0.8	U			5.1	U	
99-04-226-D8	24-15DB05-D	15	Co-60 pool	4/15/99	6/23/99	1.1	0.5					0.2	U			0.2	U			3.8	U			2.4	U			0.3	U			0.1	U			0.6	U	
99-04-226-D9	24-17DB04-D			4/17/99	6/23/99	1.0	0.5					0.2	U			0.5	U			2.5	U			2.2	U	0.3	0.3					0.1	U			0.5	U	
99-04-226-DN	24-04DB02-D			4/4/99	6/23/99	1.0	0.5					0.2	U			0.2	U			3.2	U			2.2	U	0.5	0.3					0.1	U			0.5	U	

*U=undetected.

Table B-2a. Complete listing of laboratory analytical results: samples

lab ID	Sample No.	Hole	Co-56				Co-57				Co-58				Co-60				Cr-51				Cs-134				Cs-137				Eu-152				Eu-154				Eu-155		
		No.	±	mdc	f	pCi/g	±	mdc	f	pCi/g	±	mdc	f	pCi/g	±	mdc	f	pCi/g	±	mdc	f	pCi/g	±	mdc	f	pCi/g	±	mdc	f	pCi/g	±	mdc	f	pCi/g	±	mdc	f	pCi/g	±	mdc
99-04-226-01	24-16DB17	11		0.4	U			0.1	U			0.2	U			0.1	U			4.2	U			0.1	U			0.1	U			0.4	U			0.4	U			0.3
99-04-226-02	24-16DB18	8		0.5	U			0.2	U			0.3	U			0.3	U			16.0	U			0.3	U	150.0	25.0					1.3	U			0.8	U			0.6
99-04-226-03	24-16DB19	30		0.7	U			0.1	U			0.3	U			0.3	U			4.3	U			0.2	U			0.1	U			0.8	U			0.8	U			0.2
99-04-226-04	24-16DB20	30		0.4	U			0.1	U			0.2	U			0.1	U			3.4	U			0.1	U			0.1	U			0.6	U			0.3	U			0.3
99-04-226-05	24-16DB21	29		0.7	U			0.1	U			0.3	U			0.2	U			5.4	U			0.2	U			0.2	U			0.7	U			0.4	U			0.4
99-04-226-06	24-16DB22	29		0.5	U			0.1	U			0.3	U			0.2	U			4.8	U			0.2	U			0.2	U			0.2	U			0.5	U			0.3
99-04-226-07	24-16DB23	27		0.5	U			0.1	U			0.2	U			0.2	U			5.2	U			0.2	U			0.1	U			0.6	U			0.4	U			0.4
9904226-7-D1	24-16DB23	27																																							
99-04-226-08	24-16DB24	27		0.6	U			0.1	U			0.3	U			0.1	U			4.5	U			0.1	U			0.2	U			0.9	U			0.5	U			0.3
99-04-226-09	24-16DB25	26		0.4	U			0.1	U			0.3	U			0.2	U			5.2	U			0.2	U			0.2	U			0.8	U			0.6	U			0.3
99-04-226-10	24-16DB26	26		0.6	U			0.1	U			0.3	U			0.2	U			4.7	U			0.2	U			0.2	U			0.9	U			0.3	U			0.2
99-04-226-11	24-16DB27	25		0.3	U			0.1	U			0.2	U			0.1	U			3.5	U			0.1	U			0.1	U			0.5	U			0.3	U			0.3
99-04-226-12	24-16DB28	25		0.9	U			0.1	U			0.3	U			0.2	U			5.4	U			0.2	U			0.2	U			1.1	U			0.5	U			0.4
99-04-226-13	24-16DB29	24		0.6	U			0.1	U			0.5	U			0.2	U			7.5	U			0.3	U			0.2	U			1.0	U			0.6	U			0.4
9904226-13-D1	24-16DB29	24																																							
99-04-226-14	24-16DB30	23		0.6	U			0.1	U			0.4	U			0.3	U			6.6	U			0.2	U			0.2	U			1.7	U			1.0	U			0.3
99-04-226-15	24-16DB31	23		0.2	U			0.1	U			0.2	U			0.1	U			3.6	U			0.1	U			0.1	U			0.6	U			0.3	U			0.3
99-04-226-16	24-16DB32	20		0.7	U			0.1	U			0.3	U			0.2	U			3.9	U			0.1	U			0.2	U			1.0	U			0.6	U			0.4
9904226-16-D1	24-16DB32	20																																							
99-04-226-17	24-16DB33	20		0.9	U			0.1	U			0.5	U			0.3	U			7.2	U			0.2	U			0.2	U			1.5	U			0.9	U			0.3
99-04-226-18	24-16DB34	22		0.5	U			0.1	U			0.3	U			0.2	U			4.8	U			0.2	U			0.2	U			0.8	U			0.4	U			0.2
99-04-226-19	24-16DB35	22		0.7	U			0.1	U			0.3	U			0.2	U			4.7	U			0.1	U			0.1	U			0.9	U			0.3	U			0.2
99-04-226-20	24-16DB36	21		0.6	U			0.1	U			0.2	U			0.2	U			4.2	U			0.1	U			0.1	U			0.9	U			0.5	U			0.3
99-04-226-21	24-16DB37	21		1.2	U			0.1	U			0.4	U			0.2	U			5.6	U			0.2	U			0.2	U			1.9	U			1.0	U			0.3
99-04-226-22	24-16DB38	32		1.0	U			0.1	U			0.3	U			0.2	U			3.6	U			0.1	U			0.1	U			0.2	U			0.8	U			0.2
99-04-226-23	24-16DB39	32		0.4	U			0.1	U			0.2	U			0.1	U			3.8	U			0.1	U			0.1	U			0.7	U			0.3	U			0.3
99-04-226-24	24-16DB40	33		0.5	U			0.1	U			0.2	U			0.2	U			4.9	U			0.1	U			0.2	U			0.9	U			0.6	U			0.3
99-04-226-25	24-16DB41	33		0.6	U			0.1	U			0.4	U			0.3	U			4.6	U			0.2	U			0.2	U			1.1	U			0.8	U			0.3
99-04-226-26	24-16DB42	34		0.6	U			0.1	U			0.3	U			0.2	U			4.5	U			0.2	U			0.1	U			1.0	U			0.4	U			0.2
99-04-226-27	24-16DB43	34		0.5	U			0.1	U			0.3	U			0.2	U			5.2	U			0.2	U			0.1	U			0.7	U			0.4	U			0.4
99-04-226-28	24-16DB44	35		0.6	U			0.1	U			0.2	U			0.2	U			4.6	U			0.1	U			0.2	U			0.9	U			0.6	U			0.4
99-04-226-29	24-16DB45	35		0.5	U			0.1	U			0.3	U			0.2	U			4.2	U			0.2	U			0.1	U			0.7	U			0.4	U			0.2
99-04-226-30	24-07KN01	14		0.7	U			0.3	U			0.3	U			0.3	U			31.0	U			0.5	U	479.0	79.0					0.8	U			0.5	U			0.7
99-04-226-31	24-07KN02	14		0.4	U			0.4	U			0.2	U			0.1	U			29.0	U			0.5	U	610.0	100.0					0.6	U			0.3	U			1.2
99-04-226-32	24-16DB64			0.7	U			0.5	U			0.2	U			0.1	U			40.0	U			0.7	U	680.0	150.0					1.1	U			0.6	U			1.8
99-04-226-34	24-08DB01			0.9	U			1.4	U			0.6	U			0.3	U			130.0	U			2.0	U	4700.0	770.0					1.2	U			0.9	U			3.2
99-04-226-36	24-16DB01	16		0.9	U			0.2	U			0.5	U	0.8	0.3					17.0	U			0.4	U	124.0	21.0					1.8	U			1.1	U			0.4
99-04-226-37	24-16DB02	16		0.3	U			0.1	U			0.1	U	0.2	0.1					7.0	U			0.2	U	40.4	6.7					0.6	U			0.3	U			0.4
99-04-226-38	24-16DB03	17		0.8	U			0.1	U			0.3	U			0.3	U			6.0	U			0.2	U	2.8	0.6					0.7	U			0.7	U			0.5
99-04-226-39	24-16DB04	17		0.7	U			0.1	U			0.3	U			0.2	U			4.7	U			0.1	U			0.1	U			0.9	U			0.3	U			0.2
99-04-226-40	24-16DB05	19		1.5	U			2.4	U			1.3	U	2.4	0.6					260.0	U			3.4	U	5520.0	910.0					0.8	U			0.3	U			5.7
99-04-226-41	24-16DB06	18		0.9	U			0.2	U			0.3	U	0.2	0.1					18.0	U			0.2	U	41.8	7.0					0.9	U			0.6	U			0.6
99-04-226-42	24-16DB07	18		0.4	U			0.2	U			0.4	U	0.9	0.2					20.0	U			0.4	U	268.0	44.0					1.0	U			0.8	U			0.5
99-04-226-43	24-16DB08	12		0.5	U			0.1	U			0.3	U	1.4	0.3					7.7	U			0.2	U	20.5	3.4					0.8	U			0.4	U			0.5
99-04-226-44	24-16DB09	12		0.7	U			0.1	U			0.3	U	2.4	0.5					4.8	U			0.1	U	0.3	0.2					0.7	U			0.5	U			0.4
99-04-226-45	24-16DB10	13		0.7	U			0.2	U			0.2	U			0.2	U			16.0	U			0.4	U	117.0	19.0					0.7	U			0.3	U			0.7
99-04-226-46	24-16DB11	13		0.9	U			0.3	U			0.3	U			0.2	U			22.0	U			0.5	U	366.0	61.0					0.2	U			0.8	U			0.6
99-04-226-47	24-16DB12	31		0.5	U			0.1	U			0.2	U			0.2	U			5.0	U			0.2	U			0.2	U			0.6	U			0.4	U			0.5
99-04-226-48	24-16DB13			0.7	U			0.1	U			0.3	U			0.2	U			4.8	U			0.1	U			0.2	U			0.9	U			0.5	U			0.3
99-04-226-49	24-16DB14	9		0.6	U			0.1	U			0.2	U			0.3	U			4.7	U			0.2	U			0.1	U			1.0	U			0.7	U			0.2
99-04-226-50	24-16DB15	9		0.6	U			0.1	U			0.2	U			0.2	U			5.7	U			0.2	U			0.2	U			1.0	U			0.5	U			0.4
99-04-226-51	24-16DB16	11		1.1	U			0.1	U			0.3	U			0.2	U			8.2	U			0.2	U			0.3	U			1.1	U			1.0	U			0.5
99-04-226-52	24-07JS-1			0.8	U			0.1	U			0.4	U			0.3	U			6.8	U			0.2	U			0.2	U			1.5	U			0.9	U			0.3
99-04-226-53	24-09JS-1	6		0.8	U			0.1	U			0.3	U			0.2	U			5.7	U			0.2	U	0.5	0.2					1.3	U			0.8	U			0.2

Table B-2a. Complete listing of laboratory analytical results: samples

lab ID	Sample No.	Hole	Co-56				Co-57				Co-58				Co-60				Cr-51				Cs-134				Cs-137				Eu-152				Eu-154				Eu-155			
		No.		±	mdc	f	pCi/g	±	mdc	f	pCi/g	±	mdc	f	pCi/g	±	mdc	f	pCi/g	±	mdc	f	pCi/g	±	mdc	f	pCi/g	±	mdc	f	pCi/g	±	mdc	f	pCi/g	±	mdc	f	pCi/g	±	mdc	f
99-04-226-54	24-09JS-2	6			0.4	U			0.1	U			0.1	U			0.1	U			4.5	U			0.1	U			0.1	U			0.5	U			0.3	U			0.3
99-04-226-55	24-09JS-3	7			0.8	U			0.1	U			0.4	U			0.2	U			8.1	U			0.1	U	0.5	0.2					0.2	U			0.7	U			0.4
99-04-226-56	24-09JS-4	7			0.5	U			0.1	U			0.3	U			0.2	U			5.1	U			0.1	U			0.1	U			1.2	U			0.5	U			0.2
99-04-226-57	24-09JS-5	4			0.5	U			0.1	U			0.2	U			0.3	U			4.8	U			0.1	U	1.1	0.3					1.3	U			0.8	U			0.2
99-04-226-58	24-09JS-6	4			0.3	U			0.1	U			0.2	U			0.1	U			5.0	U			0.2	U	1.5	0.3					0.4	U			0.4	U			0.4
99-04-226-59	24-09JS-7	3			0.6	U			0.1	U			0.2	U			0.2	U			6.1	U			0.2	U	3.4	0.7					0.8	U			0.6	U			0.4
99-04-226-60	24-09JS-8	3			0.6	U			0.1	U			0.4	U			0.2	U			5.6	U			0.2	U	2.0	0.4					0.6	U			0.6	U			0.2
99-04-226-61	24-09JS-9				1.1	U			0.3	U			0.7	U			0.5	U			18.0	U			0.5	U			0.4	U			1.7	U			1.0	U			1.0
99-04-226-62	24-16DB60				1.0	U			0.2	U			0.3	U	0.7	0.3					16.0	U			0.3	U	120.0	20.0					0.3	U			1.1	U			0.4
99-04-226-63	24-16DB61				0.6	U			0.3	U			0.3	U	0.6	0.2					26.0	U			0.5	U	342.0	56.0					0.7	U			0.6	U			0.8
99-04-226-64	24-16DB63				0.4	U			0.1	U			0.2	U			0.1	U			6.6	U			0.2	U	0.2	0.2					0.8	U			0.5	U			0.7
99-04-226-65	24-08DB03				0.8	U			0.2	U			0.4	U			0.2	U			14.0	U			0.3	U	0.4	0.3					1.3	U			0.8	U			1.1
99-04-226-66	24-08DB02				2.7	U			0.7	U			1.5	U			0.8	U			46.0	U			0.8	U	34.1	5.8					4.1	U			2.4	U			3.5
9904226-66-D1	24-08DB02																																									
99-04-226-67	24-16DB-70				0.8	U			0.1	U			0.3	U			0.3	U			5.8	U			0.2	U			0.2	U			1.4	U			0.6	U			0.3
99-04-226-68	24-16DB-65				2.2	U			0.4	U			1.5	U			0.9	U			28.0	U			0.8	U	30.3	5.2					4.9	U			2.5	U			1.8
9904226-68-D1	24-16DB-65																																									
99-04-226-69	24-16DB-66				0.6	U			0.2	U			0.3	U			0.2	U			9.4	U			0.2	U	0.6	0.2					0.9	U			0.5	U			1.0
99-04-226-70	24-15DB01				2.0	U			0.8	U			1.1	U			0.6	U			33.0	U			0.7	U	92.0	15.0					3.7	U			2.0	U			2.8
99-04-226-71	24-15DB02				2.8	U			0.7	U			1.7	U			1.0	U			38.0	U			0.9	U	30.2	5.2					5.7	U			2.8	U			2.6
99-04-226-72	24-15DB03				4.9	U			0.9	U			2.9	U			1.6	U			52.0	U			1.8	U			1.9	U			8.8	U			6.1	U			4.2
99-04-226-73	24-15DB04	15			0.5	U			0.1	U			0.3	U			0.3	U			6.6	U			0.2	U	11.5	2.0					0.8	U			1.1	U			0.2
99-04-226-74	24-15DB05	15			0.4	U			0.1	U			0.2	U			0.1	U			4.6	U			0.1	U	7.4	1.3					0.5	U			0.2	U			0.3
99-04-226-76	24-08DB04				0.5	U			0.1	U			0.3	U			0.2	U			5.4	U			0.1	U	10.2	1.7					0.8	U			0.5	U			0.3
99-04-226-77	24-08DB05				0.4	U			0.2	U			0.3	U			0.2	U			15.0	U			0.2	U	65.0	11.0					0.8	U			0.5	U			0.6
99-04-226-78	24-15DB06	15			0.5	U			0.1	U			0.3	U			0.3	U			6.5	U			0.2	U	7.1	1.3					0.9	U			0.5	U			0.3
99-04-226-79	24-17DB01				0.7	U			0.1	U			0.3	U			0.3	U			4.2	U			0.2	U			0.1	U			0.8	U			0.6	U			0.2
99-04-226-80	24-17DB02				0.4	U			0.1	U			0.2	U			0.1	U			4.6	U			0.2	U			0.1	U			0.6	U			0.3	U			0.4
99-04-226-81	24-17DB03				0.4	U			0.1	U			0.3	U			0.2	U			5.3	U			0.1	U			0.1	U			0.6	U			0.5	U			0.3
99-04-226-82	24-17DB04				0.3	U			0.1	U			0.2	U			0.1	U			3.8	U			0.1	U			0.1	U			0.6	U			0.3	U			0.3
99-04-226-83	24-17DB05				0.9	U			0.1	U			0.4	U			0.2	U			5.2	U			0.2	U			0.2	U			1.3	U			0.8	U			0.5
99-04-226-84	24-17KN1	2			0.6	U			0.1	U			0.2	U			0.3	U			4.0	U			0.2	U			0.2	U			1.2	U			0.7	U			0.2
99-04-226-85	24-16DB50				0.5	U			0.2	U			0.3	U			0.2	U			14.0	U			0.3	U	131.0	22.0					0.9	U			0.6	U			0.4
99-04-226-90	24-04DB01				0.8	U			0.1	U			0.4	U			0.3	U			9.1	U			0.2	U	0.2	0.2					1.4	U			0.8	U			0.5
99-04-226-91	24-04DB02				0.5	U			0.1	U			0.3	U			0.3	U			8.1	U			0.2	U	0.3	0.2					0.7	U			0.6	U			0.2
99-04-226-92	24-16DB62				0.7	U			0.1	U			0.3	U			0.2	U			3.6	U			0.1	U	0.5	0.2					0.9	U			0.4	U			0.2
99-04-226-B1	Blank				0.5	U			0.0	U			0.2	U			0.2	U			1.8	U			0.2	U			0.1	U			0.3	U			0.5	U			0.1
99-04-226-B2	Blank				0.4	U			0.1	U			0.2	U			0.1	U			1.7	U			0.1	U			0.1	U			0.6	U			0.5	U			0.3
99-04-226-B3	Blank				0.4	U			0.1	U			0.2	U			0.2	U			1.9	U			0.2	U			0.1	U			1.1	U			0.7	U			0.1
99-04-226-B4	Blank				0.3	U			0.1	U			0.1	U			0.1	U			1.9	U			0.2	U			0.2	U			0.7	U			0.3	U			0.3
99-04-226-B5	Blank				0.4	U			0.1	U			0.2	U			0.2	U			2.2	U			0.2	U			0.2	U			0.7	U			0.7	U			0.2
99-04-226-B6	Blank				0.2	U			0.1	U			0.1	U			0.1	U			1.3	U			0.1	U			0.1	U			0.6	U			0.3	U			0.2
99-04-226-B7	Blank				0.2	U			0.1	U			0.1	U			0.1	U			2.6	U			0.1	U			0.1	U			0.5	U			0.3	U			0.2
99-04-226-D1	24-16DB19-D	30			0.7	U			0.1	U			0.2	U			0.1	U			4.7	U			0.2	U			0.2	U			0.9	U			1.0	U			0.3
99-04-226-D2	24-16DB28-D	25			0.9	U			0.1	U			0.5	U			0.2	U			5.8	U			0.2	U			0.2	U			1.6	U			0.7	U			0.3
99-04-226-D3	24-16DB42-D	34			0.3	U			0.1	U			0.2	U			0.1	U			4.1	U			0.1	U			0.1	U			0.5	U			0.4	U			0.3
99-04-226-D4	24-16DB03-D	17			0.8	U			0.1	U			0.4	U			0.2	U			7.1	U			0.2	U	3.9	0.8					0.8	U			0.9	U			0.5
99-04-226-D5	24-16DB13-D				0.4	U			0.1	U			0.2	U			0.1	U			4.2	U			0.1	U			0.1	U			0.4	U			0.3	U			0.4
99-04-226-D6	24-09JS-6-D	4			0.7	U			0.1	U			0.3	U			0.2	U			7.3	U			0.2	U	1.3	0.4					1.0	U			0.8	U			0.4
99-04-226-D7	24-08DB02-D				2.7	U			0.6	U			1.7	U			1.0	U			42.0	U			0.9	U	29.6	5.1					4.9	U			2.7	U			2.3
99-04-226-D8	24-15DB05-D	15			0.6	U			0.1	U			0.4	U			0.2	U			5.1	U			0.2	U	6.3	1.2					1.2	U			0.4	U			0.2
99-04-226-D9	24-17DB04-D				0.7	U			0.1	U			0.2	U			0.2	U			5.3	U			0.1	U			0.2	U			0.9	U			0.7	U			0.2
99-04-226-DN	24-04DB02-D				0.7	U			0.1	U			0.3	U			0.2	U			6.1	U			0.1	U	0.4	0.2					1.3	U			0.5	U			0.2

*U=undetected.

Table B-2a. Complete listing of laboratory analytical results: samples

lab ID	Sample No.	Hole	Fe-59					I-131					K-40					Mn-54					Na-22					Nb-95					Pa-234m					Pb-212					Pb-214			
		No.	f	pCi/g	±	mdc	f	pCi/g	±	mdc	f	pCi/g	±	mdc	f	pCi/g	±	mdc	f	pCi/g	±	mdc	f	pCi/g	±	mdc	f	pCi/g	±	mdc	f	pCi/g	±	mdc	f	pCi/g	±	mdc	f	pCi/g	±	mdc	f	pCi/g	±	mdc	f
99-04-226-01	24-16DB17	11	U			0.6	U			27.0	U	20.1	4.0					0.1	U			0.1	U			0.2	U			18.0	U	0.8	0.3			0.5	0.2						
99-04-226-02	24-16DB18	8	U			0.8	U			130.0	U	20.2	4.8					0.2	U			0.2	U			0.4	U			26.0	U	1.3	0.7							0.9	U		
99-04-226-03	24-16DB19	30	U			1.1	U			37.0	U	19.9	5.1					0.2	U			0.3	U			0.3	U			33.0	U	0.9	0.3			0.4	0.2						
99-04-226-04	24-16DB20	30	U			0.6	U			25.0	U	16.8	3.6					0.1	U			0.1	U			0.2	U			15.0	U	1.1	0.3			0.6	0.2						
99-04-226-05	24-16DB21	29	U			1.0	U			39.0	U	22.7	5.4					0.2	U			0.1	U			0.3	U			32.0	U	1.1	0.4			0.8	0.3						
99-04-226-06	24-16DB22	29	U			0.9	U			30.0	U	18.3	4.5					0.2	U			0.3	U			0.3	U			24.0	U	0.8	0.3			0.6	0.3						
99-04-226-07	24-16DB23	27	U			0.8	U			36.0	U	24.0	4.9					0.2	U			0.2	U			0.3	U			25.0	U	1.4	0.4			0.6	0.3						
9904226-7-D1	24-16DB23	27																																												
99-04-226-08	24-16DB24	27	U			0.9	U			34.0	U	20.8	4.8					0.2	U			0.2	U			0.3	U			25.0	U	0.9	0.3			0.5	0.3						
99-04-226-09	24-16DB25	26	U			1.0	U			37.0	U	19.1	5.0					0.2	U			0.2	U			0.3	U			24.0	U	1.0	0.3			0.3	0.3						U
99-04-226-10	24-16DB26	26	U			1.1	U			38.0	U	19.1	4.6					0.2	U			0.2	U			0.3	U			23.0	U	1.0	0.3			0.5	0.2						
99-04-226-11	24-16DB27	25	U			0.6	U			29.0	U	16.8	3.5					0.1	U			0.1	U			0.2	U			19.0	U	0.8	0.2			0.6	0.2						
99-04-226-12	24-16DB28	25	U			0.9	U			50.0	U	26.0	6.1					0.2	U			0.2	U			0.3	U			30.0	U	1.2	0.4							0.3	U		
99-04-226-13	24-16DB29	24	U			1.4	U			48.0	U	5.8	3.5					0.3	U			0.2	U			0.5	U			48.0	U	2.4	0.6			2.4	0.6						
9904226-13-D1	24-16DB29	24																																												
99-04-226-14	24-16DB30	23	U			1.9	U			49.0	U	27.4	7.2					0.3	U			0.4	U			0.6	U			8.7	U	1.1	0.4							0.4	U		
99-04-226-15	24-16DB31	23	U			0.6	U			26.0	U	19.2	3.8					0.1	U			0.1	U			0.2	U			18.0	U	0.9	0.2							0.2	U		
99-04-226-16	24-16DB32	20	U			0.7	U			29.0	U	23.5	5.3					0.1	U			0.2	U			0.4	U			30.0	U	1.2	0.3			0.5	0.2						
9904226-16-D1	24-16DB32	20																																												
99-04-226-17	24-16DB33	20	U			1.3	U			51.0	U	17.8	5.8					0.2	U			0.2	U			0.6	U			53.0	U	1.1	0.4			0.5	0.3						
99-04-226-18	24-16DB34	22	U			1.0	U			31.0	U	22.2	5.5					0.2	U			0.2	U			0.4	U			36.0	U	0.9	0.3			0.4	0.3						
99-04-226-19	24-16DB35	22	U			1.1	U			37.0	U	17.7	4.4					0.2	U			0.2	U			0.3	U			19.0	U	0.8	0.3			0.5	0.2						
99-04-226-20	24-16DB36	21	U			0.6	U			35.0	U	18.5	4.5					0.1	U			0.2	U			0.3	U			29.0	U	1.0	0.3							0.2	U		
99-04-226-21	24-16DB37	21	U			1.6	U			53.0	U	19.8	5.6					0.3	U			0.4	U			0.4	U			29.0	U	1.1	0.4							0.3	U		
99-04-226-22	24-16DB38	32	U			1.1	U			33.0	U	22.7	5.6					0.3	U			0.3	U			0.3	U			27.0	U	0.7	0.3			0.4	0.2						
99-04-226-23	24-16DB39	32	U			0.6	U			26.0	U	25.8	5.1					0.2	U			0.1	U			0.2	U			19.0	U	1.0	0.3							0.2	U		
99-04-226-24	24-16DB40	33	U			0.8	U			28.0	U	24.1	5.3					0.2	U			0.2	U			0.3	U			24.0	U	0.8	0.3			0.5	0.3						
99-04-226-25	24-16DB41	33	U			1.4	U			40.0	U	27.0	6.3					0.3	U			0.3	U			0.3	U			34.0	U	1.1	0.3							0.3	U		
99-04-226-26	24-16DB42	34	U			1.2	U			32.0	U	23.6	5.6					0.2	U			0.2	U			0.4	U			28.0	U	0.7	0.3			0.4	0.3						
99-04-226-27	24-16DB43	34	U			0.8	U			36.0	U	25.3	5.2					0.2	U			0.2	U			0.3	U			21.0	U	1.1	0.3			0.6	0.3						
99-04-226-28	24-16DB44	35	U			0.9	U			32.0	U	22.6	5.3					0.1	U			0.2	U			0.3	U			23.0	U	1.0	0.3			0.5	0.2						
99-04-226-29	24-16DB45	35	U			1.1	U			34.0	U	15.8	4.3					0.2	U			0.3	U			0.3	U			37.0	U	0.9	0.3			0.4	0.2						
99-04-226-30	24-07KN01	14	U			1.2	U			450.0	U	20.1	5.0					0.2	U			0.2	U			0.4	U			26.0	U			1.0	U			1.3	U						
99-04-226-31	24-07KN02	14	U			0.7	U			400.0	U	19.0	3.8					0.1	U			0.1	U			0.2	U			18.0	U			0.6	U			1.2	U						
99-04-226-32	24-16DB64		U			0.9	U			330.0	U	22.0	5.1					0.2	U			0.3	U			0.3	U			23.0	U			1.2	U			2.1	U						
99-04-226-34	24-06DB01		U			1.7	U			1700.0	U	20.6	5.3					0.3	U			0.3	U			0.5	U			39.0	U			3.1	U			5.5	U						
99-04-226-36	24-16DB01	16	U			1.0	U			130.0	U	20.7	6.3					0.3	U			0.4	U			0.4	U			41.0	U	1.1	0.7							0.9	U		
99-04-226-37	24-16DB02	16	U			0.5	U			57.0	U	16.9	3.6					0.1	U			0.1	U			0.2	U			19.0	U	0.9	0.3							0.4	U		
99-04-226-38	24-16DB03	17	U			0.9	U			55.0	U	24.1	5.9					0.2	U			0.2	U			0.4	U			42.0	U	1.1	0.4							0.3	U		
99-04-226-39	24-16DB04	17	U			1.1	U			37.0	U	17.7	4.4					0.2	U			0.2	U			0.3	U			19.0	U	0.8	0.3			0.8	0.2						
99-04-226-40	24-16DB05	19	U			5.0	U			4500.0	U	17.6	6.3					0.6	U			0.5	U			1.2	U			110.0	U			5.4	U			9.2	U						
99-04-226-41	24-16DB06	18	U			1.4	U			260.0	U	15.7	4.2					0.2	U			0.2	U			0.3	U			29.0	U	1.0	0.5							0.6	U		
99-04-226-42	24-16DB07	18	U			1.1	U			160.0	U	18.6	5.1					0.3	U			0.3	U			0.2	U			33.0	U			0.7	U			1.0	U						
99-04-226-43	24-16DB08	12	U			0.7	U			57.0	U	19.1	4.2					0.2	U			0.1	U			0.3	U			26.0	U	0.8	0.4			0.7	0.3						
99-04-226-44	24-16DB09	12	U			1.4	U			41.0	U	18.3	4.3					0.2	U			0.2	U			0.3	U			37.0	U	1.1	0.4							0.3	U		
99-04-226-45	24-16DB10	13	U			0.7	U			130.0	U	18.2	4.6					0.2	U			0.1	U			0.2	U			21.0	U			0.5	U			0.8	U						
99-04-226-46	24-16DB11	13	U			1.3	U			190.0	U	19.8	5.2					0.2	U			0.3	U			0.4	U			40.0	U			0.8	U			1.2	U						
99-04-226-47	24-16DB12	31	U			0.7	U			43.0	U	22.7	4.8					0.2	U			0.2	U			0.3	U			26.0	U	1.4	0.4							0.3	U		
99-04-226-48	24-16DB13		U			1.0	U			41.0	U	20.2	4.9					0.2	U			0.2	U			0.3	U			30.0	U	0.8	0.3			0.7	0.3						
99-04-226-49	24-16DB14	9	U			1.3	U			35.0	U	21.6	5.7					0.3	U			0.2	U			0.4	U			34.0	U	1.0	0.3							0.2	U		
99-04-226-50	24-16DB15	9	U			0.8	U			46.0	U	21.8	4.7					0.1	U			0.2	U			0.3	U			23.0	U	1.1	0.3			0.7	0.3						
99-04-226-51	24-16DB16	11	U			1.2	U			51.0	U	23.6	6.1					0.3	U			0.3	U			0.4	U			41.0	U	1.8	0.5			0.4	0.3						U
99-04-226-52	24-07JS-1		U			1.9	U			110.0	U	17.4	4.9					0.2	U			0.3	U			0.5	U			40.0	U	1.1	0.4			0.6	0.3						
99-04-226-53	24-09JS-1	6	U			1.1	U			71.0	U	19.3	5.0					0.2	U			0.3	U			0.4	U			30.0	U	0.9	0.3							0.3	U		

Table B-2a. Complete listing of laboratory analytical results: samples

lab ID	Sample No.	Hole		Fe-59				I-131				K-40				Mn-54				Na-22				Nb-95				Pa-234m				Pb-212				Pb-214			
		No.	f	pCi/g	±	mdc	f	pCi/g	±	mdc	f	pCi/g	±	mdc	f	pCi/g	±	mdc	f	pCi/g	±	mdc	f	pCi/g	±	mdc	f	pCi/g	±	mdc	f	pCi/g	±	mdc	f	pCi/g	±	mdc	f
99-04-226-54	24-09JS-2	6	U			0.7	U			55.0	U	18.6	3.8					0.1	U			0.1	U			0.2	U			17.0	U	1.1	0.3			0.6	0.2		
99-04-226-55	24-09JS-3	7	U			1.2	U			83.0	U	24.8	6.1					0.2	U			0.3	U			0.4	U			35.0	U	1.1	0.4			0.8	0.3		
99-04-226-56	24-09JS-4	7	U			1.4	U			47.0	U	15.6	4.3					0.2	U			0.2	U			0.3	U			23.0	U	0.9	0.3					0.2	U
99-04-226-57	24-09JS-5	4	U			1.1	U			66.0	U	19.1	5.0					0.3	U			0.2	U			0.4	U			25.0	U	0.8	0.3					0.2	U
99-04-226-58	24-09JS-6	4	U			0.9	U			79.0	U	22.1	4.6					0.1	U			0.1	U			0.3	U			26.0	U	1.2	0.3			0.6	0.2		
99-04-226-59	24-09JS-7	3	U			0.5	U			82.0	U	18.9	4.5					0.2	U			0.2	U			0.3	U			27.0	U	1.1	0.3			0.5	0.3		
99-04-226-60	24-09JS-8	3	U			1.0	U			72.0	U	20.1	4.8					0.2	U			0.2	U			0.4	U			29.0	U	0.8	0.3			0.5	0.3		
99-04-226-61	24-09JS-9		U			2.3	U			220.0	U			3.8	U			0.4	U			0.4	U			0.8	U			77.0	U			0.6	U			0.7	U
99-04-226-62	24-16DB60		U			1.1	U			140.0	U	19.0	5.7					0.3	U			0.4	U			0.4	U			35.0	U	1.1	0.7					0.8	U
99-04-226-63	24-16DB61		U			1.1	U			210.0	U	16.6	4.3					0.2	U			0.2	U			0.3	U			36.0	U			0.7	U			1.3	U
99-04-226-64	24-16DB63		U			0.7	U			44.0	U	13.9	3.1					0.2	U			0.2	U			0.5	U	38.0	20.0			10.0	1.7			9.6	1.8		
99-04-226-65	24-08DB03		U			1.2	U			150.0	U	23.4	5.3					0.3	U			0.3	U			0.8	U	63.0	34.0			16.8	2.9			16.2	2.8		
99-04-226-66	24-08DB02		U			4.3	U			570.0	U	40.0	11.0					1.1	U			0.9	U			2.5	U	170.0	100.0			294.0	49.0			51.6	8.8		
9904226-66-D1	24-08DB02																																						
99-04-226-67	24-16DB-70		U			1.3	U			40.0	U	16.7	4.7					0.2	U			0.3	U			0.4	U			26.0	U	0.9	0.3					0.3	U
99-04-226-68	24-16DB-65		U			4.1	U			220.0	U	36.0	12.0					1.1	U			0.9	U			2.3	U			120.0	U	247.0	41.0			45.7	7.8		
9904226-68-D1	24-16DB-65																																						
99-04-226-69	24-16DB-66		U			1.0	U			67.0	U	19.8	4.2					0.2	U			0.2	U			0.6	U	46.0	24.0			27.5	4.6			14.5	2.5		
99-04-226-70	24-15DB01		U			3.1	U			270.0	U	29.8	8.6					0.9	U			0.8	U			1.8	U			110.0	U	182.0	30.0			45.6	7.7		
99-04-226-71	24-15DB02		U			4.9	U			310.0	U	32.0	11.0					1.2	U			1.0	U			2.6	U			140.0	U	250.0	41.0			49.5	8.4		
99-04-226-72	24-15DB03		U			8.3	U			520.0	U	22.0	21.0					2.1	U			1.8	U			3.3	U			250.0	U	3.6	3.0					2.9	U
99-04-226-73	24-15DB04	15	U			1.0	U			48.0	U	19.5	5.1					0.2	U			0.4	U			0.3	U			35.0	U	1.2	0.4			1.2	0.4		
99-04-226-74	24-15DB05	15	U			0.6	U			41.0	U	20.6	4.1					0.1	U			0.1	U			0.2	U			17.0	U	1.0	0.3			0.6	0.2		
99-04-226-76	24-08DB04		U			0.9	U			83.0	U	19.3	4.1					0.2	U			0.2	U			0.4	U			23.0	U	8.5	1.5			9.2	1.6		
99-04-226-77	24-08DB05		U			1.0	U			200.0	U	19.0	4.5					0.2	U			0.2	U			0.3	U			24.0	U	0.7	0.5					0.6	U
99-04-226-78	24-15DB06	15	U			0.8	U			55.0	U	16.0	4.1					0.1	U			0.2	U			0.3	U			41.0	U	1.0	0.3			0.7	0.3		
99-04-226-79	24-17DB01		U			1.1	U			33.0	U	19.7	5.4					0.2	U			0.2	U			0.3	U			36.0	U	0.8	0.3			0.5	0.3		
99-04-226-80	24-17DB02		U			0.6	U			34.0	U	22.4	4.6					0.1	U			0.1	U			0.2	U			20.0	U	1.0	0.3					0.2	U
99-04-226-81	24-17DB03		U			0.9	U			31.0	U	19.7	4.7					0.1	U			0.2	U			0.2	U			27.0	U	1.1	0.3			0.8	0.3		
99-04-226-82	24-17DB04		U			0.7	U			31.0	U	19.7	4.0					0.1	U			0.1	U			0.2	U			14.0	U	1.0	0.3			0.4	0.2		
99-04-226-83	24-17DB05		U			1.4	U			49.0	U	25.5	6.4					0.2	U			0.3	U			0.4	U			40.0	U	1.2	0.4			0.7	0.3		
99-04-226-84	24-17KN1	2	U			1.0	U			33.0	U	19.2	4.6					0.2	U			0.2	U			0.3	U			24.0	U	1.1	0.3			0.4	0.2		
99-04-226-85	24-16DB50		U			1.2	U			120.0	U	14.0	4.2					0.2	U			0.2	U			0.4	U			32.0	U			0.5	U			0.7	U
99-04-226-90	24-04DB01		U			1.8	U			130.0	U	23.4	5.6					0.2	U			0.2	U			0.4	U			41.0	U	1.5	0.4			0.5	0.3		
99-04-226-91	24-04DB02		U			1.3	U			100.0	U	16.4	4.2					0.2	U			0.2	U			0.4	U			29.0	U	0.8	0.3			0.5	0.2		
99-04-226-92	24-16DB62		U			0.6	U			34.0	U	16.5	4.6					0.1	U			0.1	U			0.3	U			33.0	U	0.8	0.3			0.3	0.3		
99-04-226-B1	Blank		U			0.5	U			1.9	U			0.5	U			0.2	U			0.2	U			0.2	U			30.0	U			0.1	U			0.2	U
99-04-226-B2	Blank		U			0.5	U			1.9	U			0.4	U			0.2	U			0.2	U			0.2	U			20.0	U			0.2	U			0.2	U
99-04-226-B3	Blank		U			0.5	U			1.7	U			2.9	U			0.2	U			0.3	U			0.2	U			36.0	U			0.2	U			0.2	U
99-04-226-B4	Blank		U			0.4	U			2.8	U			1.5	U			0.1	U			0.1	U			0.2	U			19.0	U			0.2	U			0.2	U
99-04-226-B5	Blank		U			0.7	U			3.2	U			1.8	U			0.2	U			0.3	U			0.3	U			31.0	U			0.2	U			0.3	U
99-04-226-B6	Blank		U			0.3	U			1.7	U			1.1	U			0.1	U			0.1	U			0.1	U			20.0	U			0.1	U			0.2	U
99-04-226-B7	Blank		U			0.4	U			6.6	U			1.2	U			0.1	U			0.1	U			0.2	U			15.0	U			0.1	U			0.2	U
99-04-226-D1	24-16DB19-D	30	U			0.8	U			33.0	U	17.8	4.5					0.2	U			0.3	U			0.4	U			28.0	U	1.0	0.3					0.2	U
99-04-226-D2	24-16DB28-D	25	U			1.3	U			42.0	U	23.0	6.4					0.3	U			0.3	U			0.5	U			48.0	U	1.2	0.4			0.7	0.3		
99-04-226-D3	24-16DB42-D	34	U			0.7	U			30.0	U	19.6	4.0					0.1	U			0.1	U			0.2	U			23.0	U	1.0	0.3			0.4	0.2		
99-04-226-D4	24-16DB03-D	17	U			1.7	U			46.0	U	25.2	6.2					0.2	U			0.3	U			0.4	U			28.0	U	1.1	0.4					0.3	U
99-04-226-D5	24-16DB13-D		U			0.5	U			28.0	U	19.3	3.9					0.1	U			0.1	U			0.2	U			15.0	U	0.9	0.3			0.6	0.2		
99-04-226-D6	24-09JS-6-D	4	U			0.9	U			97.0	U	23.5	5.6					0.2	U			0.3	U			0.4	U			41.0	U	1.4	0.4			0.7	0.3		
99-04-226-D7	24-08DB02-D		U			5.5	U			520.0	U	37.0	10.0					1.0	U			1.0	U			2.8	U			130.0	U	254.0	42.0			46.3	7.9		
99-04-226-D8	24-15DB05-D	15	U			0.6	U			53.0	U	15.9	4.8					0.2	U			0.2	U			0.4	U			39.0	U	0.9	0.4			0.6	0.3		
99-04-226-D9	24-17DB04-D		U			1.0	U			31.0	U	15.8	4.3					0.2	U			0.2	U			0.4	U			34.0	U	0.8	0.3					0.3	U
99-04-226-DN	24-04DB02-D		U			1.4	U			100.0	U	18.9	5.0					0.2	U			0.2	U			0.4	U			30.0	U	1.0	0.3			0.5	0.2		

*U=undetected.

Table B-2a. Complete listing of laboratory analytical results: samples

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lab ID	Sample No.	Hole	Ru-106				Sb-124				Sb-125				Co-46				Sr-85				Th-227				Th-234				Tl-208				U-235				Zn-6	
		No.	pCi/g	±	mdc	f	pCi/g	±	mdc	f	pCi/g	±	mdc	f	pCi/g	±	mdc	f	pCi/g	±	mdc	f	pCi/g	±	mdc	f	pCi/g	±	mdc	f	pCi/g	±	mdc	f	pCi/g	±	mdc	f	pCi/g	±
99-04-226-01	24-16DB17	11			1.0	U			0.3	U			0.3	U			0.2	U			0.3	U			0.7	U			1.5	U	0.3	0.1					0.5	U		
99-04-226-02	24-16DB18	8			3.7	U			0.7	U			1.5	U			0.3	U			0.9	U			1.9	U			2.9	U			0.4	U			1.6	U		
99-04-226-03	24-16DB19	30			1.7	U			0.3	U			0.4	U			0.2	U			0.3	U			0.7	U			1.0	U			0.1	U			0.4	U		
99-04-226-04	24-16DB20	30			1.5	U			0.3	U			0.3	U			0.2	U			0.3	U			0.8	U			1.4	U	0.3	0.1					0.5	U		
99-04-226-05	24-16DB21	29			1.3	U			0.3	U			0.5	U			0.3	U			0.4	U			0.8	U			1.9	U	0.5	0.2					0.7	U		
99-04-226-06	24-16DB22	29			1.5	U			0.4	U			0.3	U			0.4	U			0.5	U			0.6	U			1.1	U	0.4	0.2					0.5	U		
99-04-226-07	24-16DB23	27			1.8	U			0.4	U			0.3	U			0.2	U			0.4	U			1.1	U			1.9	U	0.6	0.2					0.6	U		
9904226-7-D1	24-16DB23	27																																						
99-04-226-08	24-16DB24	27			1.5	U			0.3	U			0.3	U			0.3	U			0.3	U			0.7	U			1.6	U			0.1	U			0.5	U		
99-04-226-09	24-16DB25	26			1.4	U			0.4	U			0.3	U			0.3	U			0.4	U			0.8	U			1.3	U			0.2	U			0.5	U		
99-04-226-10	24-16DB26	26			1.4	U			0.3	U			0.3	U			0.3	U			0.5	U			0.7	U			1.1	U	0.0	0.0	0.2	U			0.5	U		
99-04-226-11	24-16DB27	25			1.2	U			0.3	U			0.2	U			0.2	U			0.3	U			0.7	U			1.5	U	0.4	0.1					0.5	U		
99-04-226-12	24-16DB28	25			1.8	U			0.3	U			0.4	U			0.2	U			0.4	U			0.8	U			2.2	U			0.2	U			0.6	U		
99-04-226-13	24-16DB29	24			2.3	U			0.4	U			0.5	U			0.3	U			0.7	U			1.1	U			2.0	U	0.8	0.3					0.9	U		
9904226-13-D1	24-16DB29	24																																						
99-04-226-14	24-16DB30	23			2.0	U			0.4	U			0.5	U			0.4	U			0.5	U			1.1	U			1.3	U			0.2	U			0.6	U		
99-04-226-15	24-16DB31	23			1.0	U			0.3	U			0.2	U			0.2	U			0.3	U			0.7	U			1.3	U			0.1	U			0.5	U		
99-04-226-16	24-16DB32	20			1.3	U			0.2	U			0.3	U			0.3	U			0.3	U			0.6	U			1.6	U			0.1	U			0.5	U		
9904226-16-D1	24-16DB32	20																																						
99-04-226-17	24-16DB33	20			1.7	U			0.4	U			0.5	U			0.5	U			0.6	U			0.8	U			1.6	U			0.2	U			0.7	U		
99-04-226-18	24-16DB34	22			1.7	U			0.4	U			0.4	U			0.3	U			0.4	U			0.6	U			1.0	U	0.4	0.2					0.4	U		
99-04-226-19	24-16DB35	22			1.5	U			0.3	U			0.3	U			0.3	U			0.4	U			0.6	U			1.1	U			0.2	U			0.5	U		
99-04-226-20	24-16DB36	21			1.5	U			0.3	U			0.4	U			0.2	U			0.3	U			0.7	U			1.7	U			0.2	U			0.5	U		
99-04-226-21	24-16DB37	21			2.0	U			0.5	U			0.4	U			0.5	U			0.6	U			0.6	U			1.4	U			0.2	U			0.7	U		
99-04-226-22	24-16DB38	32			1.7	U			0.3	U			0.4	U			0.3	U			0.4	U			0.6	U			0.9	U	0.3	0.2					0.4	U		
99-04-226-23	24-16DB39	32			1.4	U			0.3	U			0.4	U			0.2	U			0.3	U			0.6	U			1.7	U			0.2	U			0.6	U		
99-04-226-24	24-16DB40	33			1.3	U			0.3	U			0.3	U			0.2	U			0.3	U			0.6	U			1.4	U			0.1	U			0.5	U		
99-04-226-25	24-16DB41	33			1.6	U			0.4	U			0.3	U			0.4	U			0.4	U			0.7	U			1.3	U			0.2	U			0.6	U		
99-04-226-26	24-16DB42	34			2.0	U			0.3	U			0.4	U			0.3	U			0.4	U			0.7	U			1.1	U			0.1	U			0.4	U		
99-04-226-27	24-16DB43	34			1.4	U			0.4	U			0.4	U			0.2	U			0.4	U			1.0	U			2.1	U			0.2	U			0.7	U		
99-04-226-28	24-16DB44	35			1.5	U			0.3	U			0.3	U			0.2	U			0.3	U			0.7	U			1.6	U	0.4	0.2					0.5	U		
99-04-226-29	24-16DB45	35			1.2	U			0.2	U			0.3	U			0.3	U			0.4	U			0.6	U			1.1	U	0.3	0.2					0.5	U		
99-04-226-30	24-07KN01	14			5.4	U			1.2	U			2.8	U			0.4	U			1.5	U			3.4	U			3.6	U			0.6	U			2.0	U		
99-04-226-31	24-07KN02	14			4.9	U			1.0	U			2.0	U			0.2	U			1.1	U			2.9	U			6.1	U			0.5	U			2.6	U		
99-04-226-32	24-16DB64				8.1	U			1.3	U			3.6	U			0.2	U			1.7	U			4.5	U			9.0	U			0.8	U			3.7	U		
99-04-226-34	24-08DB01				22.0	U			4.4	U			9.4	U			0.8	U			5.6	U			11.0	U			16.0	U			2.3	U			9.1	U		
99-04-226-36	24-16DB01	16			3.3	U			0.7	U			1.8	U			0.3	U			1.0	U			2.1	U			2.4	U			0.4	U			1.4	U		
99-04-226-37	24-16DB02	16			1.8	U			0.4	U			0.6	U			0.2	U			0.4	U			1.1	U			2.2	U			0.2	U			0.9	U		
99-04-226-38	24-16DB03	17			2.0	U			0.4	U			0.5	U			0.2	U			0.4	U			0.9	U			2.2	U	0.6	0.2					0.8	U		
99-04-226-39	24-16DB04	17			1.5	U			0.3	U			0.3	U			0.3	U			0.4	U			0.6	U			1.1	U			0.2	U			0.5	U		
99-04-226-40	24-16DB05	19			37.0	U			8.3	U			16.0	U			1.4	U			10.0	U			19.0	U			27.0	U			4.1	U			16.0	U		
99-04-226-41	24-16DB06	18			2.4	U			0.7	U			0.9	U			0.3	U			0.6	U			1.2	U			2.5	U			0.3	U			1.0	U		
99-04-226-42	24-16DB07	18			4.1	U			0.8	U			2.1	U			0.4	U			1.0	U			2.6	U			2.8	U			0.5	U			1.5	U		
99-04-226-43	24-16DB08	12			2.0	U			0.4	U			0.5	U			0.3	U			0.4	U			1.2	U			2.6	U			0.2	U			0.9	U		
99-04-226-44	24-16DB09	12			2.0	U			0.3	U			0.4	U			0.4	U			0.4	U			0.7	U			1.6	U	0.4	0.2					0.8	U		
99-04-226-45	24-16DB10	13			3.7	U			0.6	U			1.4	U			0.3	U			0.8	U			1.7	U			3.6	U			0.4	U			1.5	U		
99-04-226-46	24-16DB11	13			4.6	U			1.0	U			2.6	U			0.3	U			1.2	U			3.0	U			3.2	U			0.5	U			1.8	U		
99-04-226-47	24-16DB12	31			1.8	U			0.4	U			0.4	U			0.3	U			0.4	U			1.1	U			2.1	U			0.2	U			0.7	U		
99-04-226-48	24-16DB13				1.6	U			0.2	U			0.4	U			0.3	U			0.4	U			0.7	U			1.8	U	0.3	0.2					0.6	U		
99-04-226-49	24-16DB14	9			1.1	U			0.3	U			0.3	U			0.3	U			0.4	U			0.8	U			1.0	U	0.4	0.2					0.4	U		
99-04-226-50	24-16DB15	9			1.7	U			0.4	U			0.4	U			0.2	U			0.4	U			1.0	U			2.1	U	0.3	0.2					0.7	U		
99-04-226-51	24-16DB16	11			2.5	U			0.4	U			0.5	U			0.4	U			0.5	U			1.2	U			2.2	U			0.2	U			0.8	U		
99-04-226-52	24-07JS-1				2.0	U			0.5	U			0.4	U			0.4	U			0.6	U			0.9	U			1.4	U			0.2	U			0.8	U		
99-04-226-53	24-09JS-1	6			1.2	U			0.3	U			0.3	U			0.4	U			0.4	U			0.7	U			1.0	U			0.1	U			0.5	U		

Table B-2a. Complete listing of laboratory analytical results: samples

lab ID	Sample No.	Hole	Ru-106				Sb-124				Sb-125				Co-60				Sr-90				Th-227				Th-234				Tl-208				U-235				Zn-65			
		No.	pCi/g	±	mdc	f	pCi/g	±	mdc	f	pCi/g	±	mdc	f	pCi/g	±	mdc	f	pCi/g	±	mdc	f	pCi/g	±	mdc	f	pCi/g	±	mdc	f	pCi/g	±	mdc	f	pCi/g	±	mdc	f	pCi/g	±	mdc	f
99-04-226-54	24-09JS-2	6			1.4	U			0.3	U			0.2	U			0.2	U			0.3	U			0.8	U			1.5	U	0.3	0.1					0.6	U				
99-04-226-55	24-09JS-3	7			1.5	U			0.4	U			0.4	U			0.3	U			0.5	U			0.8	U			1.9	U			0.2	U			0.8	U				
99-04-226-56	24-09JS-4	7			1.0	U			0.3	U			0.3	U			0.2	U			0.3	U			0.5	U			1.0	U			0.1	U			0.4	U				
99-04-226-57	24-09JS-5	4			1.5	U			0.4	U			0.4	U			0.3	U			0.4	U			0.7	U			0.9	U			0.2	U			0.4	U				
99-04-226-58	24-09JS-6	4			1.4	U			0.4	U			0.4	U			0.2	U			0.4	U			0.9	U			2.0	U			0.1	U			0.6	U				
99-04-226-59	24-09JS-7	3			1.9	U			0.3	U			0.4	U			0.2	U			0.4	U			0.7	U			1.6	U			0.2	U			0.6	U				
99-04-226-60	24-09JS-8	3			1.6	U			0.4	U			0.3	U			0.3	U			0.5	U			0.6	U			1.2	U			0.2	U			0.5	U				
99-04-226-61	24-09JS-9				5.0	U			1.2	U			1.0	U			0.6	U			1.3	U			2.0	U			4.6	U			0.4	U			1.8	U				
99-04-226-62	24-16DB60				3.7	U			0.6	U			1.7	U			0.4	U			0.9	U			2.1	U			2.4	U			0.4	U			1.2	U				
99-04-226-63	24-16DB61				6.2	U			1.0	U			2.1	U			0.3	U			1.3	U			2.7	U			3.7	U			0.5	U			2.2	U				
99-04-226-64	24-16DB63				1.4	U			0.4	U			0.4	U			0.2	U			0.4	U			1.8	U			3.3	U	3.2	0.6			1.5	1.0						
99-04-226-65	24-06DB03				2.4	U			0.6	U			0.7	U			0.4	U			0.8	U			3.0	U			5.6	U	5.5	1.0			2.6	1.8						
99-04-226-66	24-06DB02				10.0	U			1.7	U			2.4	U			1.3	U			2.7	U			7.5	U			16.0	U	99.0	17.0			22.7	7.9						
9904226-66-D1	24-06DB02																																									
99-04-226-67	24-16DB-70				1.2	U			0.3	U			0.4	U			0.4	U			0.4	U			0.7	U			1.3	U			0.2	U			0.6	U				
99-04-226-68	24-16DB-65				8.3	U			1.5	U			2.3	U			1.2	U			2.0	U			5.4	U			9.6	U	85.0	14.0			16.4	5.3						
9904226-68-D1	24-16DB-65																																									
99-04-226-69	24-16DB-66				2.2	U			0.5	U			0.6	U			0.3	U			0.6	U			2.9	U	27.0	6.0			8.4	1.4					1.4	U				
99-04-226-70	24-15DB01				7.8	U			1.3	U			2.1	U			1.0	U			1.9	U			5.9	U			14.0	U	62.0	10.0			9.9	4.8						
99-04-226-71	24-15DB02				9.6	U			2.0	U			2.4	U			1.6	U			3.6	U			6.8	U			12.0	U	84.0	14.0			10.5	5.0						
99-04-226-72	24-15DB03				19.0	U			3.8	U			4.3	U			2.9	U			4.8	U			7.9	U			18.0	U			1.7	U			6.4	U				
99-04-226-73	24-15DB04	15			1.6	U			0.4	U			0.6	U			0.3	U			0.4	U			0.8	U			1.1	U	0.4	0.2					0.5	U				
99-04-226-74	24-15DB05	15			1.4	U			0.3	U			0.3	U			0.2	U			0.3	U			0.9	U			1.7	U	0.3	0.1					0.6	U				
99-04-226-76	24-06DB04				1.3	U			0.3	U			0.4	U			0.2	U			0.4	U			0.8	U			1.3	U	2.7	0.5					0.5	U				
99-04-226-77	24-06DB05				2.6	U			0.4	U			1.0	U			0.3	U			0.6	U			1.4	U			2.9	U			0.3	U			1.1	U				
99-04-226-78	24-15DB06	15			1.7	U			0.3	U			0.4	U			0.2	U			0.5	U			0.7	U			1.3	U			0.2	U			0.6	U				
99-04-226-79	24-17DB01				1.5	U			0.3	U			0.4	U			0.3	U			0.3	U			0.8	U			0.9	U	0.4	0.2					0.5	U				
99-04-226-80	24-17DB02				1.5	U			0.4	U			0.3	U			0.2	U			0.3	U			0.9	U			1.9	U			0.1	U			0.6	U				
99-04-226-81	24-17DB03				1.3	U			0.3	U			0.3	U			0.2	U			0.3	U			0.7	U			1.7	U	0.4	0.2					0.5	U				
99-04-226-82	24-17DB04				1.2	U			0.3	U			0.3	U			0.2	U			0.3	U			0.8	U			1.6	U			0.1	U			0.6	U				
99-04-226-83	24-17DB05				2.6	U			0.4	U			0.4	U			0.3	U			0.5	U			1.0	U			2.2	U	0.5	0.3					0.7	U				
99-04-226-84	24-17KN1	2			1.4	U			0.3	U			0.3	U			0.3	U			0.4	U			0.6	U			1.1	U			0.2	U			0.6	U				
99-04-226-85	24-16DB50				3.0	U			0.6	U			1.4	U			0.3	U			0.7	U			1.8	U			2.0	U			0.4	U			1.2	U				
99-04-226-90	24-04DB01				2.3	U			0.4	U			0.3	U			0.3	U			0.5	U			0.9	U			2.0	U			0.2	U			0.7	U				
99-04-226-91	24-04DB02				1.6	U			0.4	U			0.3	U			0.4	U			0.5	U			0.6	U			1.1	U			0.2	U			0.5	U				
99-04-226-92	24-16DB62				1.3	U			0.3	U			0.3	U			0.3	U			0.3	U			0.6	U			0.9	U			0.1	U			0.4	U				
99-04-226-B1	Blank				1.7	U			0.2	U			0.4	U			0.2	U			0.3	U			0.5	U			0.8	U			0.2	U			0.4	U				
99-04-226-B2	Blank				1.3	U			0.2	U			0.3	U			0.1	U			0.3	U			0.5	U			1.0	U			0.1	U			0.6	U				
99-04-226-B3	Blank				1.4	U			0.2	U			0.3	U			0.2	U			0.3	U			0.5	U			0.7	U			0.2	U			0.4	U				
99-04-226-B4	Blank				1.2	U			0.2	U			0.4	U			0.2	U			0.3	U			0.8	U			1.4	U			0.1	U			0.5	U				
99-04-226-B5	Blank				1.5	U			0.3	U			0.3	U			0.3	U			0.3	U			0.6	U			1.4	U			0.2	U			0.5	U				
99-04-226-B6	Blank				1.0	U			0.2	U			0.2	U			0.1	U			0.2	U			0.5	U			1.1	U			0.1	U			0.4	U				
99-04-226-B7	Blank				1.0	U			0.3	U			0.2	U			0.1	U			0.2	U			0.5	U			1.1	U			0.1	U			0.4	U				
99-04-226-D1	24-16DB19-D	30			1.4	U			0.3	U			0.3	U			0.3	U			0.4	U			0.8	U			1.1	U	0.5	0.2					0.6	U				
99-04-226-D2	24-16DB28-D	25			1.5	U			0.4	U			0.5	U			0.5	U			0.4	U			0.9	U			1.4	U			0.2	U			0.5	U				
99-04-226-D3	24-16DB42-D	34			1.2	U			0.3	U			0.2	U			0.2	U			0.3	U			0.7	U			1.6	U	0.3	0.1					0.5	U				
99-04-226-D4	24-16DB03-D	17			2.0	U			0.4	U			0.6	U			0.3	U			0.4	U			0.9	U			1.9	U			0.2	U			0.8	U				
99-04-226-D5	24-16DB13-D				1.1	U			0.3	U			0.3	U			0.2	U			0.3	U			0.8	U			1.6	U			0.1	U			0.5	U				
99-04-226-D6	24-09JS-6-D	4			1.9	U			0.4	U			0.4	U			0.3	U			0.5	U			0.8	U			1.9	U	0.3	0.2					0.6	U				
99-04-226-D7	24-06DB02-D				9.3	U			1.9	U			2.2	U			1.6	U			3.5	U			6.3	U			11.0	U	86.0	14.0			16.0	5.6						
99-04-226-D8	24-15DB05-D	15			1.9	U			0.3	U			0.6	U			0.3	U			0.4	U			0.7	U			1.1	U			0.2	U			0.5	U				
99-04-226-D9	24-17DB04-D				1.7	U			0.3	U			0.3	U			0.3	U			0.4	U			0.7	U			1.2	U			0.2	U			0.6	U				
99-04-226-DN	24-04DB02-D				1.3	U			0.3	U			0.4	U			0.3	U			0.4	U			0.6	U			1.0	U			0.2	U			0.5	U				

*U=undetected.

Table B-2a. Complete listing of laboratory analytical results: samples

lab ID	Sample No.	Hole No.	5 mdc	f	Th-228 pCi/g	±	mdc	f	Th-230 pCi/g	±	mdc	f	Th-232 pCi/g	±	mdc	f	U-234 pCi/g	±	mdc	f	U-235 pCi/g	±	mdc	f	U-238 pCi/g	±	mdc	f
99-04-226-01	24-16DB17	11	0.3	U																								
99-04-226-02	24-16DB18	8	0.6	U																								
99-04-226-03	24-16DB19	30	0.6	U																								
99-04-226-04	24-16DB20	30	0.3	U																								
99-04-226-05	24-16DB21	29	0.4	U																								
99-04-226-06	24-16DB22	29	0.6	U																								
99-04-226-07	24-16DB23	27	0.3	U	1.0	0.4	0.5		0.7	0.3	0.3		1.1	0.3	0.3													
9904226-7-D1	24-16DB23	27			1.1	0.4	0.5		0.9	0.3	0.2		1.3	0.4	0.3													
99-04-226-08	24-16DB24	27	0.3	U																								
99-04-226-09	24-16DB25	26	0.4	U																								
99-04-226-10	24-16DB26	26	0.6	U																								
99-04-226-11	24-16DB27	25	0.3	U																								
99-04-226-12	24-16DB28	25	0.5	U																								
99-04-226-13	24-16DB29	24	0.9	U	2.9	0.4	0.1		3.2	0.5	0.0		3.0	0.4	0.0		2.8	0.4	0.1		0.2	0.1	0.1		3.4	0.5	0.0	
9904226-13-D1	24-16DB29	24			3.2	0.5	0.1		3.8	0.5	0.0		3.0	0.4	0.0		2.9	0.4	0.1		0.2	0.1	0.1		3.5	0.5	0.1	
99-04-226-14	24-16DB30	23	0.6	U																								
99-04-226-15	24-16DB31	23	0.3	U																								
99-04-226-16	24-16DB32	20	0.5	U	0.9	0.2	0.1		0.4	0.1	0.0		0.7	0.1	0.0		0.4	0.1	0.1		0.0	0.0	0.0	U	0.5	0.1	0.1	
9904226-16-D1	24-16DB32	20			0.8	0.2	0.1		0.4	0.1	0.0		0.7	0.1	0.0		0.4	0.1	0.0		0.0	0.0	0.0	U	0.4	0.1	0.0	
99-04-226-17	24-16DB33	20	0.4	U																								
99-04-226-18	24-16DB34	22	0.6	U																								
99-04-226-19	24-16DB35	22	0.5	U																								
99-04-226-20	24-16DB36	21	0.4	U	0.4	0.2	0.4		0.5	0.2	0.2		0.7	0.2	0.2													
99-04-226-21	24-16DB37	21	0.6	U																								
99-04-226-22	24-16DB38	32	0.4	U	0.8	0.2	0.0		0.4	0.1	0.0		0.9	0.2	0.0		0.3	0.1	0.0		0.0	0.0	0.1	U	0.3	0.1	0.1	
99-04-226-23	24-16DB39	32	0.3	U	0.3	0.3	0.5	U	1.0	0.3	0.2		0.4	0.2	0.3													
99-04-226-24	24-16DB40	33	0.5	U	0.8	0.2	0.1		0.5	0.1	0.0		0.7	0.1	0.0		0.5	0.1	0.1		0.0	0.0	0.0	U	0.4	0.1	0.1	
99-04-226-25	24-16DB41	33	0.6	U	1.9	0.5	0.4		0.9	0.3	0.2		1.7	0.4	0.3													
99-04-226-26	24-16DB42	34	0.4	U	1.1	0.2	0.1		0.4	0.1	0.0		1.0	0.2	0.0		0.4	0.1	0.1		0.0	0.0	0.1	U	0.4	0.1	0.1	
99-04-226-27	24-16DB43	34	0.4	U	0.7	0.4	0.5		0.8	0.3	0.3		0.5	0.2	0.2													
99-04-226-28	24-16DB44	35	0.4	U																								
99-04-226-29	24-16DB45	35	0.6	U																								
99-04-226-30	24-07KN01	14	0.3	U	1.0	0.2	0.1		0.8	0.2	0.0		0.9	0.2	0.0		0.4	0.1	0.1		0.0	0.0	0.1	U	0.4	0.1	0.1	
99-04-226-31	24-07KN02	14	0.3	U	1.1	0.2	0.0		0.5	0.1	0.0		1.0	0.2	0.0		0.3	0.1	0.1		0.0	0.0	0.1	U	0.3	0.1	0.1	
99-04-226-32	24-16DB64		0.3	U																								
99-04-226-34	24-08DB01		1.0	U	1.0	0.2	0.1		0.6	0.1	0.0		0.8	0.1	0.0		0.4	0.1	0.1		0.0	0.0	0.1	U	0.3	0.1	0.1	
99-04-226-36	24-16DB01	16	0.9	U																								
99-04-226-37	24-16DB02	16	0.2	U																								
99-04-226-38	24-16DB03	17	0.6	U																								
99-04-226-39	24-16DB04	17	0.5	U																								
99-04-226-40	24-16DB05	19	1.9	U	0.8	0.2	0.1		0.4	0.1	0.0		0.8	0.1	0.0		0.4	0.1	0.1		0.0	0.0	0.1	U	0.3	0.1	0.1	
99-04-226-41	24-16DB06	18	0.5	U	0.7	0.3	0.3		0.9	0.3	0.2		0.9	0.3	0.2													
99-04-226-42	24-16DB07	18	0.6	U	0.8	0.3	0.3		0.7	0.3	0.2		0.9	0.3	0.2													
99-04-226-43	24-16DB08	12	0.4	U																								
99-04-226-44	24-16DB09	12	0.5	U																								
99-04-226-45	24-16DB10	13	0.5	U																								
99-04-226-46	24-16DB11	13	0.4	U																								
99-04-226-47	24-16DB12	31	0.4	U																								
99-04-226-48	24-16DB13		0.4	U																								
99-04-226-49	24-16DB14	9	0.5	U																								
99-04-226-50	24-16DB15	9	0.3	U																								
99-04-226-51	24-16DB16	11	0.7	U																								
99-04-226-52	24-07JS-1		0.5	U																								
99-04-226-53	24-09JS-1	6	0.5	U																								

Table B-2a. Complete listing of laboratory analytical results: samples

lab ID	Sample No.	Hole No.	5 mdc	f	Th-228 pCi/g	±	mdc	f	Th-230 pCi/g	±	mdc	f	Th-232 pCi/g	±	mdc	f	U-234 pCi/g	±	mdc	f	U-235 pCi/g	±	mdc	f	U-238 pCi/g	±	mdc	f
99-04-226-54	24-09JS-2	6	0.3	U																								
99-04-226-55	24-09JS-3	7	0.5	U																								
99-04-226-56	24-09JS-4	7	0.4	U																								
99-04-226-57	24-09JS-5	4	0.3	U																								
99-04-226-58	24-09JS-6	4	0.3	U																								
99-04-226-59	24-09JS-7	3	0.5	U																								
99-04-226-60	24-09JS-8	3	0.5	U																								
99-04-226-61	24-09JS-9		1.0	U																								
99-04-226-62	24-16DB60		0.6	U																								
99-04-226-63	24-16DB61		0.7	U	1.1	0.3	0.3		0.9	0.3	0.1		1.2	0.3	0.1													
99-04-226-64	24-16DB63		0.4	U																								
99-04-226-65	24-08DB03		0.7	U	11.5	1.6	0.3		88.0	11.0	0.2		10.8	1.5	0.2													
99-04-226-66	24-08DB02		2.1	U	400.0	130.0	110.0		3690.0	550.0	64.0		470.0	140.0	76.0		183.0	43.0	25.0		18.0	15.0	23.0	U	170.0	41.0	20.0	
9904226-66-D1	24-08DB02				320.0	110.0	100.0		4010.0	570.0	51.0		360.0	110.0	51.0													
99-04-226-67	24-16DB-70		0.7	U	1.0	0.2	0.1		0.5	0.1	0.0		1.0	0.2	0.0		0.8	0.2	0.1		0.3	0.1	0.0		0.6	0.1	0.1	
99-04-226-68	24-16DB-65		1.9	U	320.0	110.0	100.0		3870.0	560.0	64.0		420.0	120.0	68.0		131.0	27.0	7.8		10.3	6.2	2.9		149.0	29.0	7.3	
9904226-68-D1	24-16DB-65																141.0	31.0	11.0		7.3	6.5	9.5	U	155.0	33.0	10.0	
99-04-226-69	24-16DB-66		0.5	U	25.0	35.0	70.0	U	177.0	72.0	22.0		18.0	25.0	45.0	U	15.8	4.2	2.4		1.5	1.3	2.0	U	15.6	4.1	0.9	
99-04-226-70	24-15DB01		1.8	U	158.0	87.0	130.0		2240.0	360.0	65.0		162.0	80.0	85.0		37.0	13.0	9.4		3.7	4.9	9.4	U	43.0	14.0	6.8	
99-04-226-71	24-15DB02		2.8	U	410.0	130.0	100.0		3960.0	570.0	52.0		450.0	130.0	57.0		58.0	18.0	3.8		5.2	5.5	8.8	U	63.0	19.0	9.6	
99-04-226-72	24-15DB03		4.1	U																								
99-04-226-73	24-15DB04	15	0.5	U																								
99-04-226-74	24-15DB05	15	0.3	U																								
99-04-226-76	24-08DB04		0.4	U																								
99-04-226-77	24-08DB05		0.5	U																								
99-04-226-78	24-15DB06	15	0.4	U																								
99-04-226-79	24-17DB01		0.4	U	0.9	0.2	0.1		0.6	0.1	0.0		1.0	0.2	0.0		0.8	0.2	0.1		0.3	0.1	0.1		0.5	0.1	0.1	
99-04-226-80	24-17DB02		0.4	U	0.9	0.2	0.1		0.5	0.1	0.0		1.0	0.2	0.0		0.6	0.1	0.0		0.1	0.1	0.1		0.6	0.1	0.1	
99-04-226-81	24-17DB03		0.4	U	0.9	0.2	0.1		0.5	0.1	0.0		0.9	0.2	0.0		0.7	0.1	0.0		0.0	0.0	0.1	U	0.8	0.2	0.1	
99-04-226-82	24-17DB04		0.2	U	1.0	0.2	0.1		0.6	0.1	0.0		0.9	0.2	0.0		0.3	0.1	0.1		0.0	0.0	0.1	U	0.5	0.1	0.1	
99-04-226-83	24-17DB05		0.4	U	1.1	0.2	0.1		0.6	0.1	0.0		1.0	0.2	0.0		0.5	0.1	0.1		0.0	0.0	0.1	U	0.5	0.1	0.0	
99-04-226-84	24-17KN1	2	0.5	U																								
99-04-226-85	24-16DB50		0.7	U																								
99-04-226-90	24-04DB01		0.5	U																								
99-04-226-91	24-04DB02		0.5	U																								
99-04-226-92	24-16DB62		0.1	U	1.1	0.3	0.3		1.0	0.3	0.1		1.0	0.3	0.2													
99-04-226-B1	Blank		0.4	U																								
99-04-226-B2	Blank		0.4	U																								
99-04-226-B3	Blank		0.2	U																								
99-04-226-B4	Blank		0.3	U																								
99-04-226-B5	Blank		0.5	U																								
99-04-226-B6	Blank		0.2	U																								
99-04-226-B7	Blank		0.2	U																								
99-04-226-D1	24-16DB19-D	30	0.3	U																								
99-04-226-D2	24-16DB26-D	26	0.5	U																								
99-04-226-D3	24-16DB42-D	34	0.3	U																								
99-04-226-D4	24-16DB03-D	17	0.8	U																								
99-04-226-D5	24-16DB13-D		0.2	U																								
99-04-226-D6	24-09JS-6-D	4	0.5	U																								
99-04-226-D7	24-08DB02-D		2.4	U																								
99-04-226-D8	24-15DB05-D	15	0.5	U																								
99-04-226-D9	24-17DB04-D		0.5	U																								
99-04-226-DN	24-04DB02-D		0.6	U																								

*U=undetected.

Table B-2b. Complete listing of laboratory analytical results: lab control samples

lab ID	Sample No.	Sample	Count	Am-241				Cd-109				Ce-139				Co-57				Co-60				Cs-137				
		Date	Date	pCi/g	±	f	%rec	pCi/g	±	f	%rec	pCi/g	±	f	%rec	pCi/g	±	f	%rec	pCi/g	±	f	%rec	pCi/g	±	f	%rec	pCi/g
99-04-226-S1	Lab Control	10/1/98	6/22/99	443	73	P	96	6700	1100	P	106					148	24	P	102	303	50	P	106	204	34	P	110	502
99-04-226-S2	Lab Control	10/1/98	6/22/99	441	73	P	96	6500	1100	P	103					141	23	P	97	299	49	P	105	188	31	P	102	532
99-04-226-S3	Lab Control	10/1/98	6/23/99	429	71	P	93	6400	1100	P	101					141	23	P	97	304	50	P	106	191	32	P	103	475
99-04-226-S4	Lab Control	10/1/98	6/24/99	475	78	P	103	6400	1100	P	101					151	25	P	104	318	53	P	111	196	32	P	106	497
99-04-226-S5	Lab Control	10/1/98	6/24/99	476	79	P	103	6400	1100	P	101					152	25	P	105	319	53	P	112	193	32	P	104	506
99-04-226-S6	Lab Control	4/1/99	6/23/99	203	34	P	100	2690	440	P	99	97	16	P	100	68	11	P	100	141	23	P	99	84	14	P	99	219
99-04-226-S7	Lab Control	10/1/98	7/8/99	443	74	P	96	6500	1100	P	103					145	24	P	100	301	50	P	105	197	33	P	106	480
99-04-226-S8	Lab Control	10/1/98	7/8/99	443	74	P	96	6500	1100	P	103					145	24	P	100	301	50	P	105	197	33	P	106	480
AS02428BLK1		5/20/99	6/16/99																									
AS02428LCS1		5/20/99	6/16/99																									
AS02430BLK1		5/20/99	6/20/99																									
AS02430LCS1		5/20/99	6/20/99																									
AS02527BLK1		6/22/99	6/27/99																									
AS02527LCS1		6/22/99	6/27/99																									
AS02529BLK1		6/22/99	6/26/99																									
AS02529LCS1		6/22/99	6/26/99																									
AS02530BLK1		6/22/99	6/26/99																									
AS02530LCS1		6/22/99	6/27/99																									

Table B-2b. Complete listing of laboratory analytical results: lab control samples

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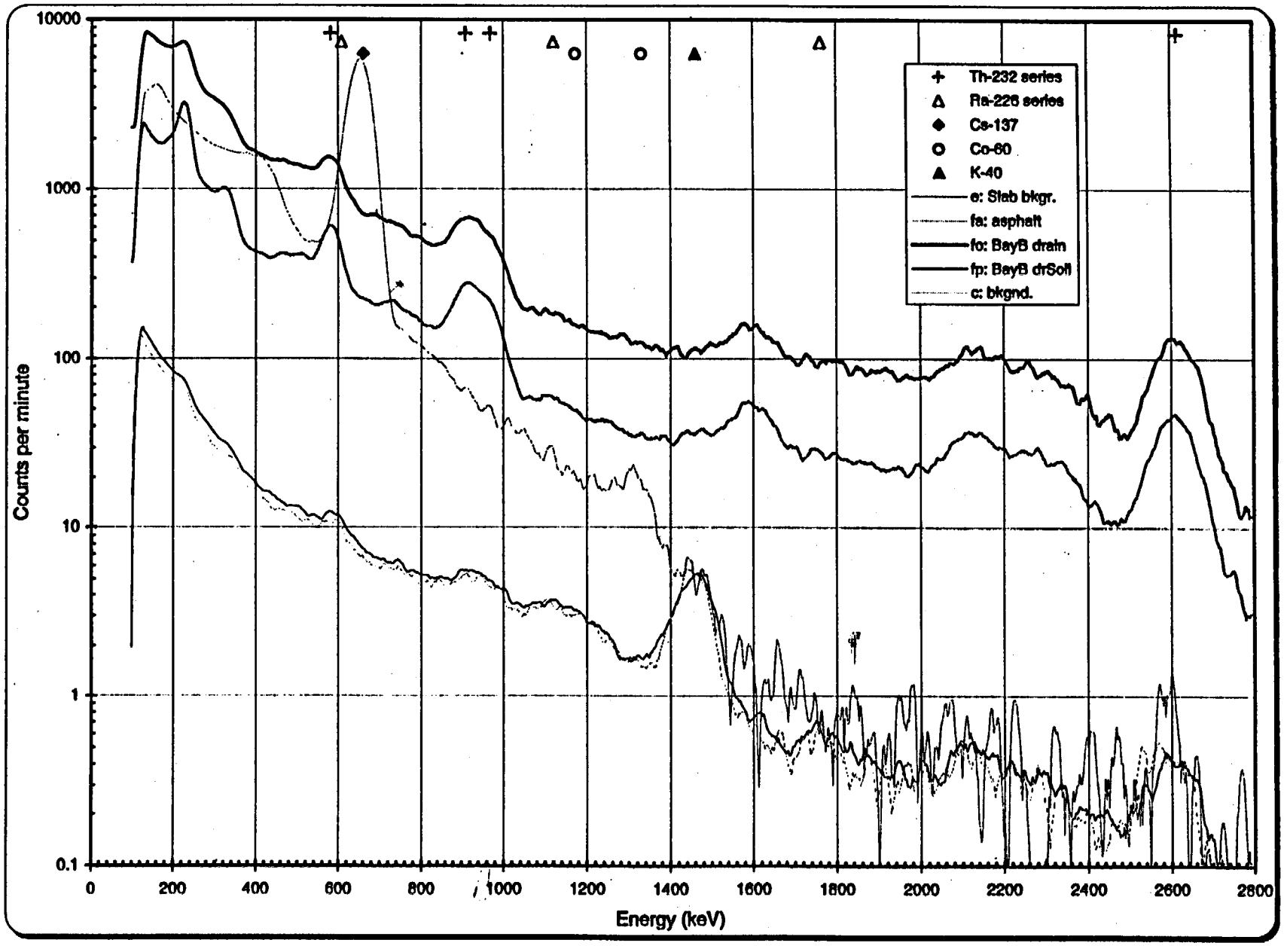
lab ID	Sample No.	Hg-203			Sn-113				Y-88				Th-228					
		±	mdc	f	pCi/g	±	f	%rec	pCi/g	±	f	%rec	pCi/g	±	mdc	f	%rec	pCi/g
99-04-226-S1	Lab Control	88	443	P	413	68	P											
99-04-226-S2	Lab Control	99	441	P	395	66	P											
99-04-226-S3	Lab Control	90	429	P	402	67	P											
99-04-226-S4	Lab Control	93	475	P	410	68	P											
99-04-226-S5	Lab Control	94	476	P	402	67	P'											
99-04-226-S6	Lab Control	36	203	P	171	28	P	99	291	48	P	97						
99-04-226-S7	Lab Control	100	443	P	404	67	P											
99-04-226-S8	Lab Control	100	443	P	404	67	P											
AS02428BLK1																		
AS02428LCS1																		
AS02430BLK1													0.1	0.4	0.7	U	0	0.4
AS02430LCS1													0.0	0.2	0.4	U	0	46.1
AS02527BLK1													0.0	0.0	0.1	U	0	0.1
AS02527LCS1													0.0	0.0	0.1	U	0	2.3
AS02529BLK1													-11.0	33.0	100.0	U	0	123.0
AS02529LCS1													-10.0	26.0	92.0	U	0	4440.0
AS02530BLK1																		
AS02530LCS1																		

Table B-2b. Complete listing of laboratory analytical results: lab control samples

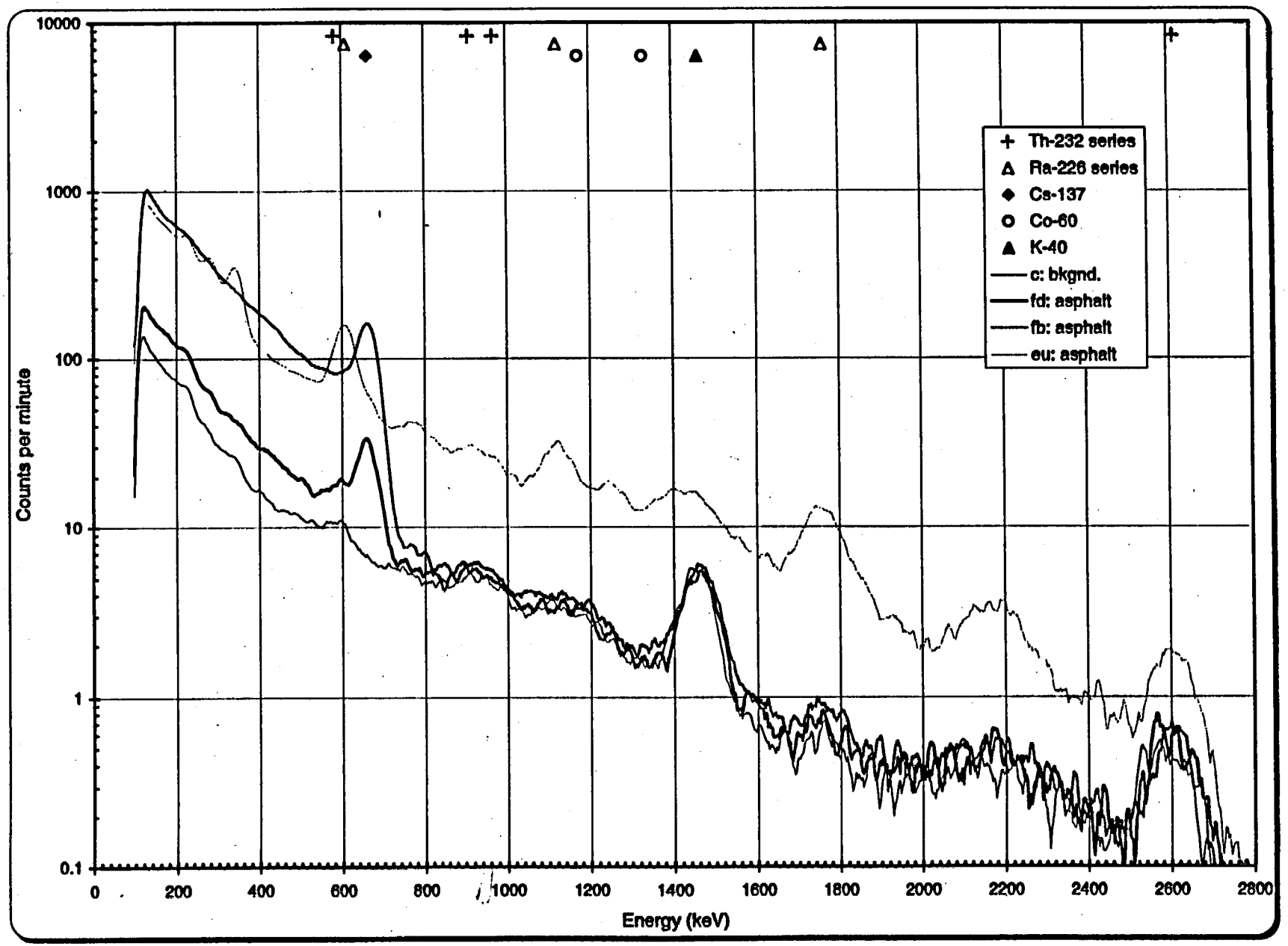
page 3 of 3

lab ID	Sample No.	Th-230				Th-232					U-234					U-235					U-238			
		±	mdc	f	%rec	pCi/g	±	mdc	f	%rec	pCi/g	±	mdc	f	%rec	pCi/g	±	mdc	f	%rec	pCi/g	±	mdc	f
99-04-226-S1	Lab Control																							
99-04-226-S2	Lab Control																							
99-04-226-S3	Lab Control																							
99-04-226-S4	Lab Control																							
99-04-226-S5	Lab Control																							
99-04-226-S6	Lab Control																							
99-04-226-S7	Lab Control																							
99-04-226-S8	Lab Control																							
AS02428BLK1											0.0	0.0	0.1	U	0	0.0	0.0	0.1	U	0	0.0	0.0	0.1	U
AS02428LCS1											10.2	1.3	0.1	Pass	101	0.5	0.1	0.0		0	10.1	1.2	0.0	Pass
AS02430BLK1		0.2	0.2	B	0	0.1	0.1	0.2	U	0														
AS02430LCS1		5.7	0.1	Pass	103	0.2	0.1	0.2	U	0														
AS02527BLK1		0.0	0.0	B3	0	0.0	0.0	0.0	U	0														
AS02527LCS1		0.3	0.0	Pass	101	0.0	0.0	0.0	U	0														
AS02529BLK1		63.0	66.0	B	0	29.0	32.0	55.0	U	0														
AS02529LCS1		640.0	43.0	Pass	99	22.0	28.0	43.0	U	0														
AS02530BLK1											0.6	3.5	7.2	U	0	0.8	3.5	6.1	U	0	-0.3	3.5	6.1	U
AS02530LCS1											529.0	78.0	10.0	Pass	105	40.0	14.0	8.7		0	522.0	77.0	8.7	Pass

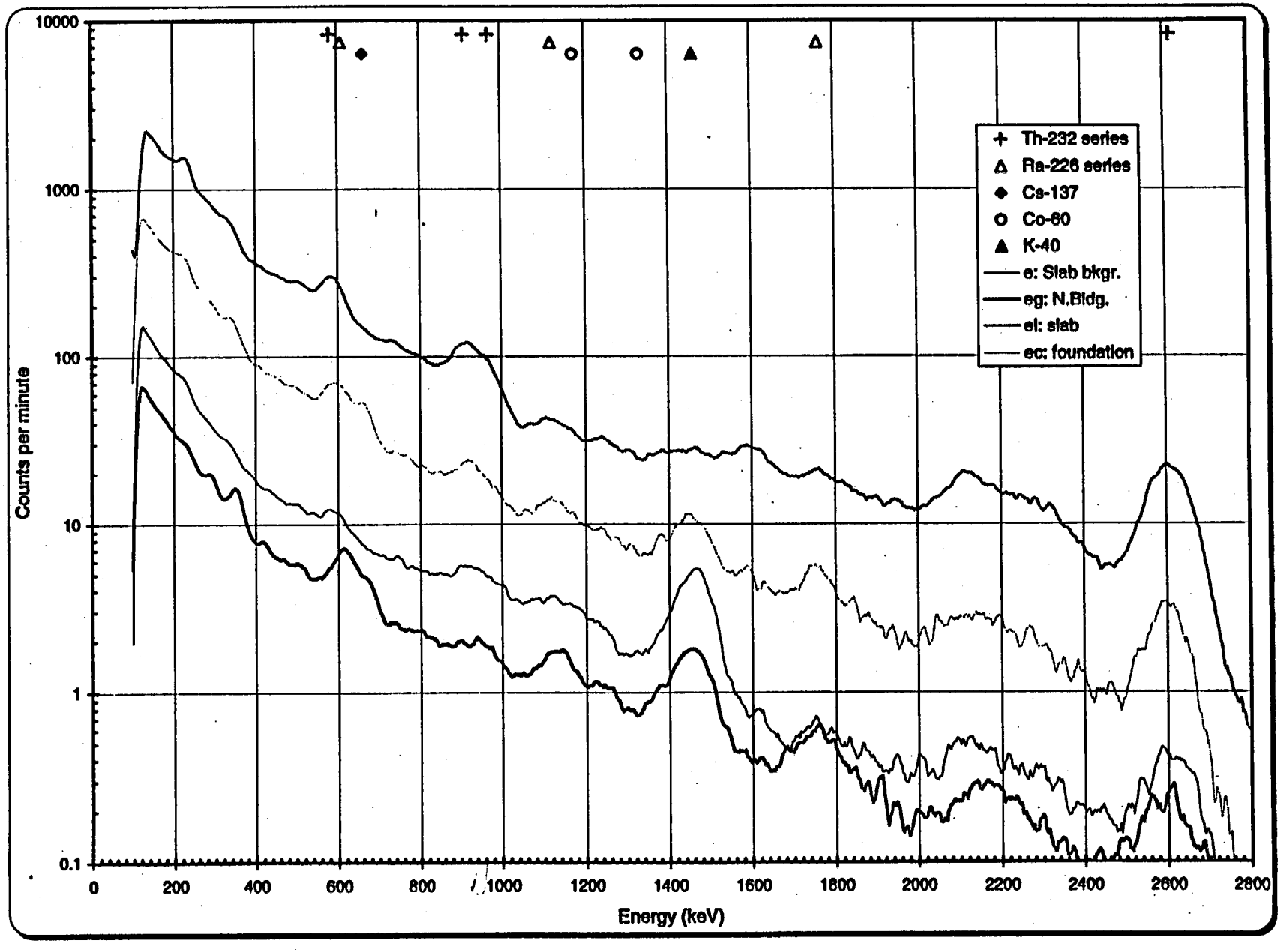
Appendix C


Th-232 series
Ra-226 series
Cs-137
Co-60
K-40
e: Slab bkgr.
fa: asphalt
fo: BayB drain
fp: BayB drSoil
c: bkgnd.
Counts per minute
Energy (keV)
10000
1000
100
10
1
0.1
0
200
400
600
800
1000
1200
1400
1600
1800
2000
2200
2400
2600
2800

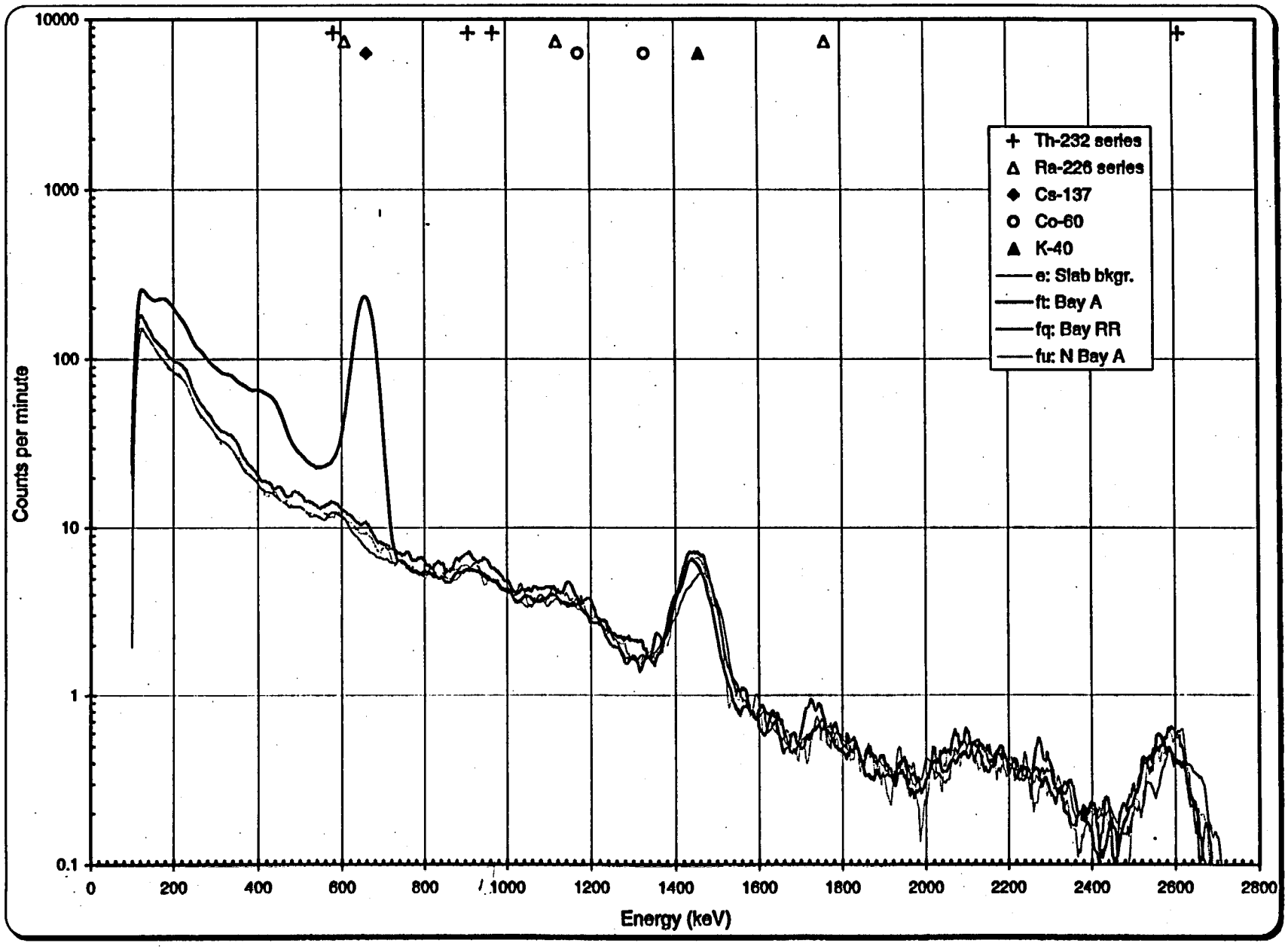
3-30 Chart 7


Counts per minute
10000
1000
100
10
1
0.1
0
200
400
600
800
1000
1200
1400
1600
1800
2000
2200
2400
2600
2800
Energy (keV)
Th-232 series
Ra-226 series
Cs-137
Co-60
K-40
c: bkgnd.
fd: asphalt
fb: asphalt
eu: asphalt

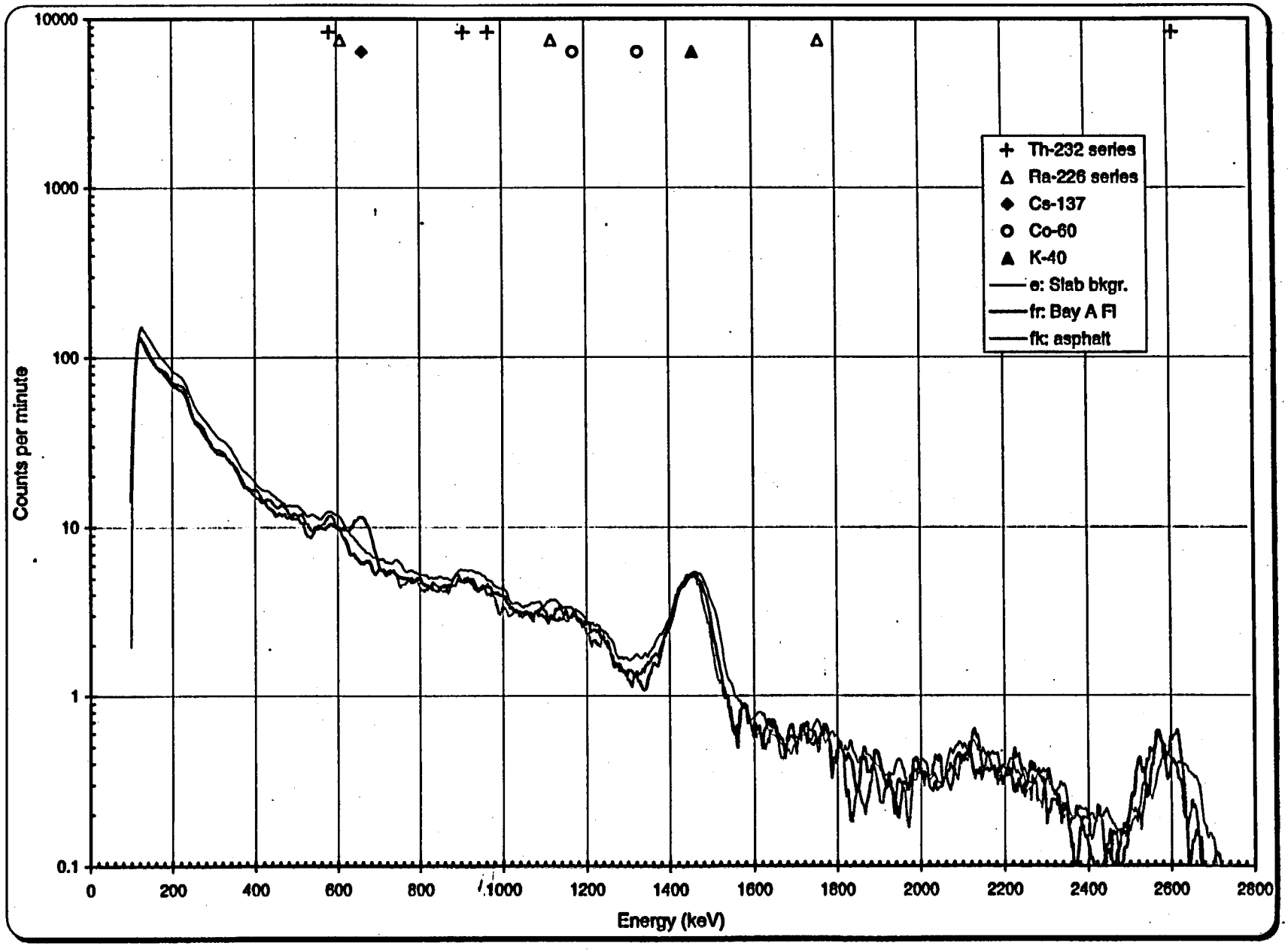
3-30 Chart 8


Th-232 series
Ra-226 series
Cs-137
Co-60
K-40
e: Slab bkgr.
eg: N.Bldg.
el: slab
ec: foundation
Counts per minute
10000
1000
100
10
1
0.1
0
200
400
600
800
1000
1200
1400
1600
1800
2000
2200
2400
2600
2800
Energy (keV)

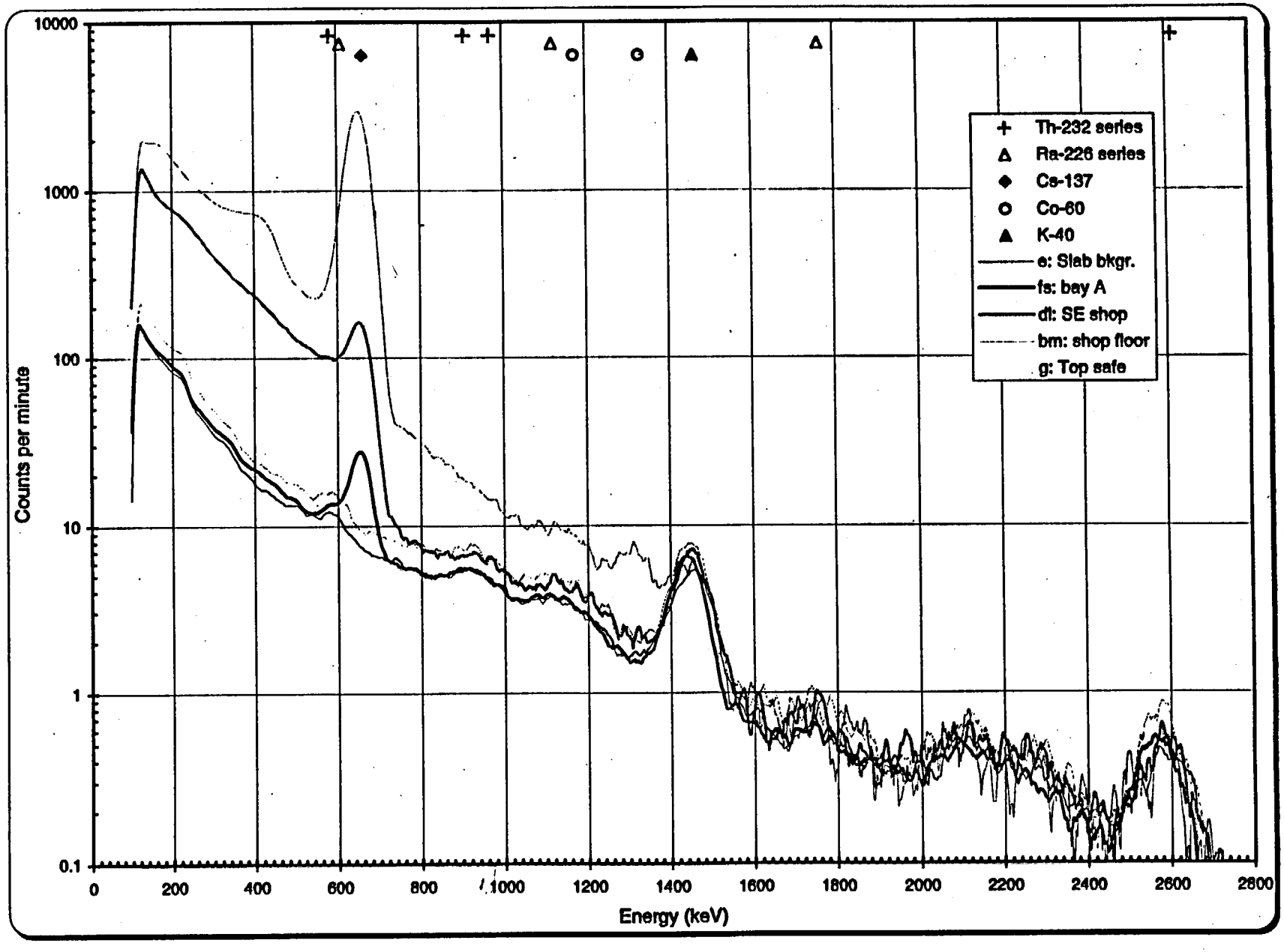
3-30 Chart 9


Counts per minute
10000
1000
100
10
1
0.1
0
200
400
600
800
1000
1200
1400
1600
1800
2000
2200
2400
2600
2800
Energy (keV)
Th-232 series
Ra-226 series
Cs-137
Co-60
K-40
e: Slab bkgr.
ft: Bay A
fq: Bay RR
fu: N Bay A

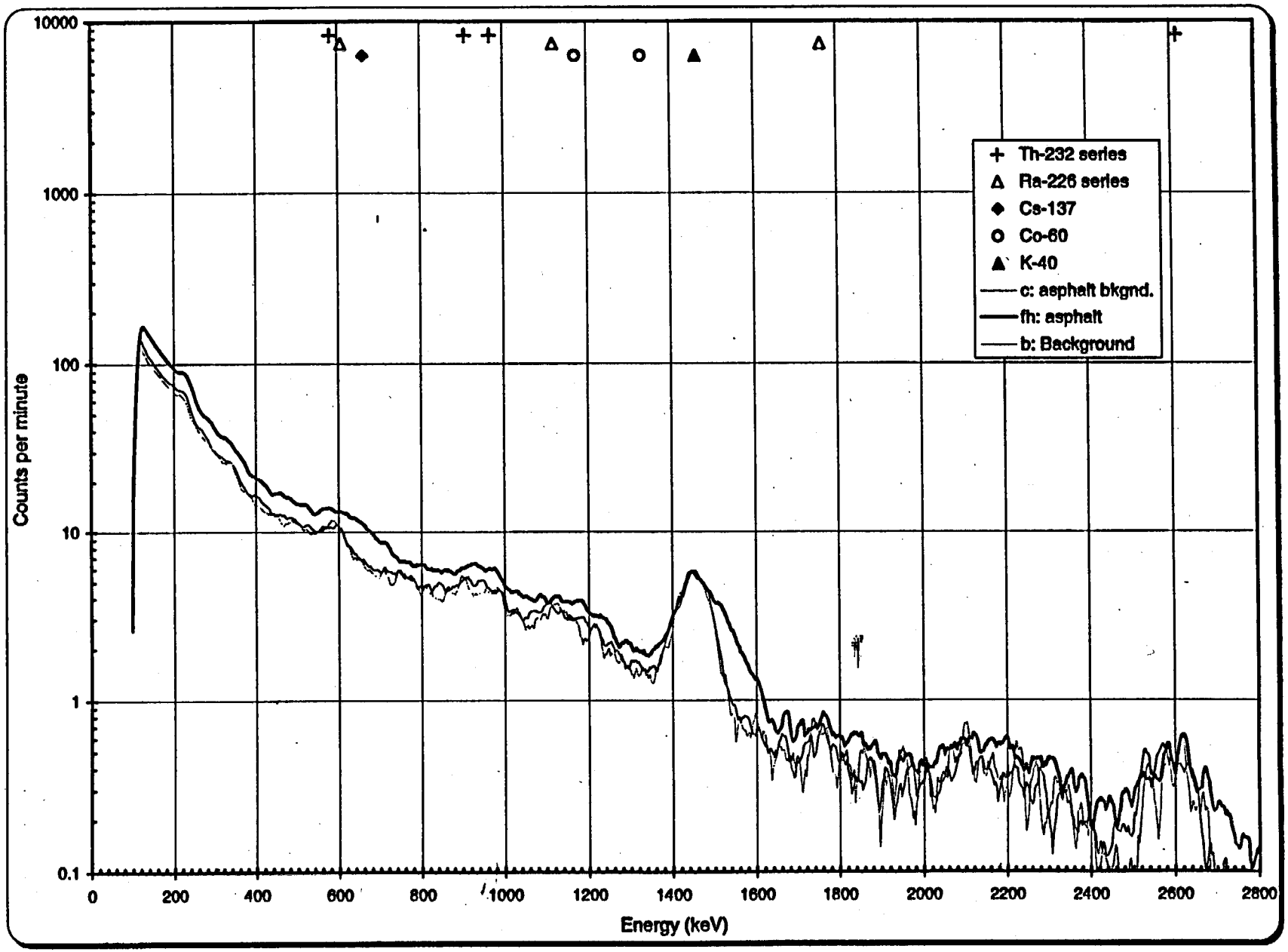
3-31 Chart 7


Counts per minute
10000
1000
100
10
1
0.1
0
200
400
600
800
1000
1200
1400
1600
1800
2000
2200
2400
2600
2800
Energy (keV)
Th-232 series
Ra-226 series
Cs-137
Co-60
K-40
e: Slab bkgr.
fr: Bay A Fl
fk: asphalt

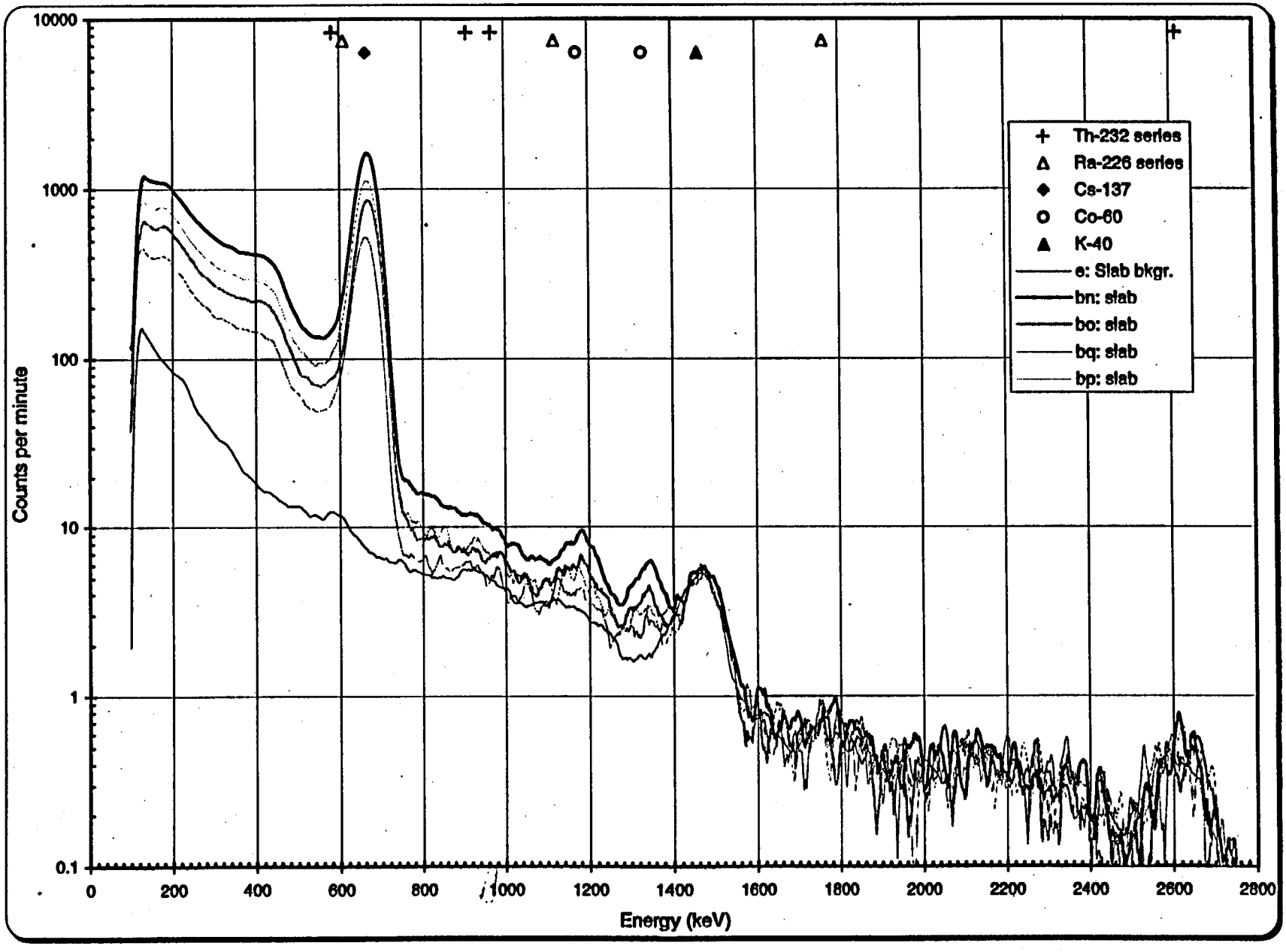
3-31 Chart 8


Counts per minute
10000
1000
100
10
1
0.1
0
200
400
600
800
1000
1200
1400
1600
1800
2000
2200
2400
2600
2800
Energy (keV)
Th-232 series
Ra-226 series
Cs-137
Co-60
K-40
e: Slab bkgr.
fs: bay A
dl: SE shop
bm: shop floor
g: Top safe

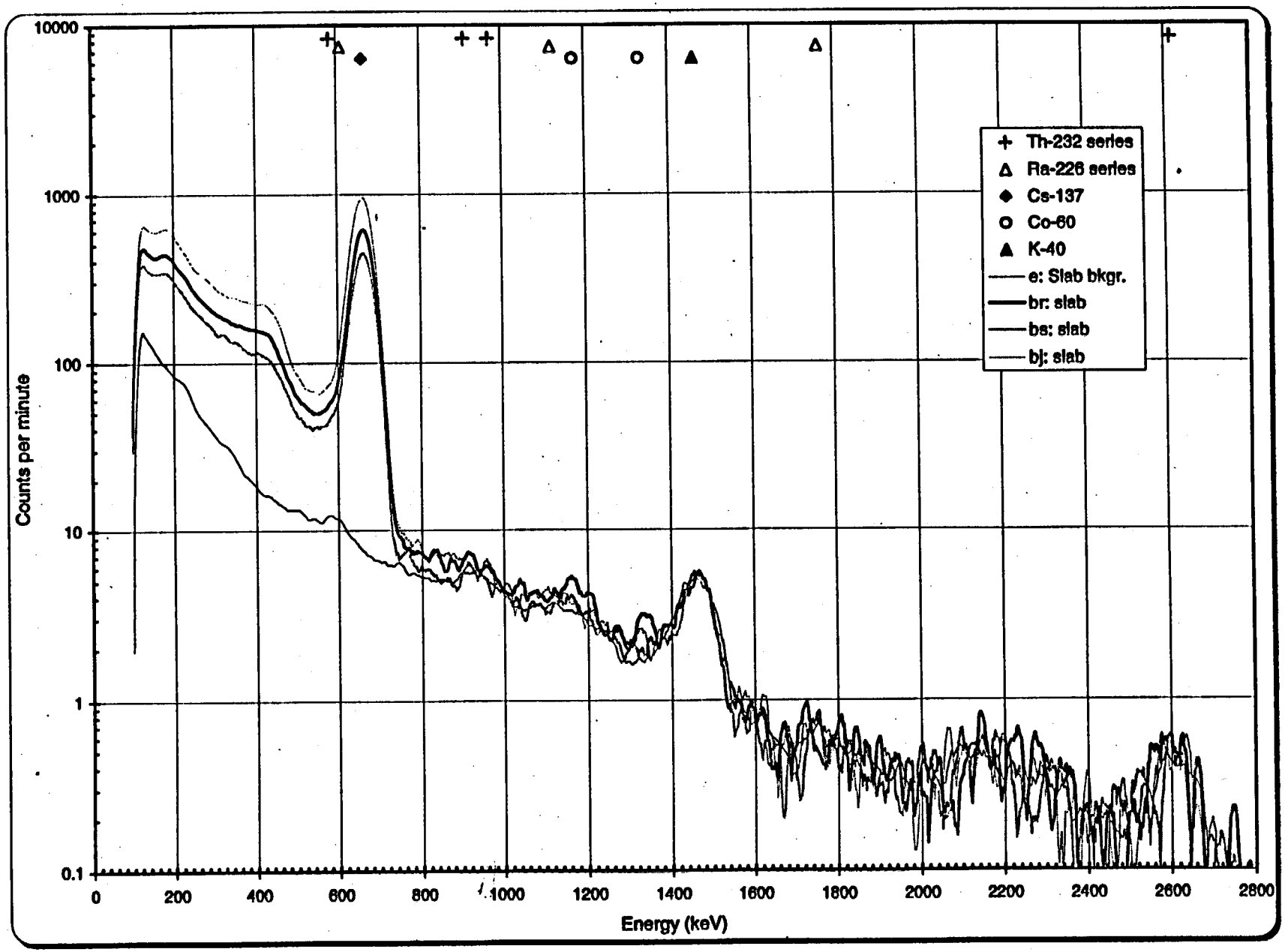
4-1 Chart 7


Th-232 series
Ra-226 series
Cs-137
Co-60
K-40
c: asphalt bkgnd.
fh: asphalt
b: Background
Counts per minute
Energy (keV)
10000
1000
100
10
1
0.1
0
200
400
600
800
1000
1200
1400
1600
1800
2000
2200
2400
2600
2800

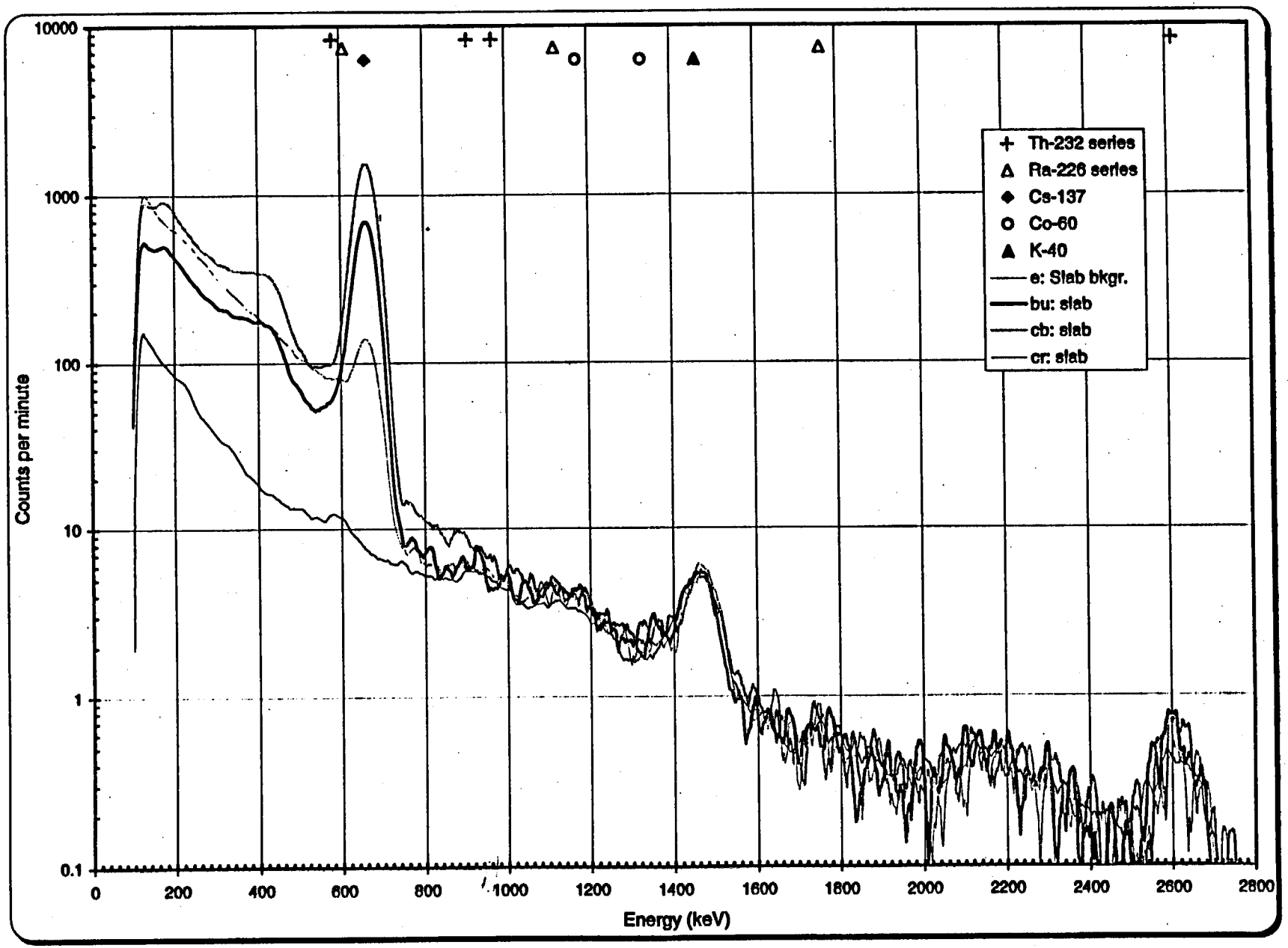
4-1 Chart 8


Counts per minute
10000
1000
100
10
1
0.1
0
200
400
600
800
1000
1200
1400
1600
1800
2000
2200
2400
2600
2800
Energy (keV)
Th-232 series
Ra-226 series
Cs-137
Co-60
K-40
e: Slab bkgr.
bn: slab
bo: slab
bq: slab
bp: slab

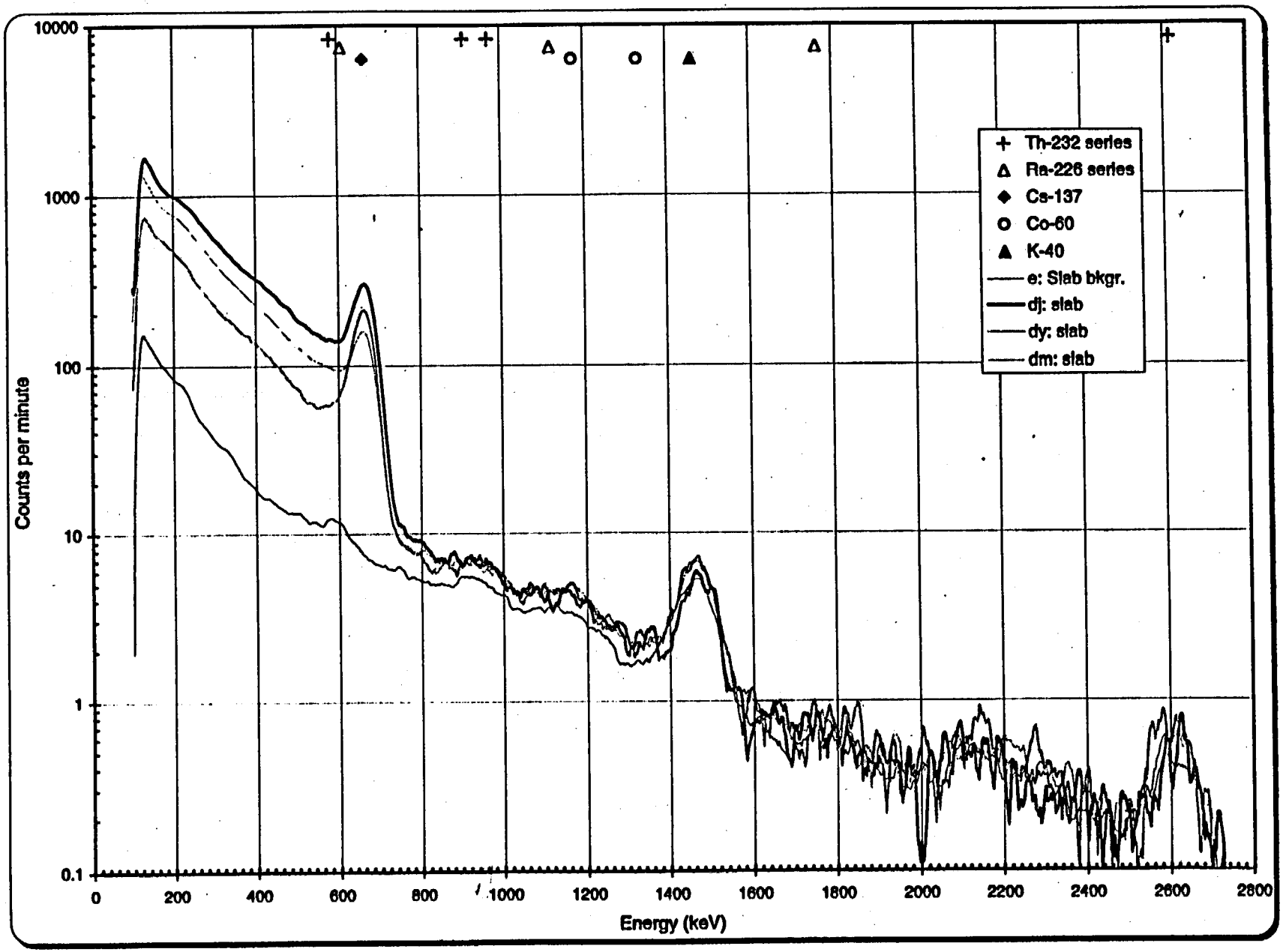
4-2a Chart 7


Th-232 series
Ra-226 series
Cs-137
Co-60
K-40
e: Slab bkgr.
br: slab
bs: slab
bj: slab
Counts per minute
10000
1000
100
10
1
0.1
0
200
400
600
800
1000
1200
1400
1600
1800
2000
2200
2400
2600
2800
Energy (keV)

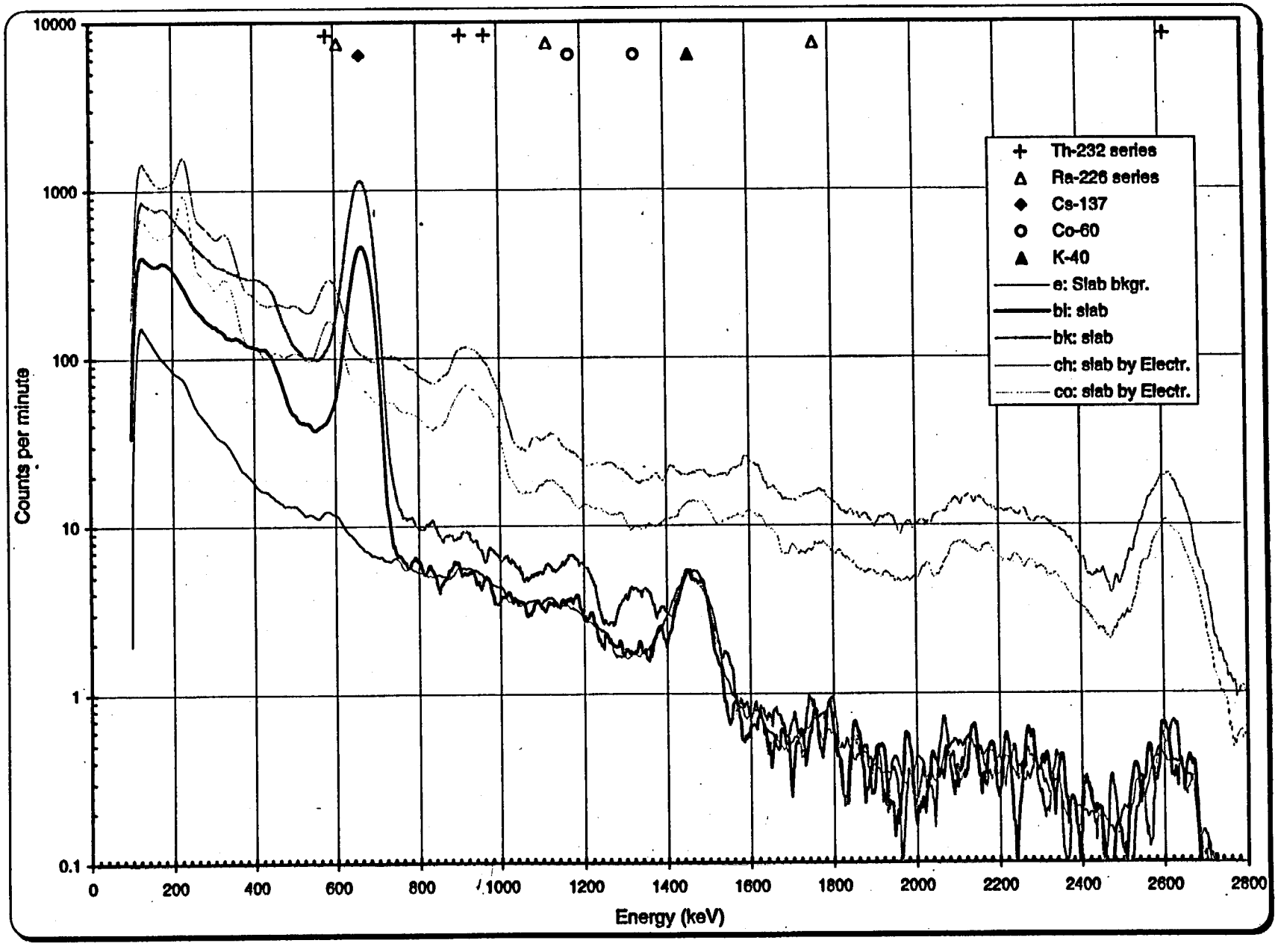
4-2a Chart 8


Th-232 series
Ra-226 series
Cs-137
Co-60
K-40
e: Slab bkgr.
bu: slab
cb: slab
cr: slab
Counts per minute
Energy (keV)
10000
1000
100
10
1
0.1
0
200
400
600
800
1000
1200
1400
1600
1800
2000
2200
2400
2600
2800

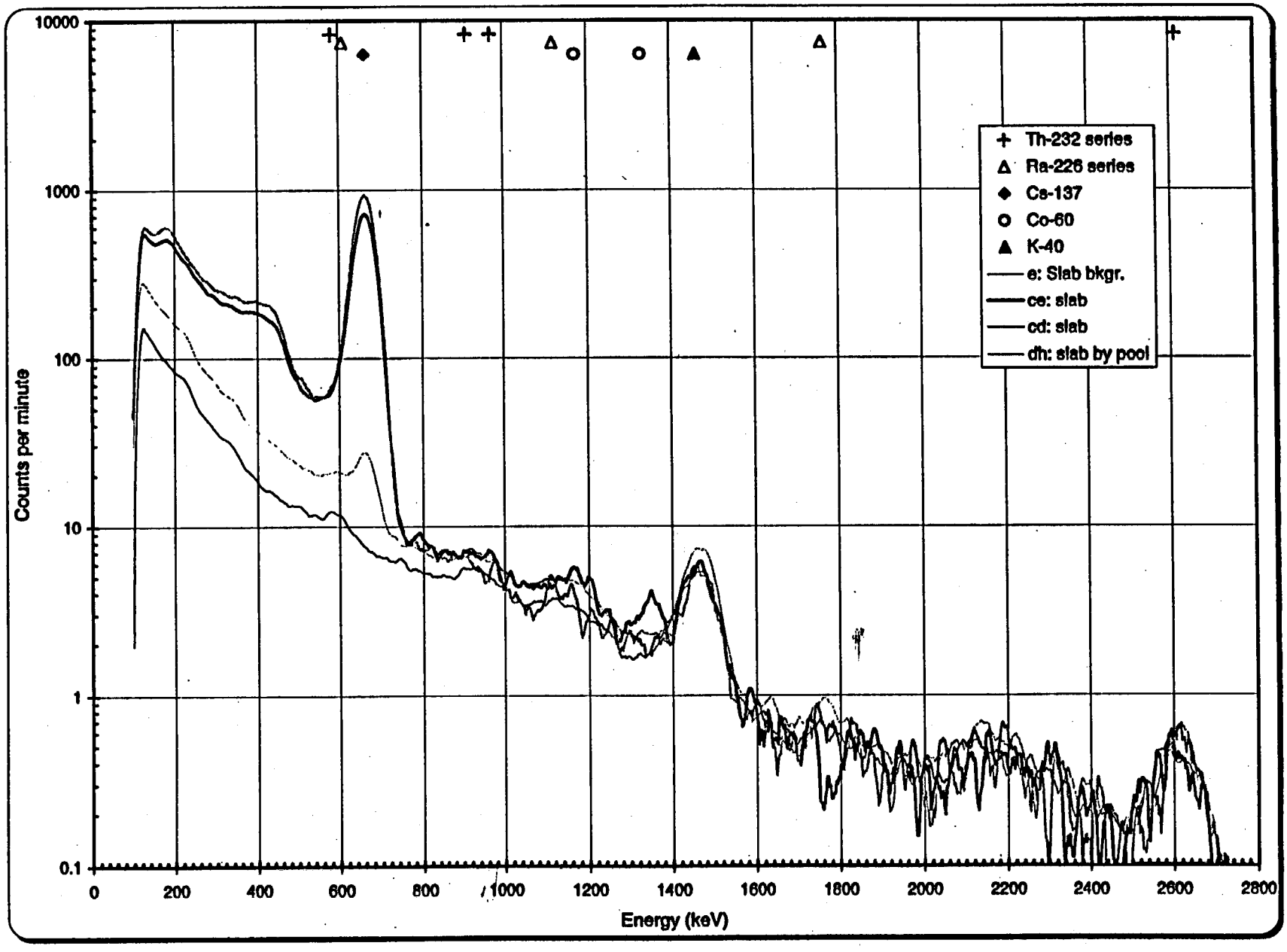
4-2a Chart 9


Counts per minute
10000
1000
100
10
1
0.1
0
200
400
600
800
1000
1200
1400
1600
1800
2000
2200
2400
2600
2800
Energy (keV)
Th-232 series
Ra-226 series
Cs-137
Co-60
K-40
e: Slab bkgr.
dj: slab
dy: slab
dm: slab

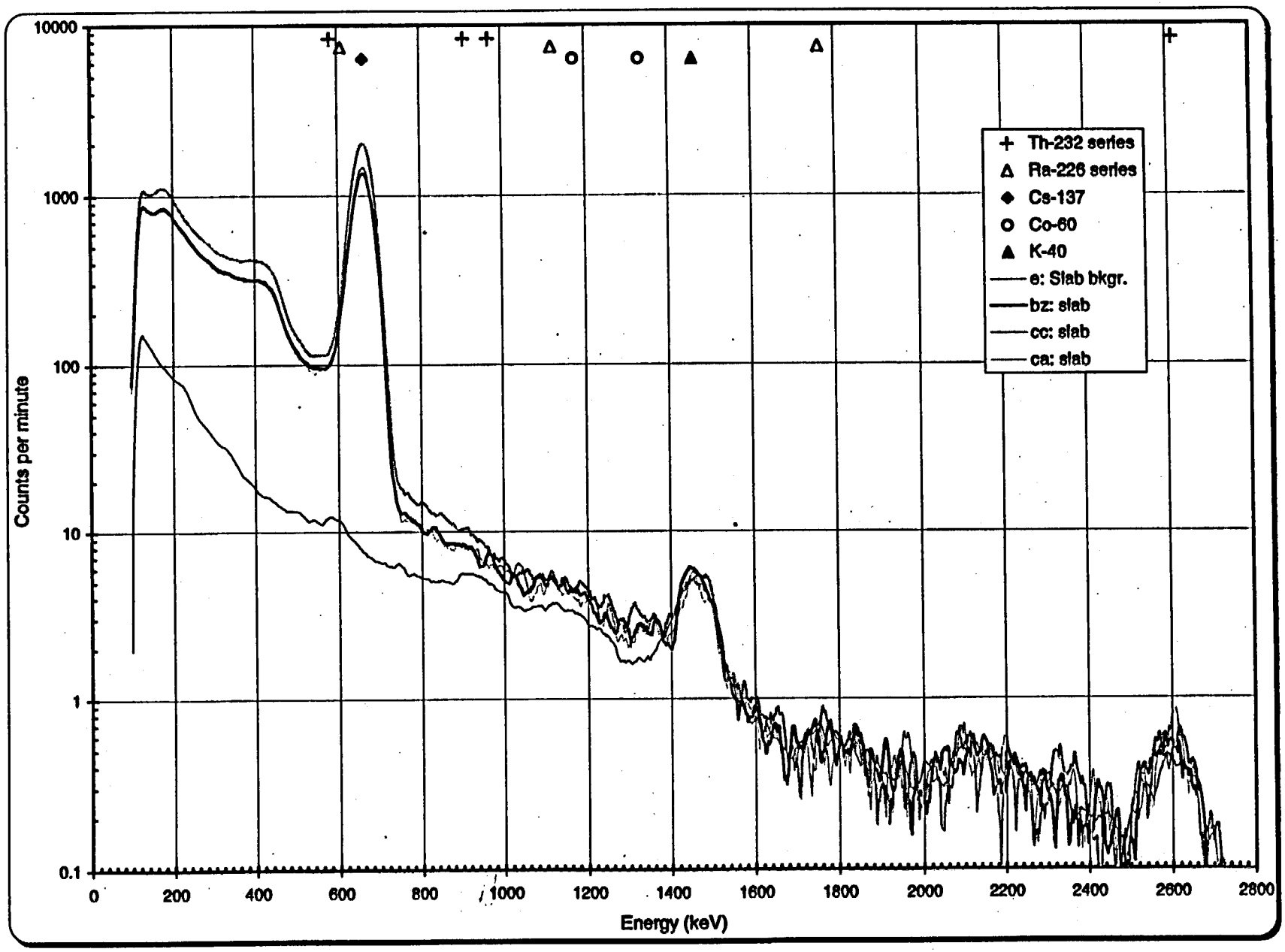
4-2a Chart 10


Th-232 series
Ra-226 series
Cs-137
Co-60
K-40
e: Slab bkgr.
bl: slab
bk: slab
ch: slab by Electr.
co: slab by Electr.
Counts per minute
10000
1000
100
10
1
0.1
0
200
400
600
800
1000
1200
1400
1600
1800
2000
2200
2400
2600
2800
Energy (keV)

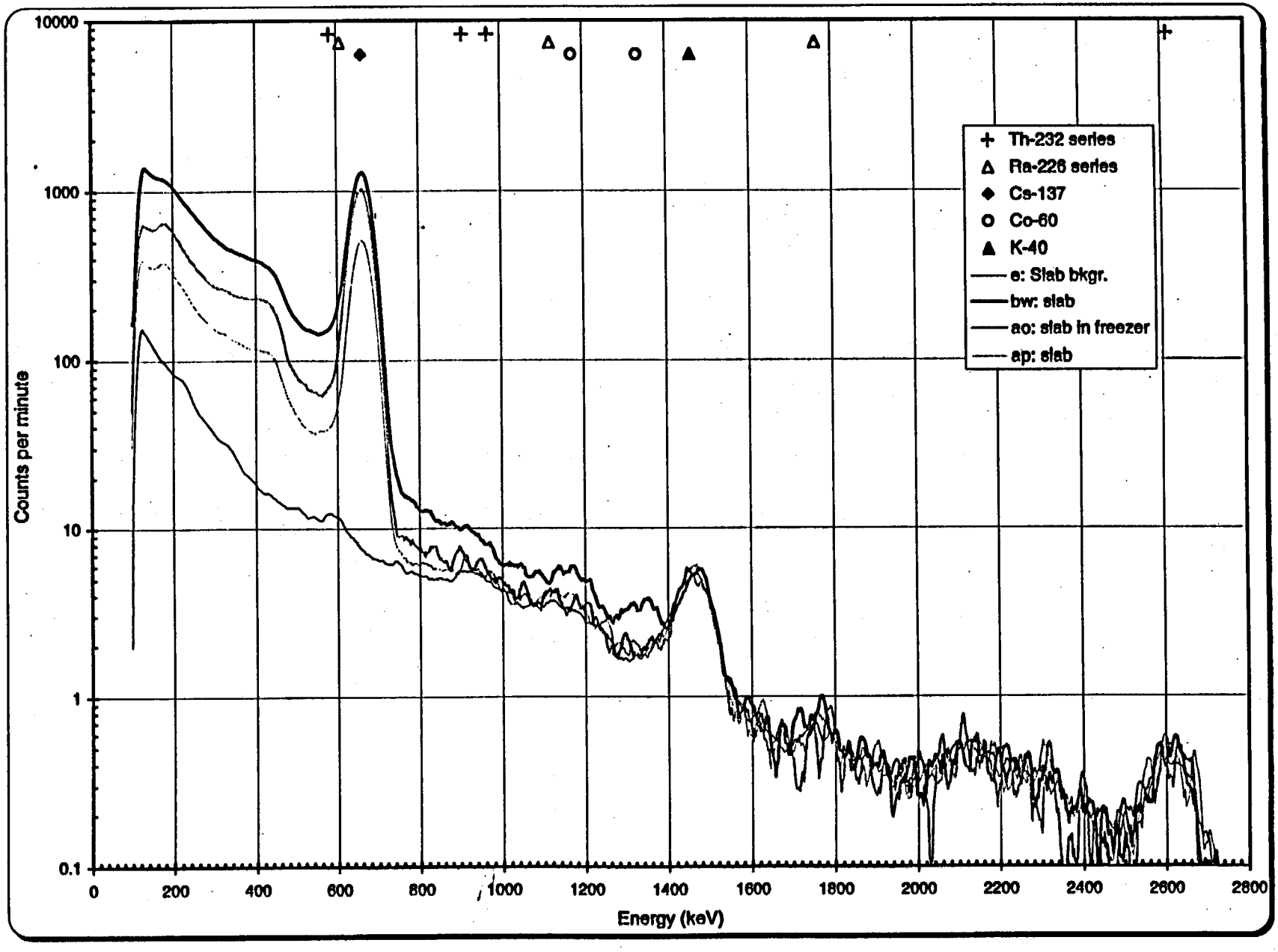
4-2b Chart 7


Th-232 series
Ra-226 series
Cs-137
Co-60
K-40
e: Slab bkgr.
ce: slab
cd: slab
dh: slab by pool
Counts per minute
10000
1000
100
10
1
0.1
0
200
400
600
800
1000
1200
1400
1600
1800
2000
2200
2400
2600
2800
Energy (keV)

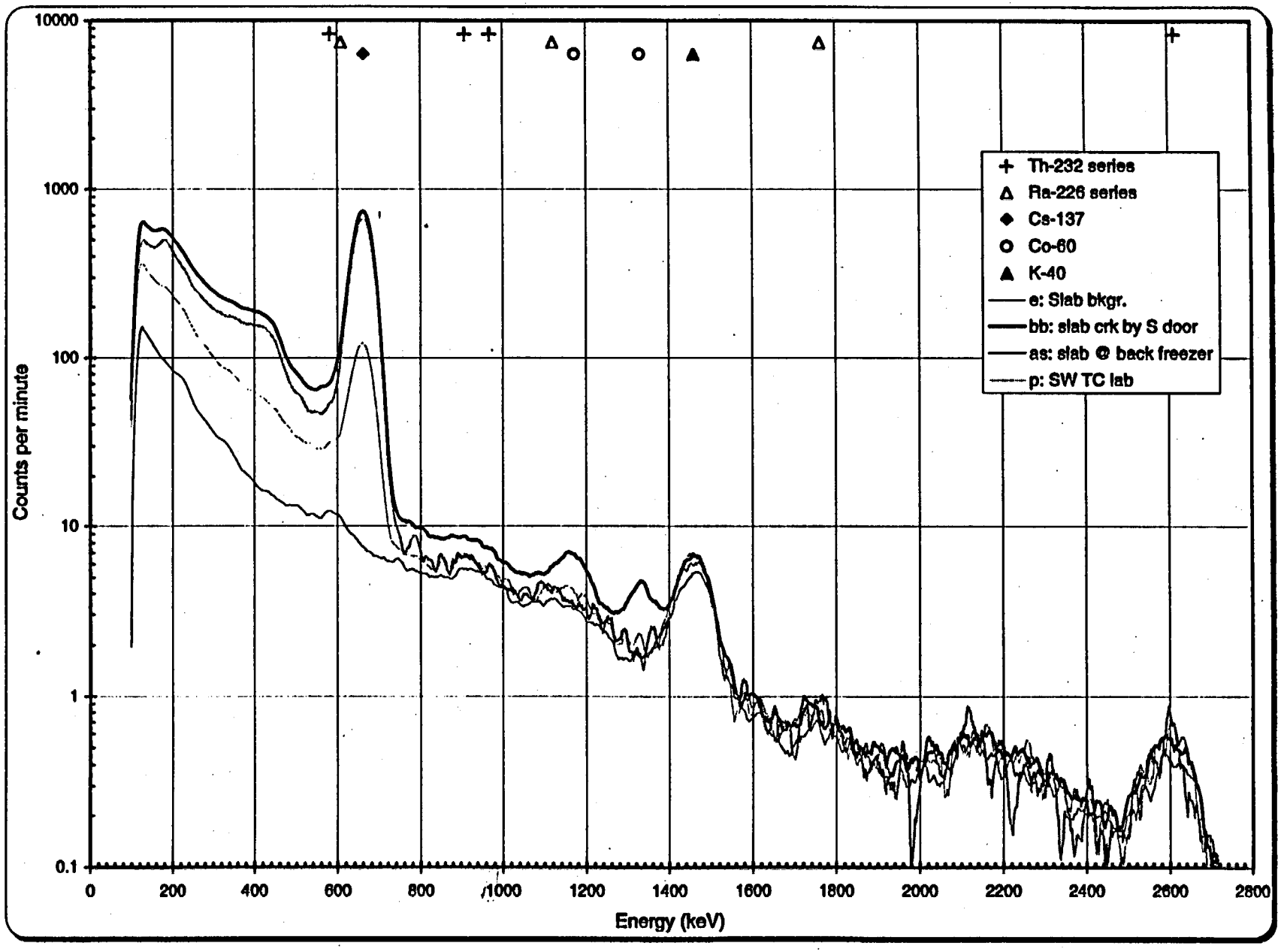
4-2b Chart 8


Th-232 series
Ra-226 series
Cs-137
Co-60
K-40
e: Slab bkgr.
bz: slab
cc: slab
ca: slab
Counts per minute
10000
1000
100
10
1
0.1
0
200
400
600
800
1000
1200
1400
1600
1800
2000
2200
2400
2600
2800
Energy (keV)

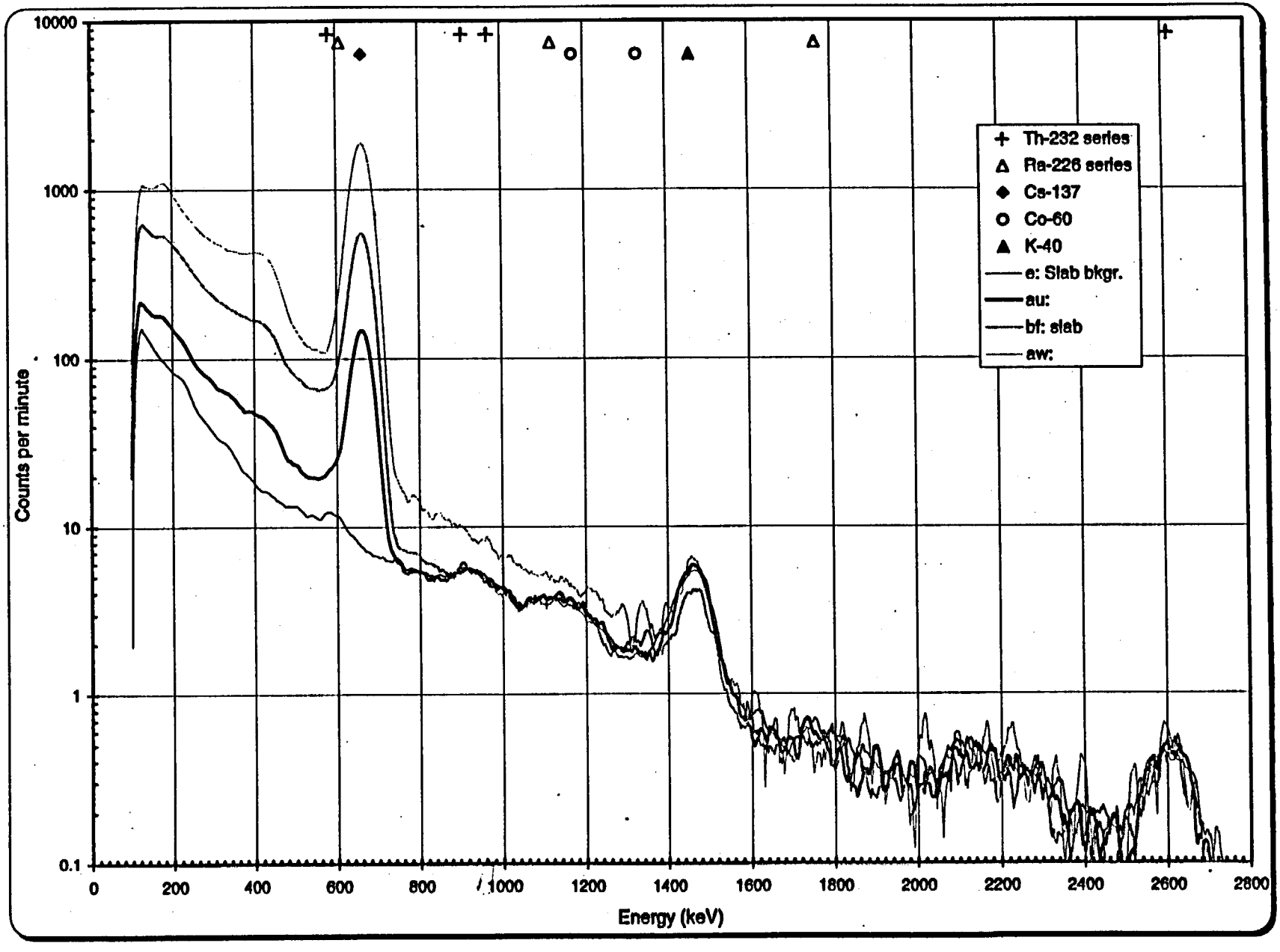
4-2b Chart 9


Th-232 series
Ra-226 series
Cs-137
Co-60
K-40
e: Slab bkgr.
bw: slab
ao: slab in freezer
ap: slab
Counts per minute
10000
1000
100
10
1
0.1
0
200
400
600
800
1000
1200
1400
1600
1800
2000
2200
2400
2600
2800
Energy (keV)

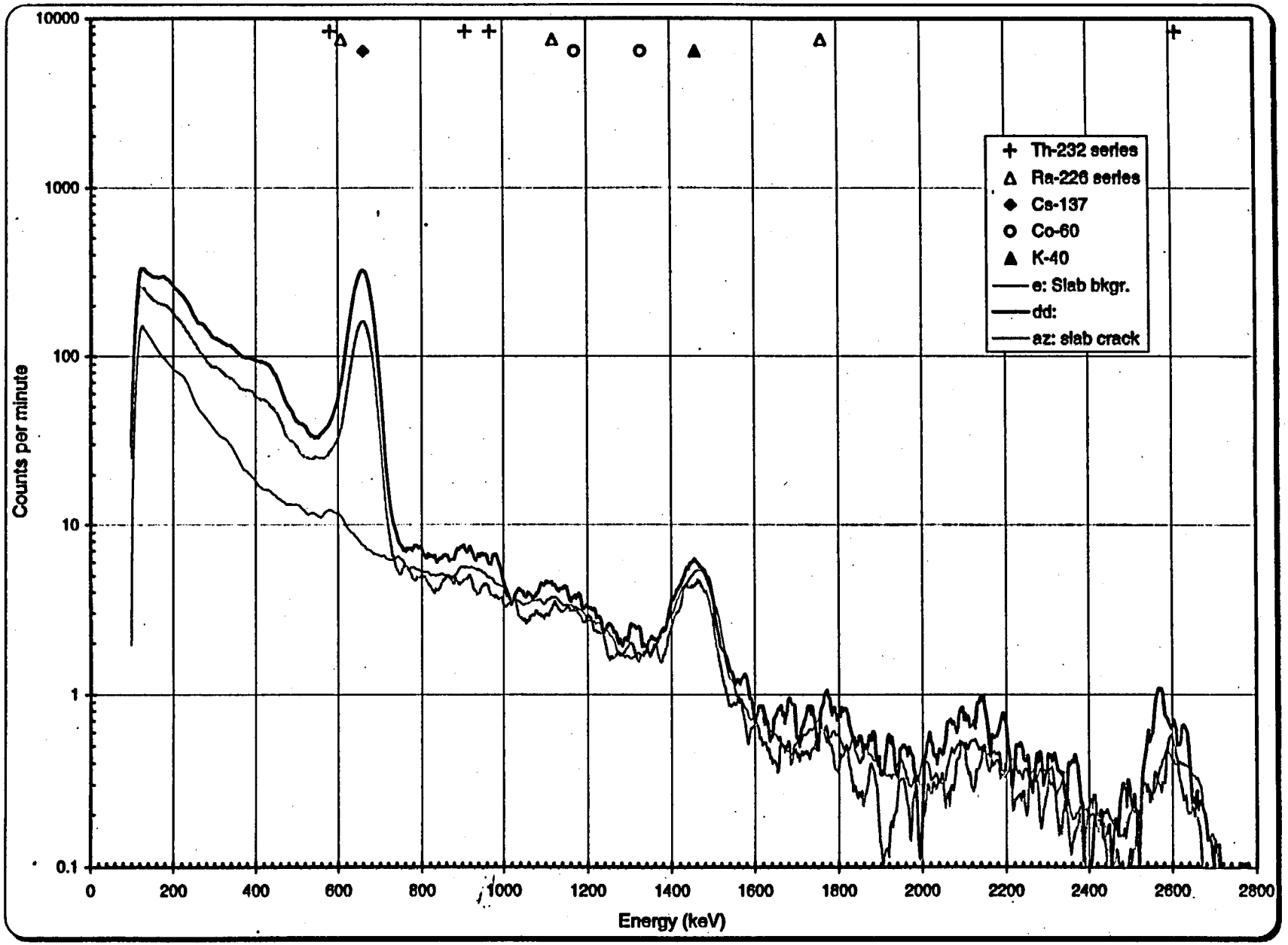
4-2b Chart 10


Th-232 series
Ra-226 series
Cs-137
Co-60
K-40
e: Slab bkgr.
bb: slab crk by S door
as: slab @ back freezer
p: SW TC lab
Counts per minute
10000
1000
100
10
1
0.1
0
200
400
600
800
1000
1200
1400
1600
1800
2000
2200
2400
2600
2800
Energy (keV)

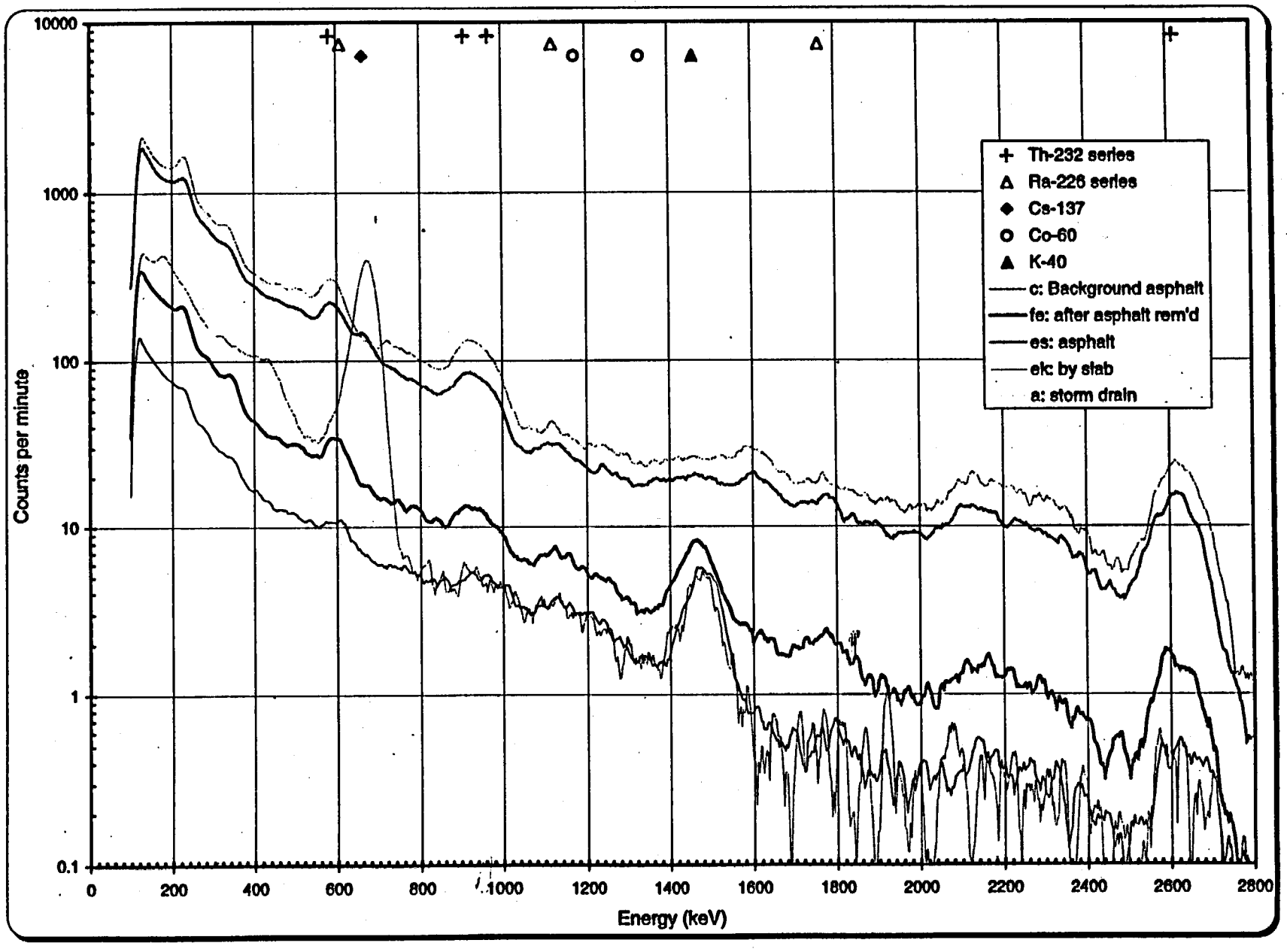
4-2c Chart 7


Th-232 series
Ra-226 series
Cs-137
Co-60
K-40
e: Slab bkgr.
au:
bf: slab
aw:
Counts per minute
10000
1000
100
10
1
0.1
0
200
400
600
800
1000
1200
1400
1600
1800
2000
2200
2400
2600
2800
Energy (keV)

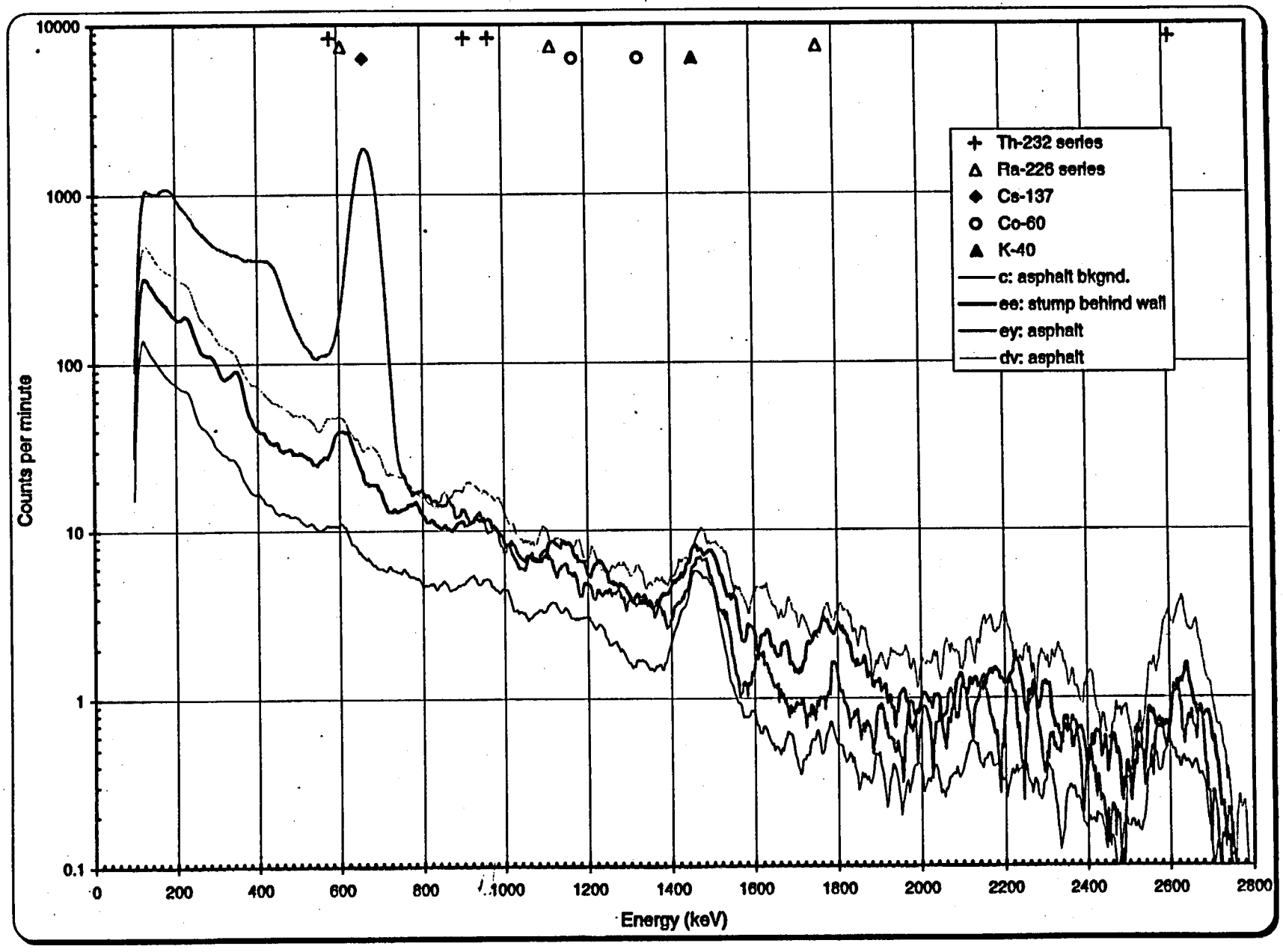
4-2c Chart 8


Th-232 series
Ra-226 series
Cs-137
Co-60
K-40
e: Slab bkgr.
dd:
az: slab crack
Counts per minute
10000
1000
100
10
1
0.1
0
200
400
600
800
1000
1200
1400
1600
1800
2000
2200
2400
2600
2800
Energy (keV)

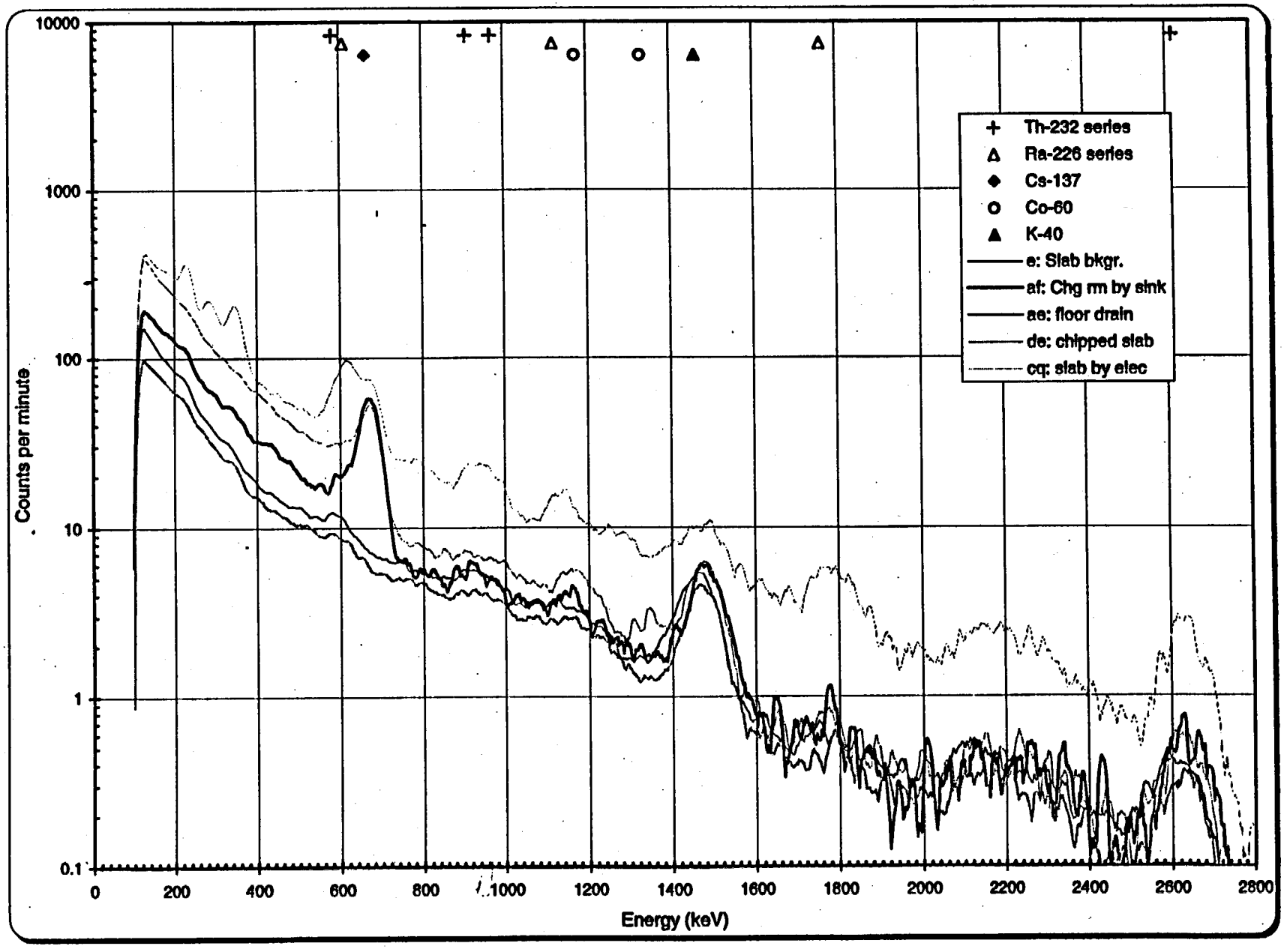
4-2c Chart 9


Th-232 series
Ra-226 series
Cs-137
Co-60
K-40
c: Background asphalt
fe: after asphalt rem'd
es: asphalt
elc by slab
a: storm drain
Counts per minute
Energy (keV)
10000
1000
100
10
1
0.1
0
200
400
600
800
1000
1200
1400
1600
1800
2000
2200
2400
2600
2800

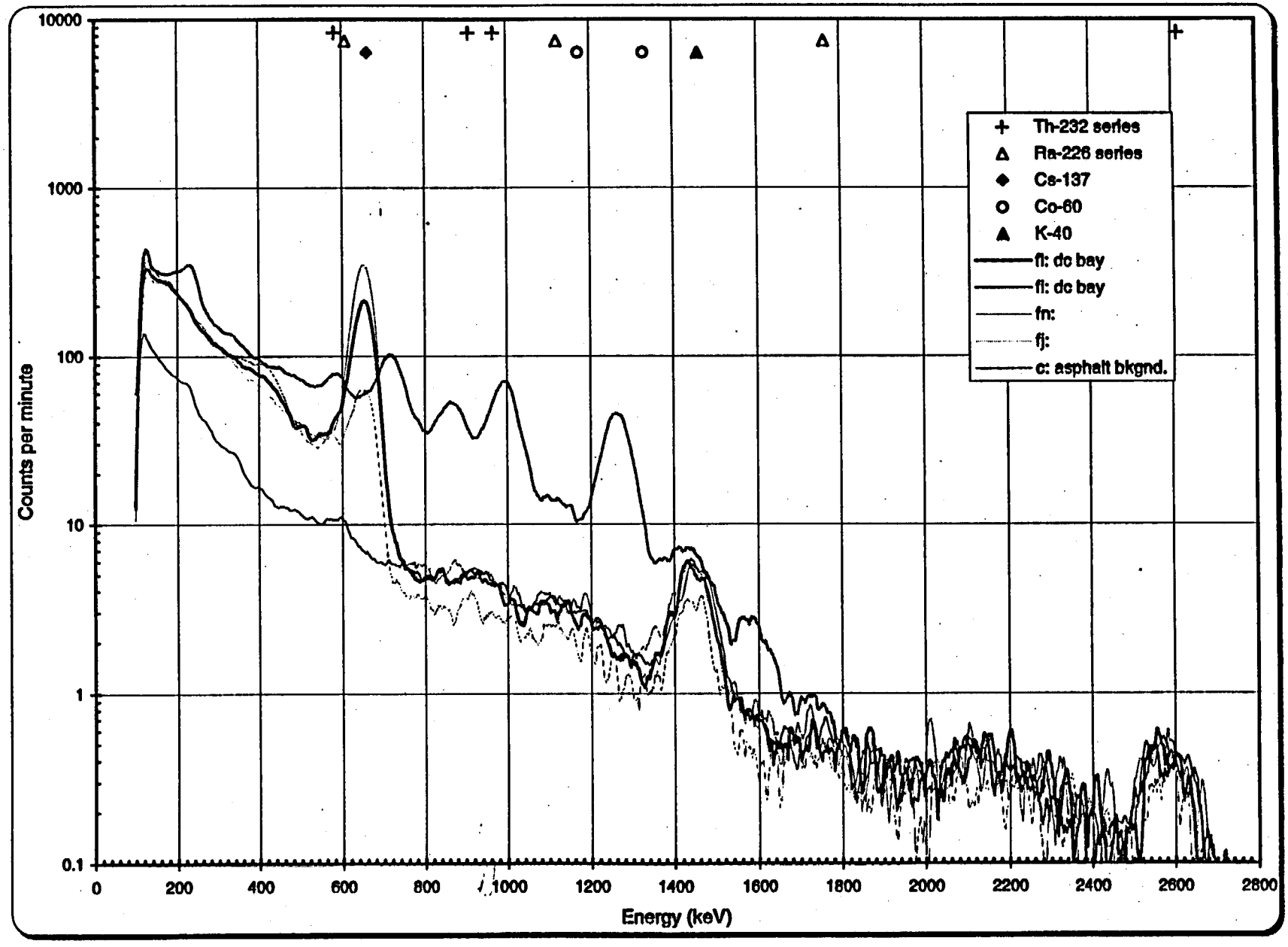
4-3 Chart 7


Th-232 series
Ra-226 series
Cs-137
Co-60
K-40
c: asphalt bkgnd.
ee: stump behind wall
ey: asphalt
dv: asphalt
Counts per minute
10000
1000
100
10
1
0.1
0
200
400
600
800
1000
1200
1400
1600
1800
2000
2200
2400
2600
2800
Energy (keV)

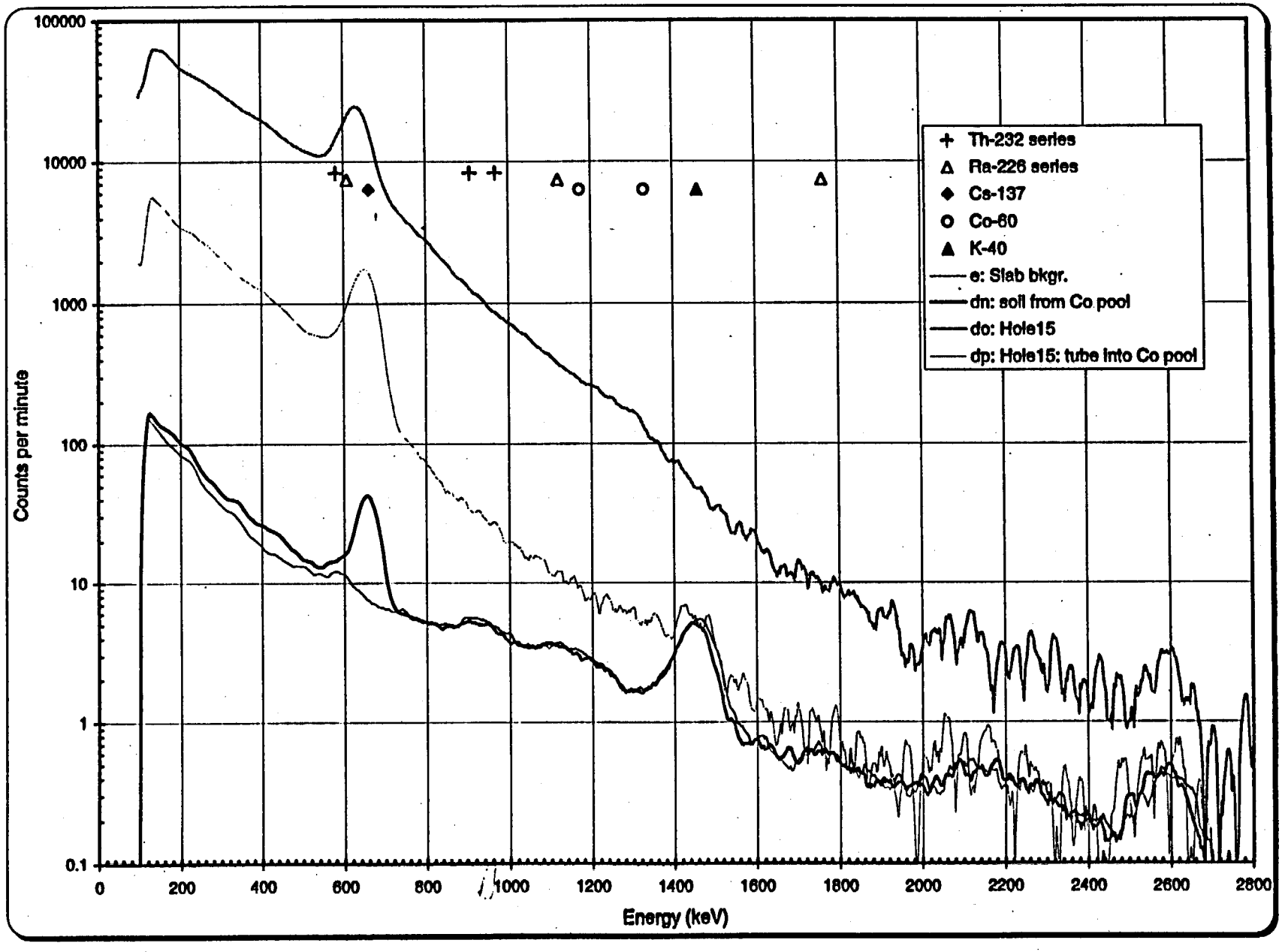
4-3 Chart 8


Th-232 series
Ra-226 series
Cs-137
Co-60
K-40
e: Slab bkgr.
af: Chg rm by sink
ae: floor drain
de: chipped slab
cq: slab by elec
Counts per minute
10000
1000
100
10
1
0.1
0
200
400
600
800
1000
1200
1400
1600
1800
2000
2200
2400
2600
2800
Energy (keV)

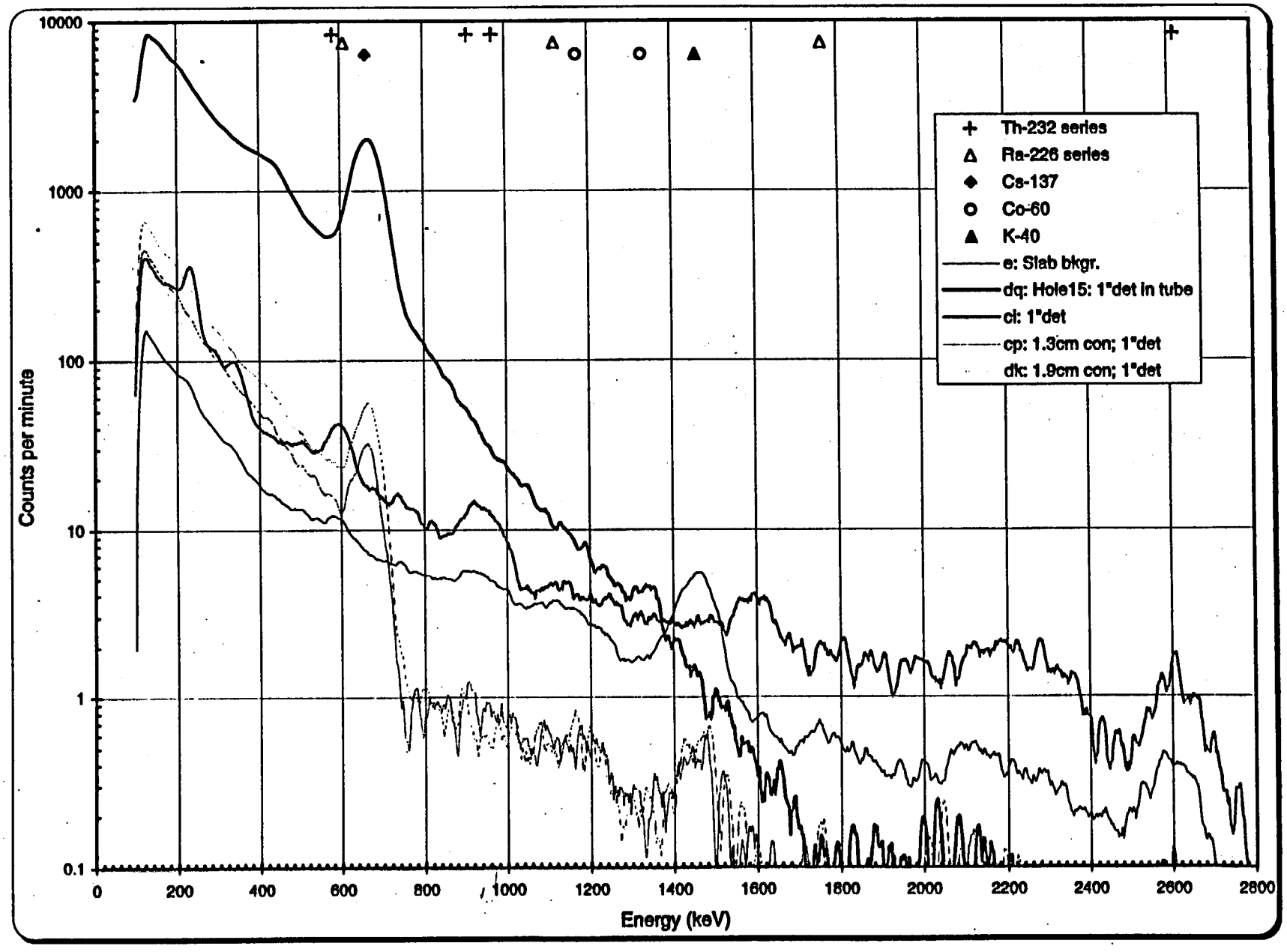
4-3 Chart 10


Counts per minute
10000
1000
100
10
1
0.1
0
200
400
600
800
1000
1200
1400
1600
1800
2000
2200
2400
2600
2800
Energy (keV)
Th-232 series
Ra-226 series
Cs-137
Co-60
K-40
fl: dc bay
fl: dc bay
fn:
fj:
c: asphalt bkgnd.

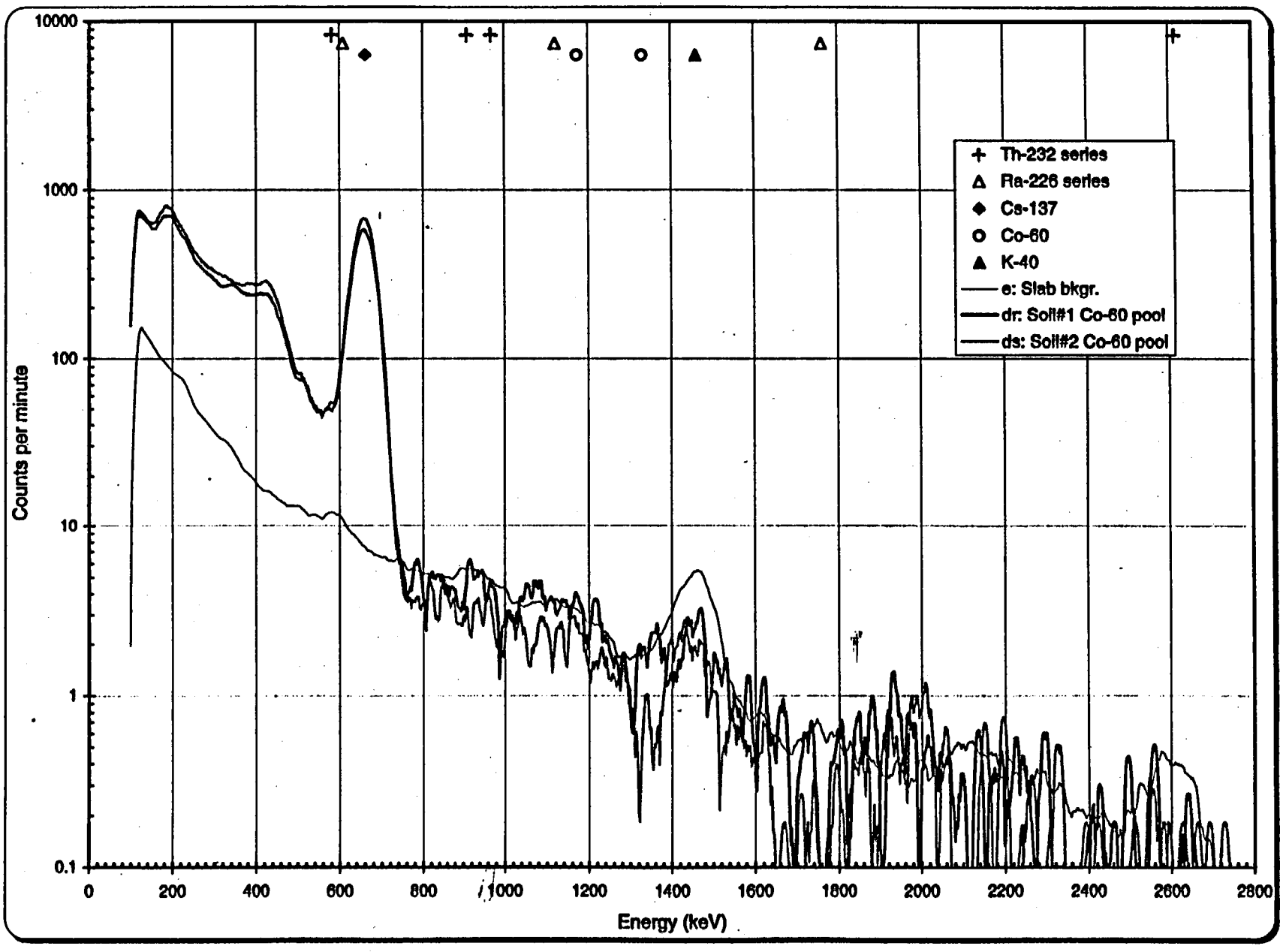
4-5 Chart 7


Counts per minute
100000
10000
1000
100
10
1
0.1
0
200
400
600
800
1000
1200
1400
1600
1800
2000
2200
2400
2600
2800
Energy (keV)
Th-232 series
Ra-226 series
Cs-137
Co-60
K-40
e: Slab bkgr.
dn: soil from Co pool
do: Hole15
dp: Hole15: tube into Co pool

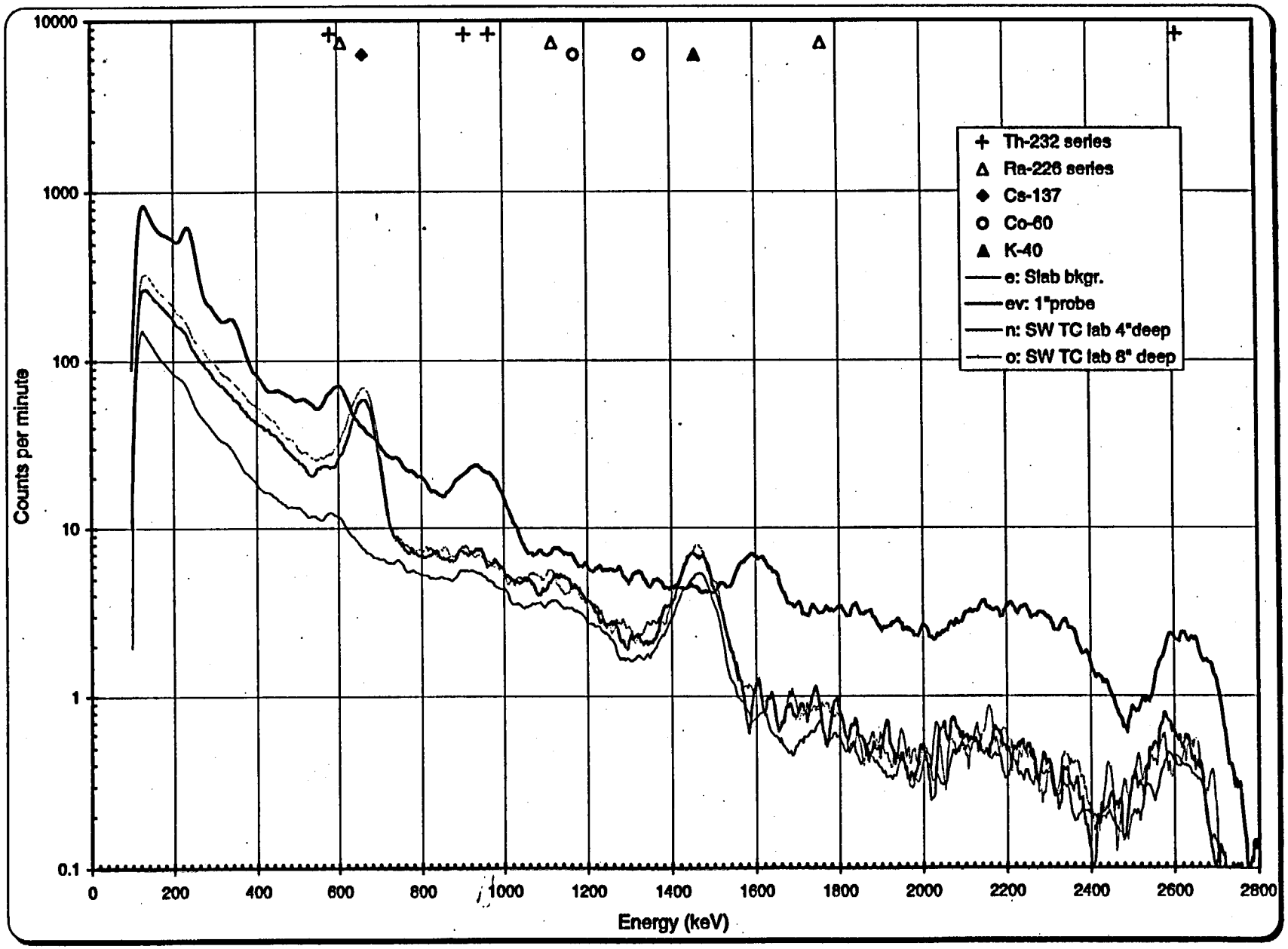
4-5 Chart 8


Counts per minute
10000
1000
100
10
1
0.1
0
200
400
600
800
1000
1200
1400
1600
1800
2000
2200
2400
2600
2800
Energy (keV)
Th-232 series
Ra-226 series
Cs-137
Co-60
K-40
e: Slab bkgr.
dq: Hole15: 1"det in tube
cl: 1"det
cp: 1.3cm con; 1"det
dk: 1.9cm con; 1"det

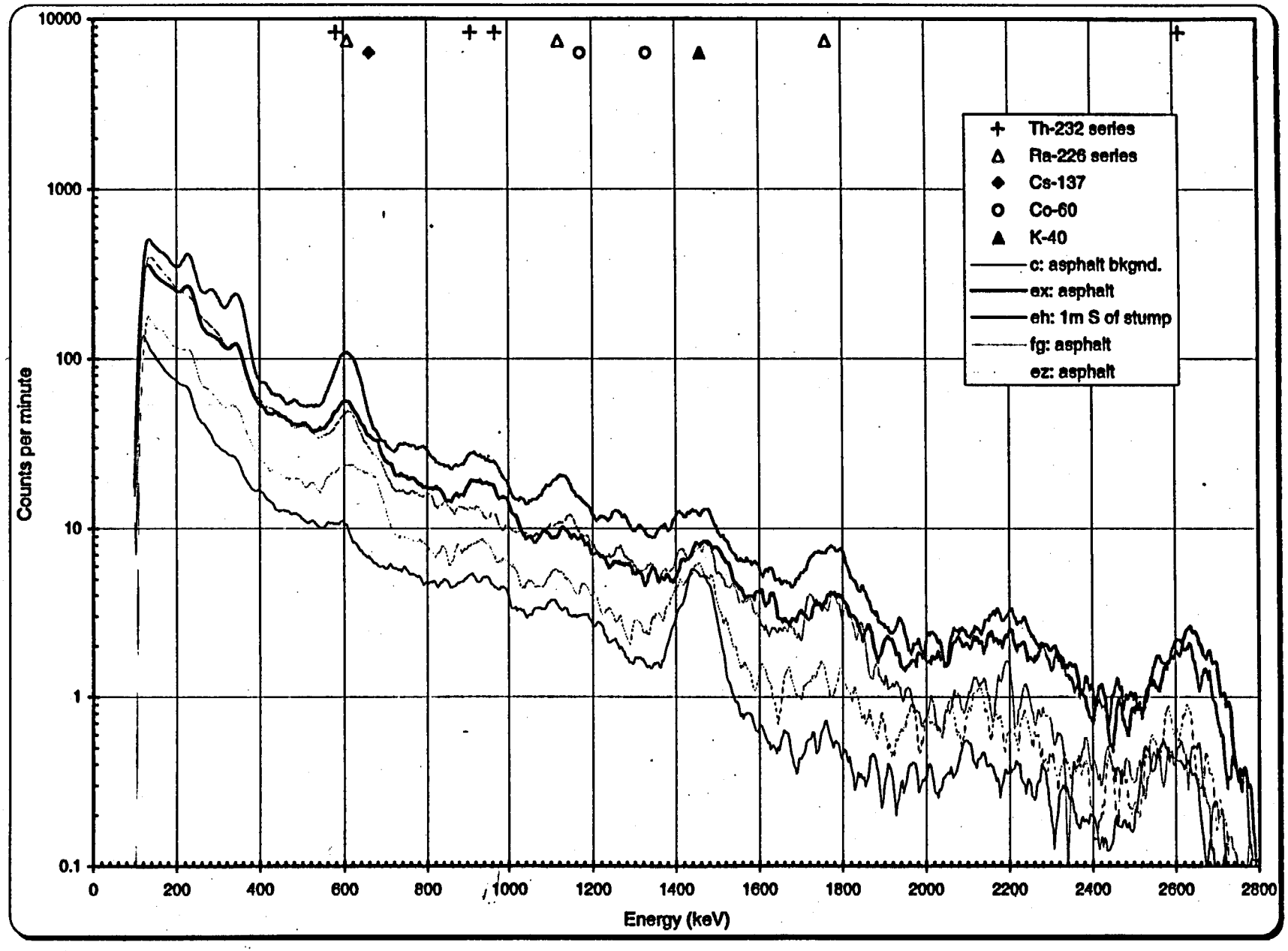
4-6 Chart 7


Th-232 series
Ra-226 series
Cs-137
Co-60
K-40
e: Slab bkgr.
dr: Soil#1 Co-60 pool
ds: Soil#2 Co-60 pool
Counts per minute
10000
1000
100
10
1
0.1
0
200
400
600
800
1000
1200
1400
1600
1800
2000
2200
2400
2600
2800
Energy (keV)

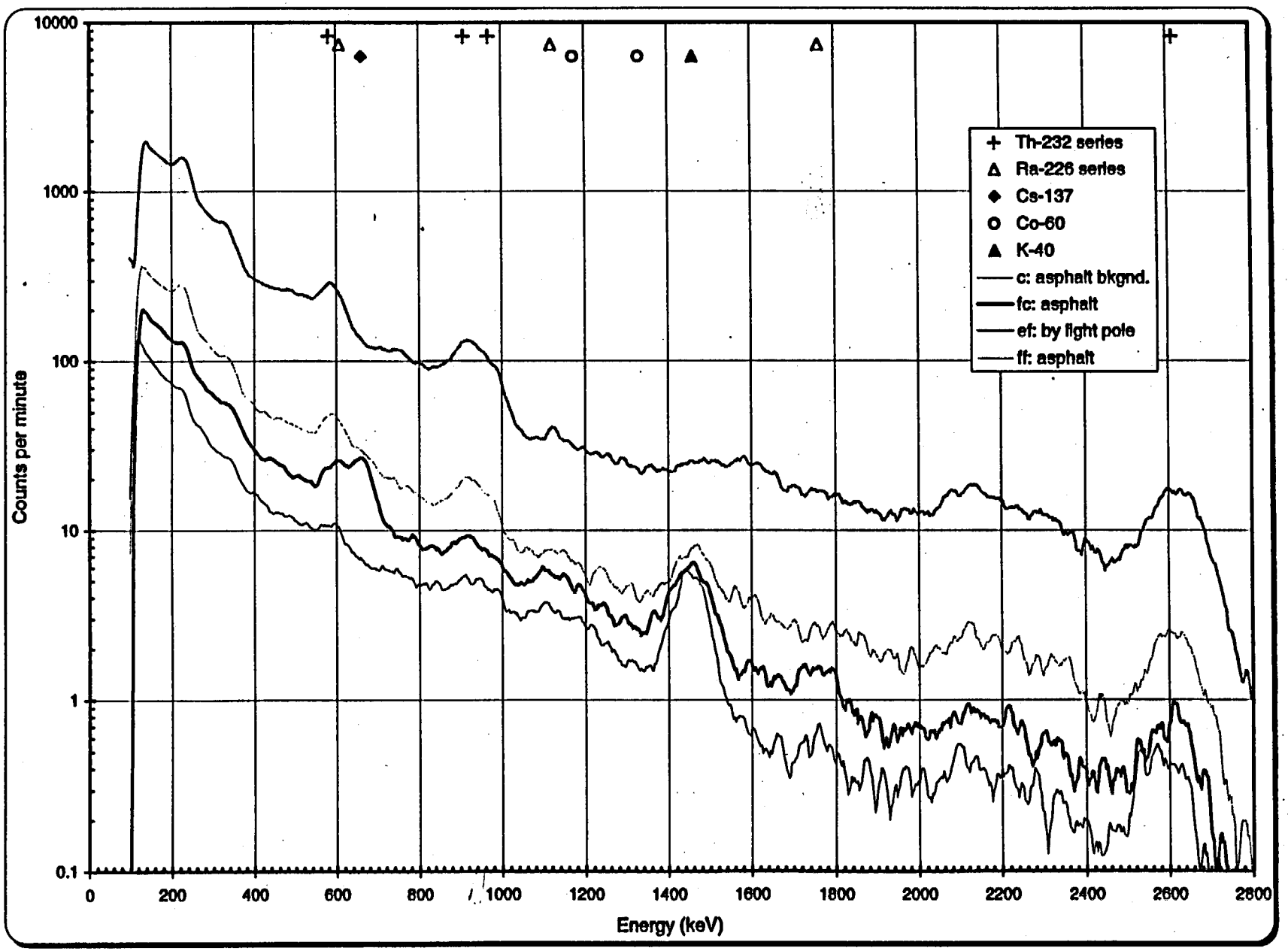
4-7 Chart 7


Th-232 series
Ra-226 series
Cs-137
Co-60
K-40
e: Slab bkgr.
ev: 1"probe
n: SW TC lab 4"deep
o: SW TC lab 8" deep
Counts per minute
10000
1000
100
10
1
0.1
0
200
400
600
800
1000
1200
1400
1600
1800
2000
2200
2400
2600
2800
Energy (keV)

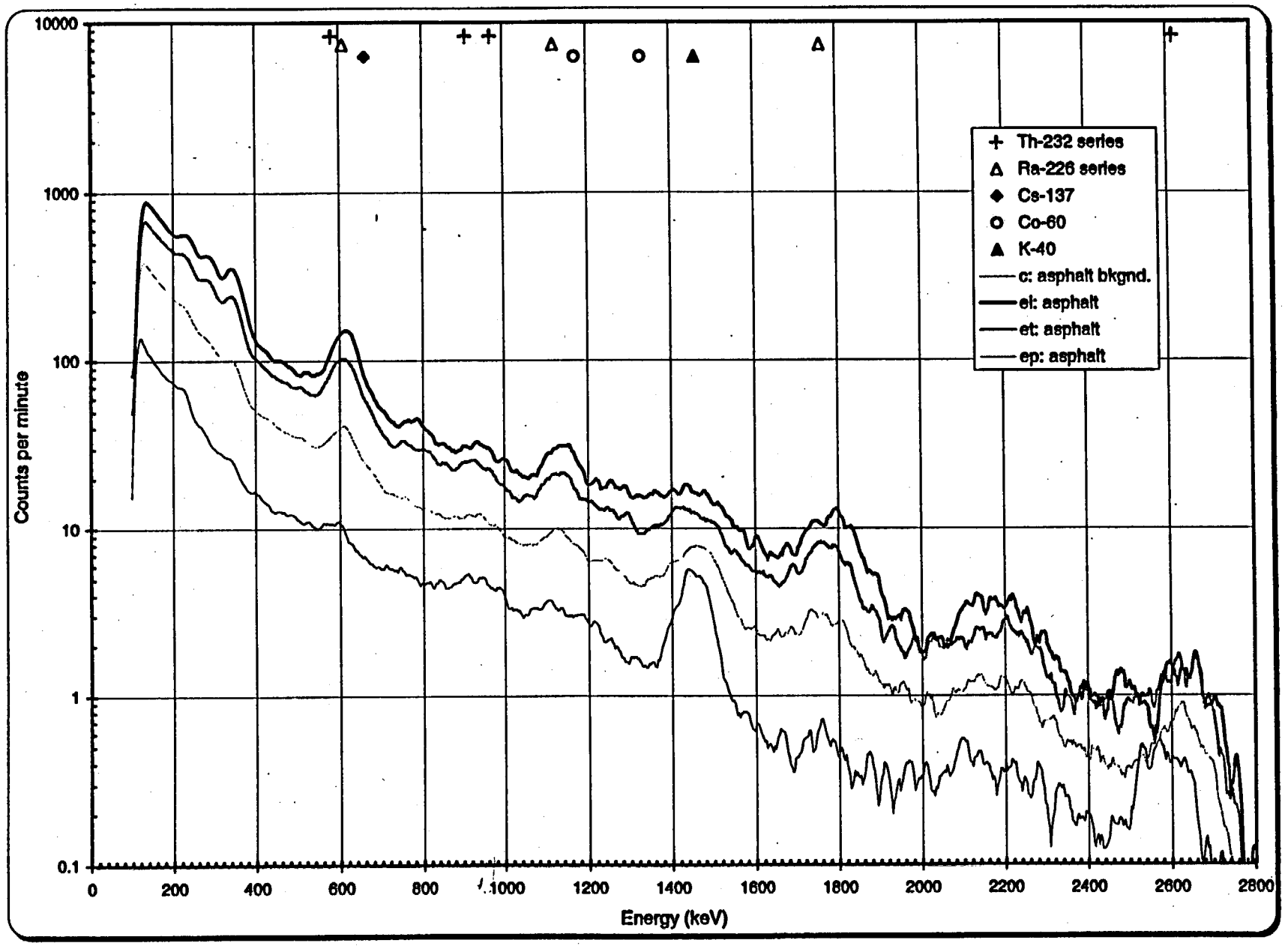
4-8 Chart 7


Counts per minute
10000
1000
100
10
1
0.1
0
200
400
600
800
1000
1200
1400
1600
1800
2000
2200
2400
2600
2800
Energy (keV)
Th-232 series
Ra-226 series
Cs-137
Co-60
K-40
c: asphalt bkgnd.
ex: asphalt
eh: 1m S of stump
fg: asphalt
ez: asphalt

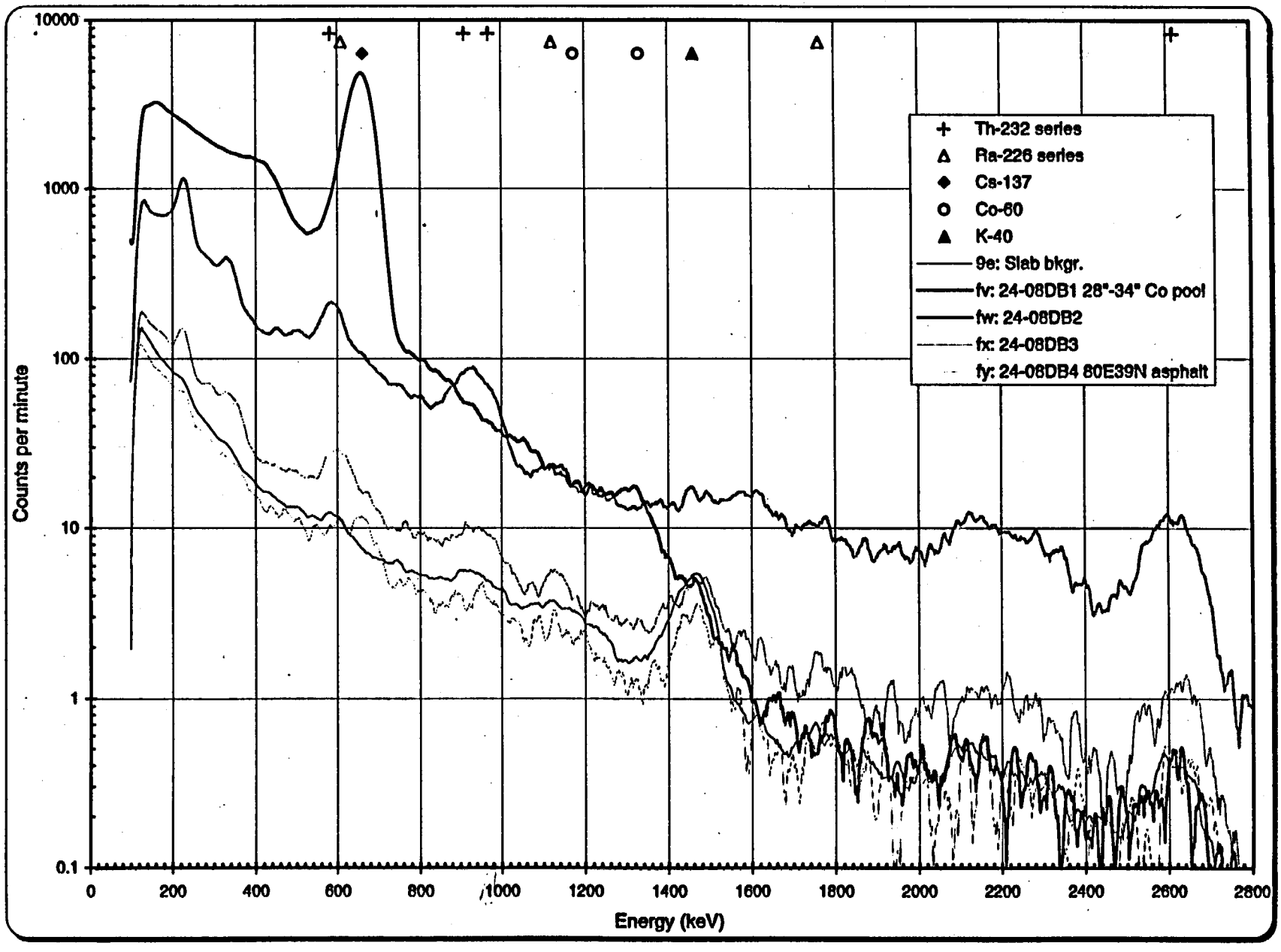
4-8 Chart 8


Counts per minute
10000
1000
100
10
1
0.1
0
200
400
600
800
1000
1200
1400
1600
1800
2000
2200
2400
2600
2800
Energy (keV)
Th-232 series
Ra-226 series
Cs-137
Co-60
K-40
c: asphalt bkgnd.
fc: asphalt
ef: by light pole
ff: asphalt

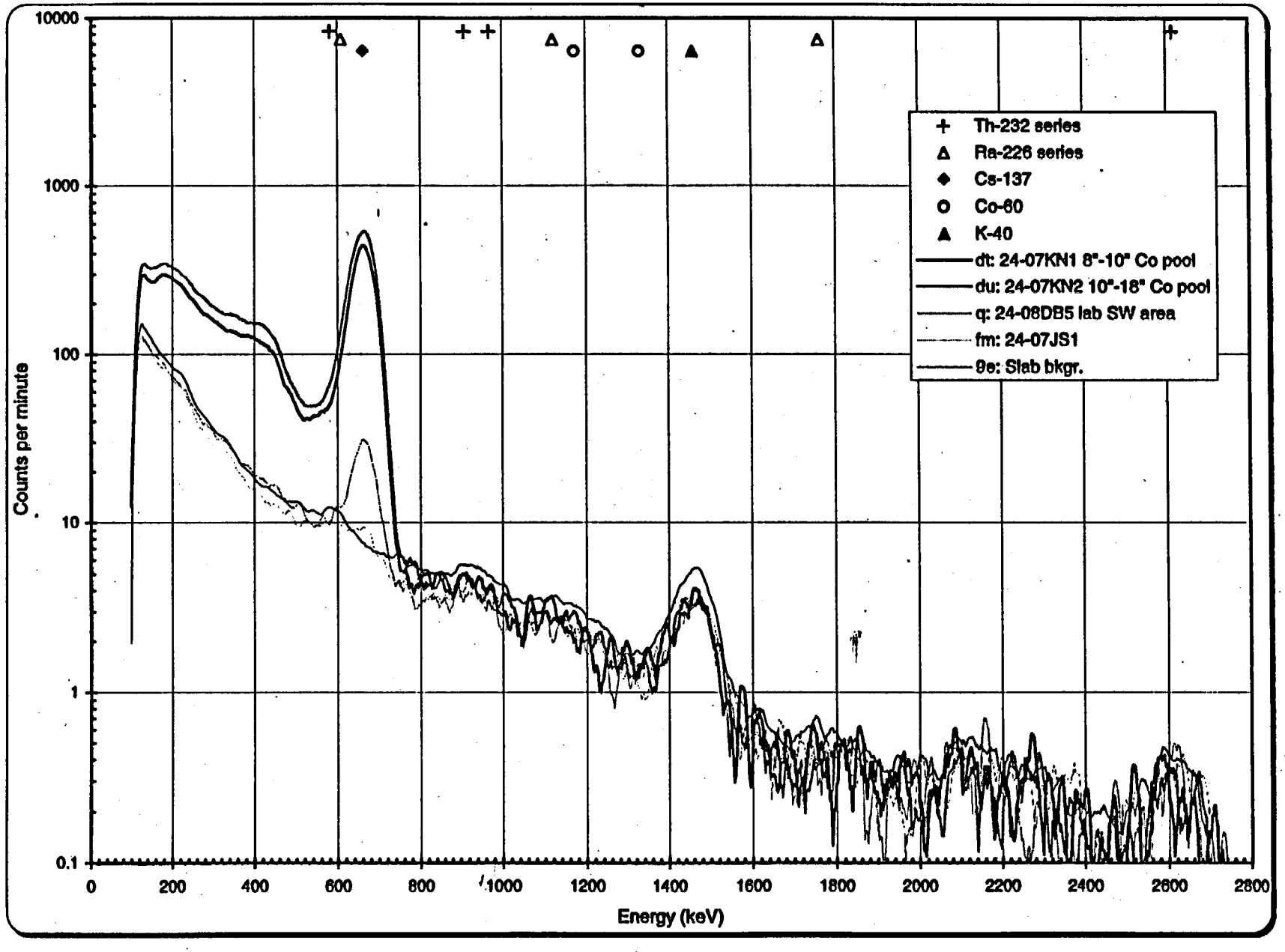
4-8 Chart 9


Th-232 series
Ra-226 series
Cs-137
Co-60
K-40
c: asphalt bkgnd.
el: asphalt
et: asphalt
ep: asphalt
Counts per minute
10000
1000
100
10
1
0.1
0
200
400
600
800
1000
1200
1400
1600
1800
2000
2200
2400
2600
2800
Energy (keV)

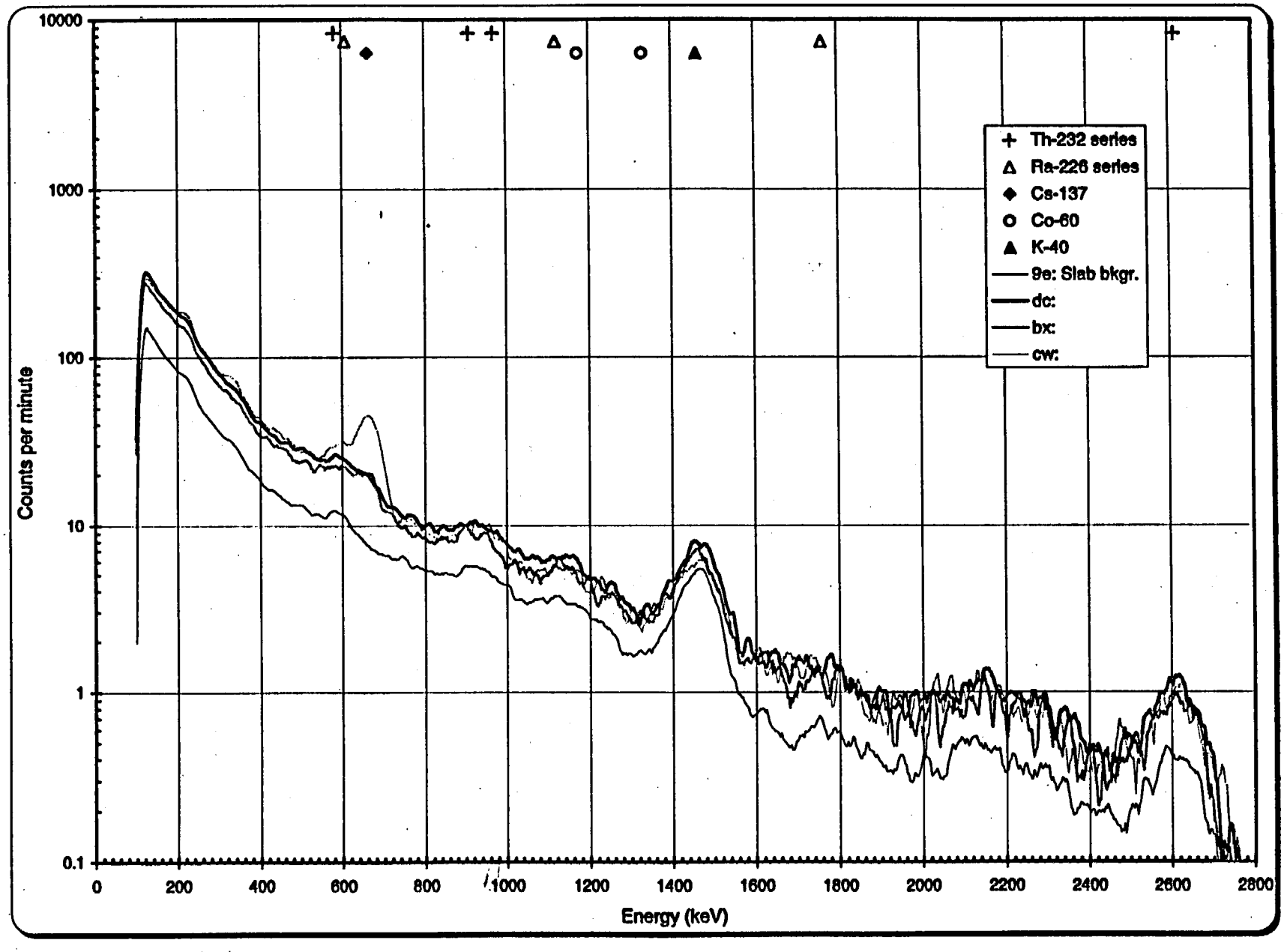
4-8 Chart 10


Counts per minute
10000
1000
100
10
1
0.1
0
200
400
600
800
1000
1200
1400
1600
1800
2000
2200
2400
2600
2800
Energy (keV)
Th-232 series
Ra-226 series
Cs-137
Co-60
K-40
9e: Slab bkgr.
fv: 24-08DB1 28"-34" Co pool
fw: 24-08DB2
fx: 24-08DB3
fy: 24-08DB4 80E39N asphalt

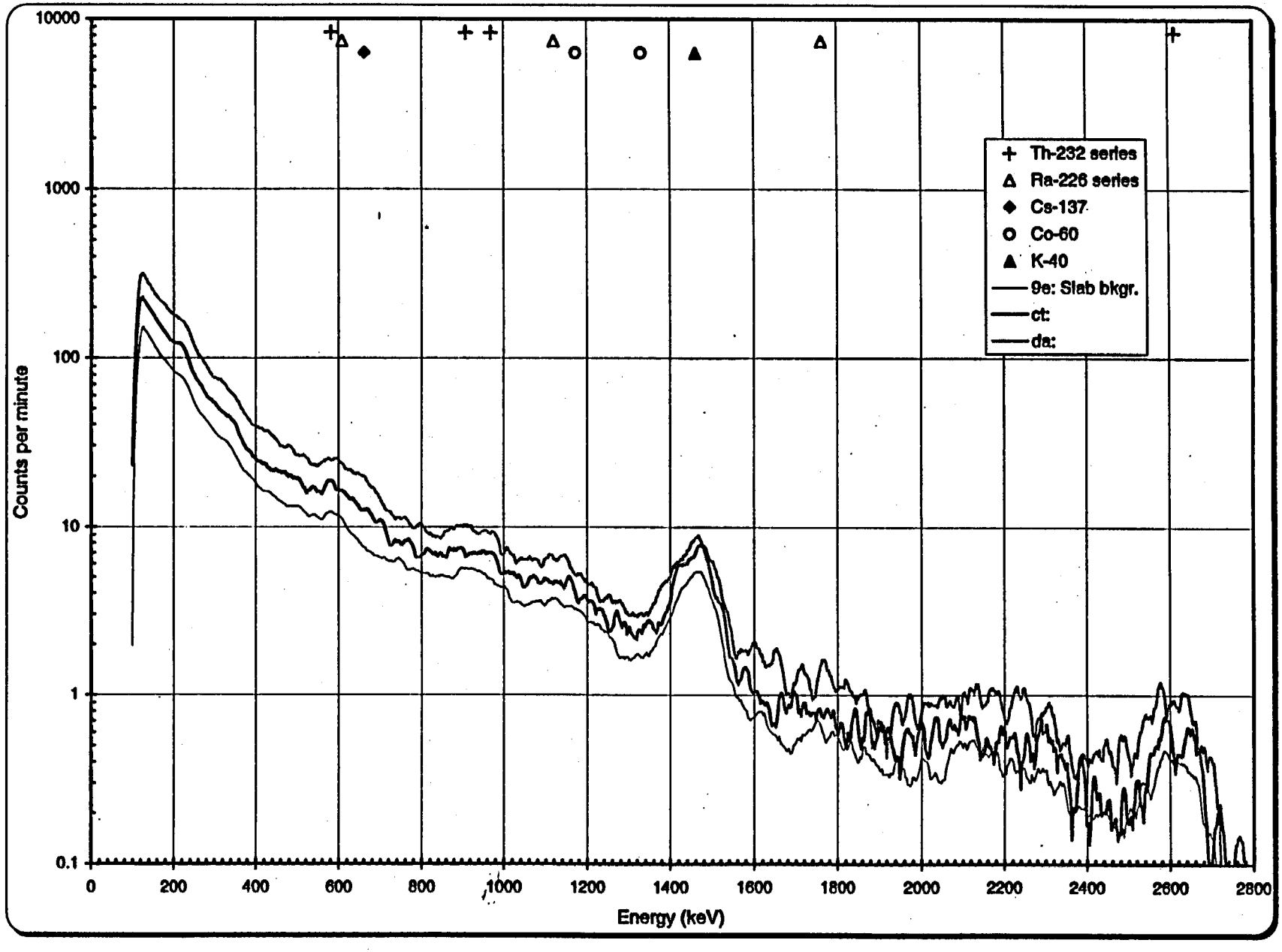
4-9a Chart 7


Th-232 series
Ra-226 series
Cs-137
Co-60
K-40
dt: 24-07KN1 8"-10" Co pool
du: 24-07KN2 10"-18" Co pool
q: 24-06DB5 lab SW area
fm: 24-07JS1
9e: Slab bkgr.
Counts per minute
Energy (keV)
10000
1000
100
10
1
0.1
0
200
400
600
800
1000
1200
1400
1600
1800
2000
2200
2400
2600
2800

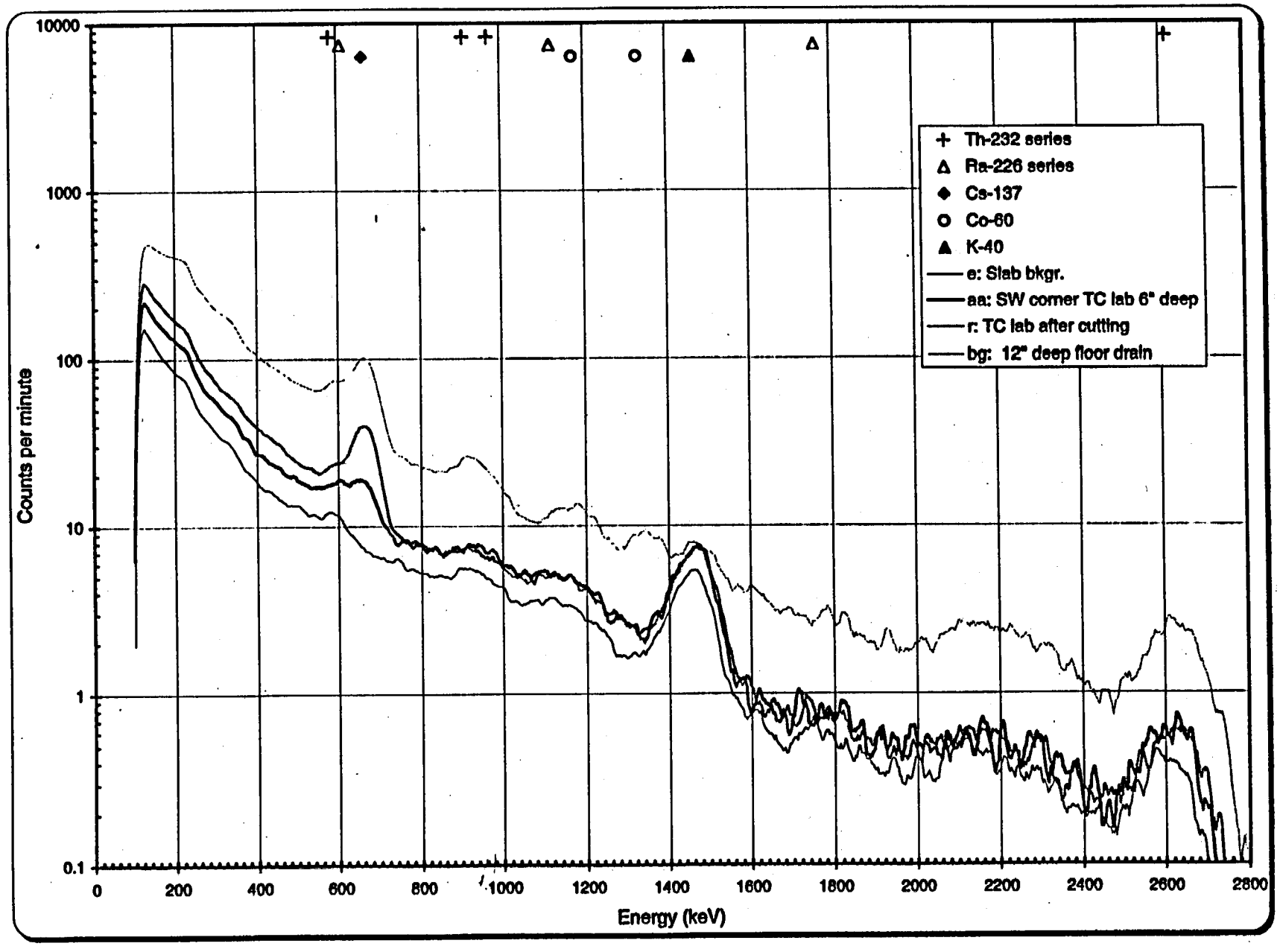
4-9a Chart 8


Th-232 series
Ra-226 series
Cs-137
Co-60
K-40
9e: Slab bkgr.
dc:
bx:
cw:
Counts per minute
10000
1000
100
10
1
0.1
0
200
400
600
800
1000
1200
1400
1600
1800
2000
2200
2400
2600
2800
Energy (keV)

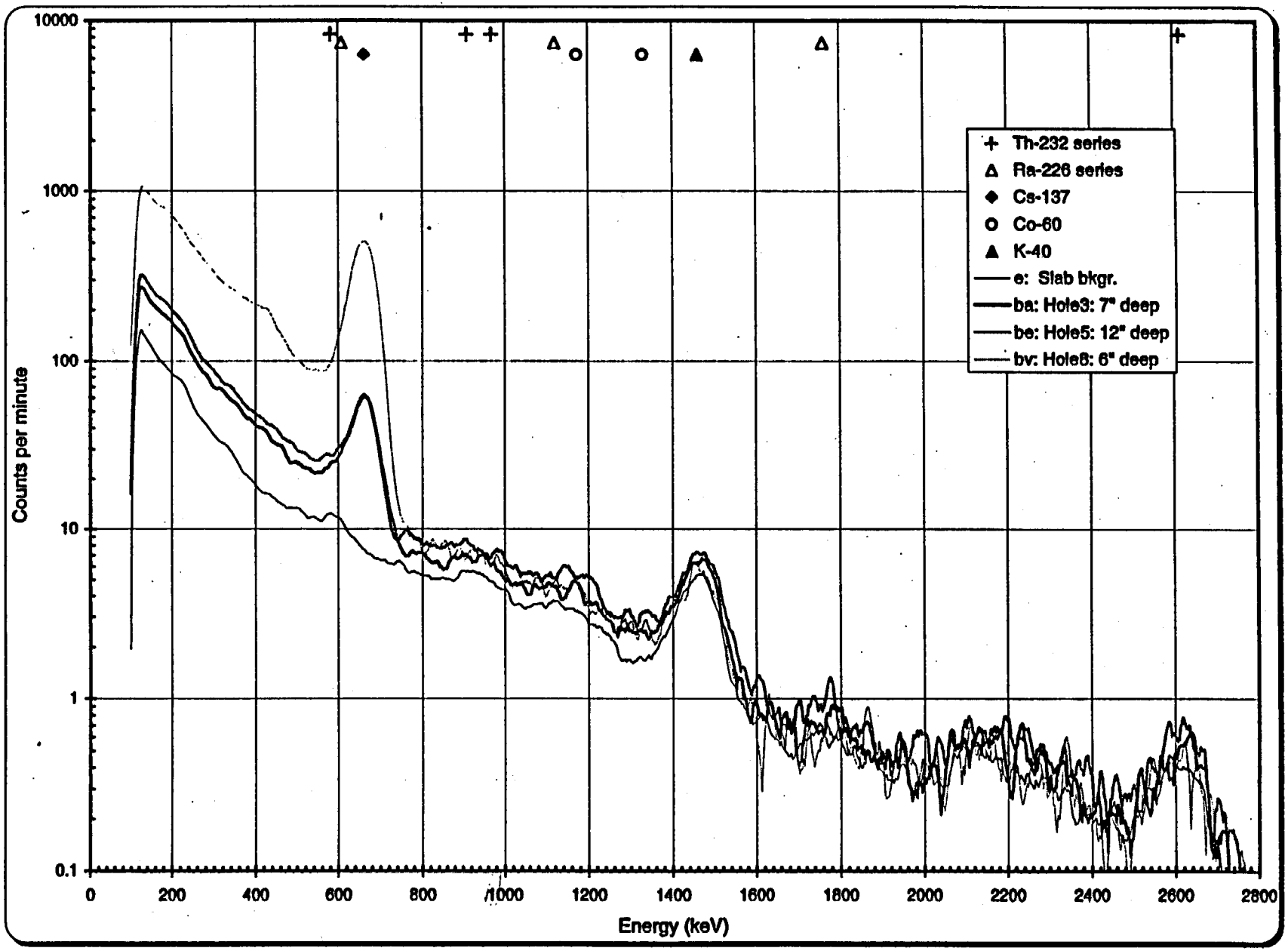
4-9a Chart 9


10000
1000
100
10
1
0.1
Counts per minute
0
200
400
600
800
1000
1200
1400
1600
1800
2000
2200
2400
2600
2800
Energy (keV)
Th-232 series
Ra-226 series
Cs-137
Co-60
K-40
9e: Slab bkgr.
ct:
da:

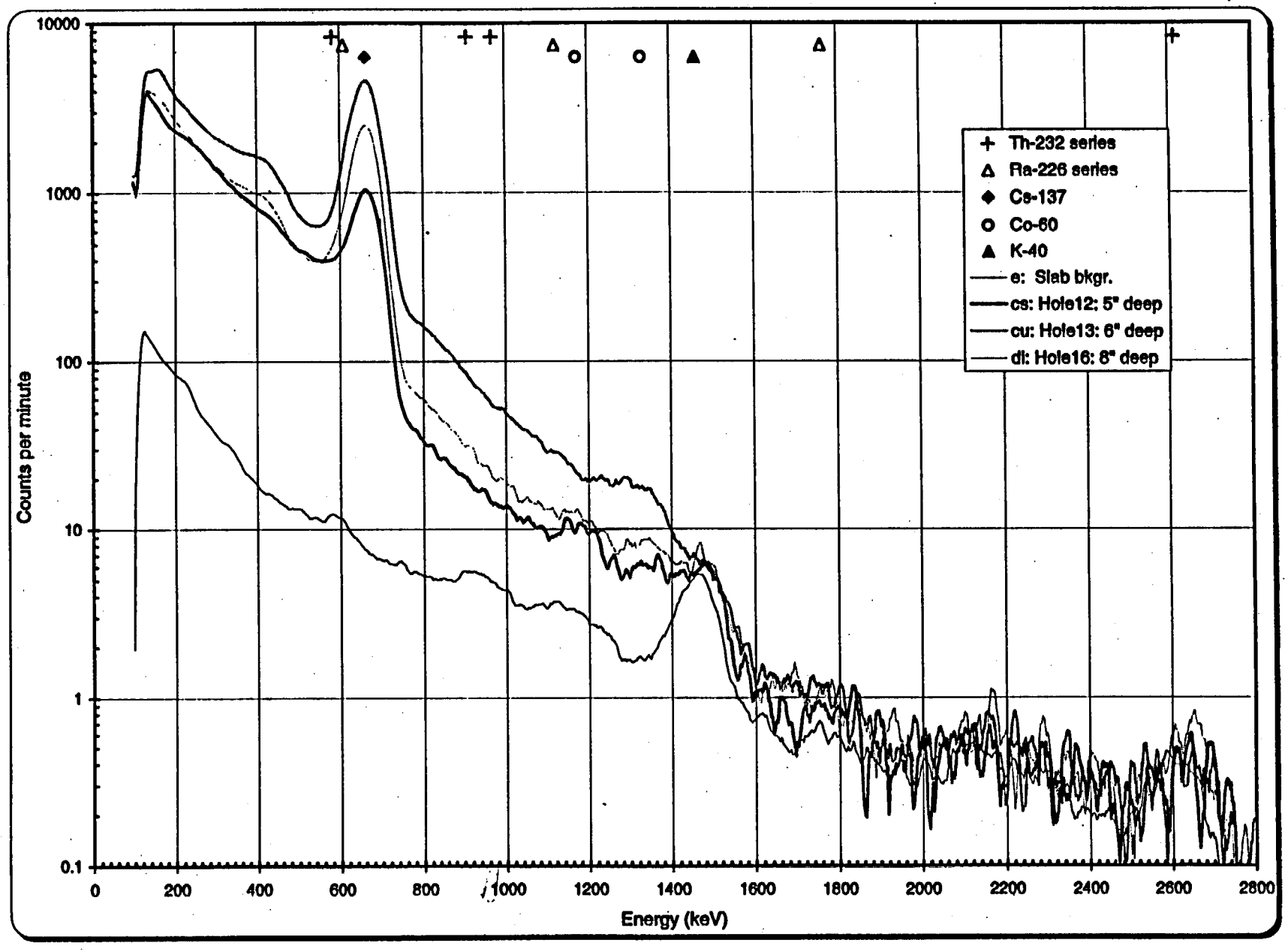
4-9a Chart 10


Th-232 series
Ra-226 series
Cs-137
Co-60
K-40
e: Slab bkgr.
aa: SW corner TC lab 6" deep
r: TC lab after cutting
bg: 12" deep floor drain
Counts per minute
Energy (keV)
10000
1000
100
10
1
0.1
0
200
400
600
800
1000
1200
1400
1600
1800
2000
2200
2400
2600
2800

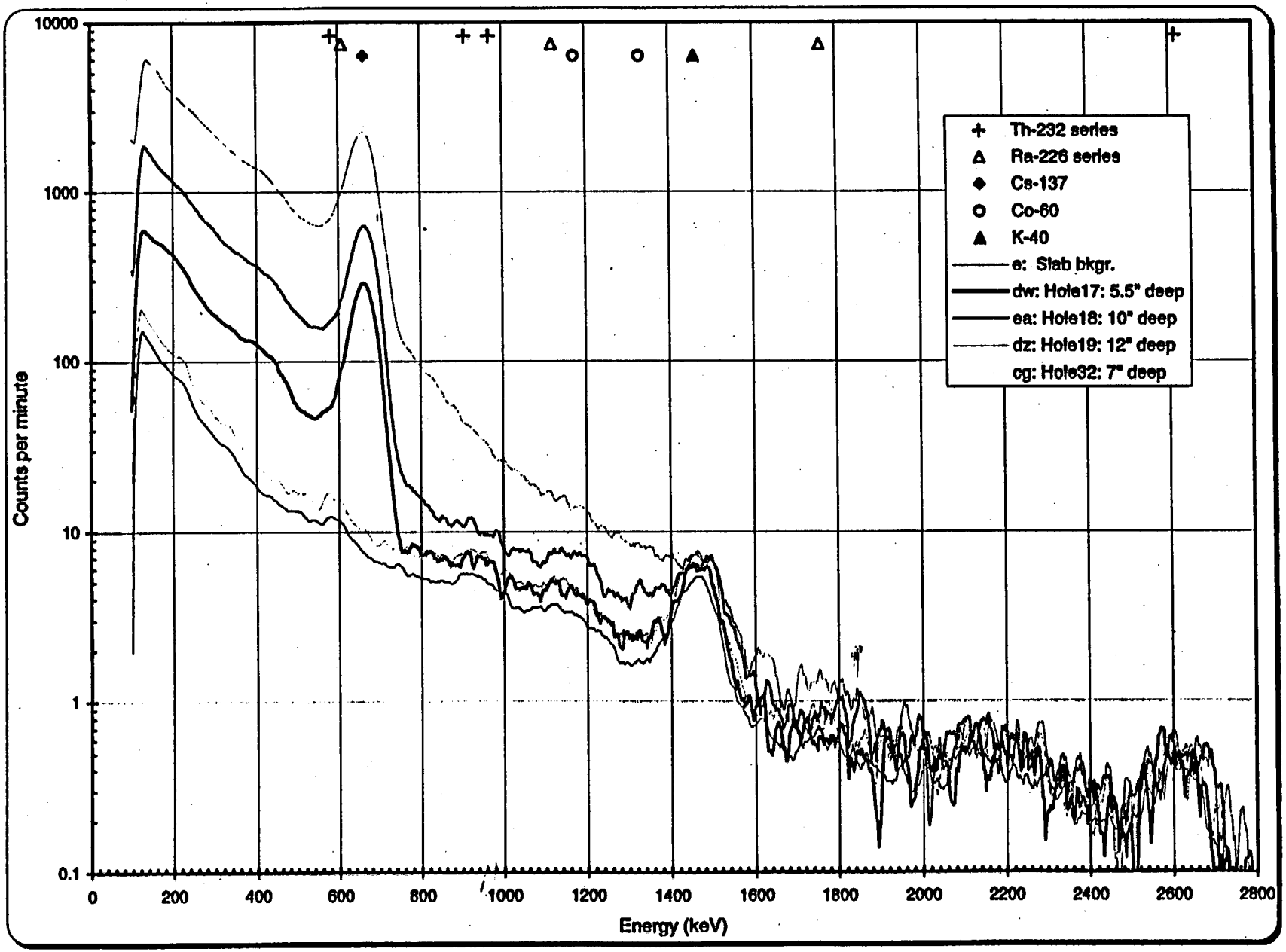
4-9b Chart 7


Th-232 series
Ra-226 series
Cs-137
Co-60
K-40
e: Slab bkgr.
ba: Hole3: 7" deep
be: Hole5: 12" deep
bv: Hole8: 6" deep
Counts per minute
10000
1000
100
10
1
0.1
0
200
400
600
800
1000
1200
1400
1600
1800
2000
2200
2400
2600
2800
Energy (keV)

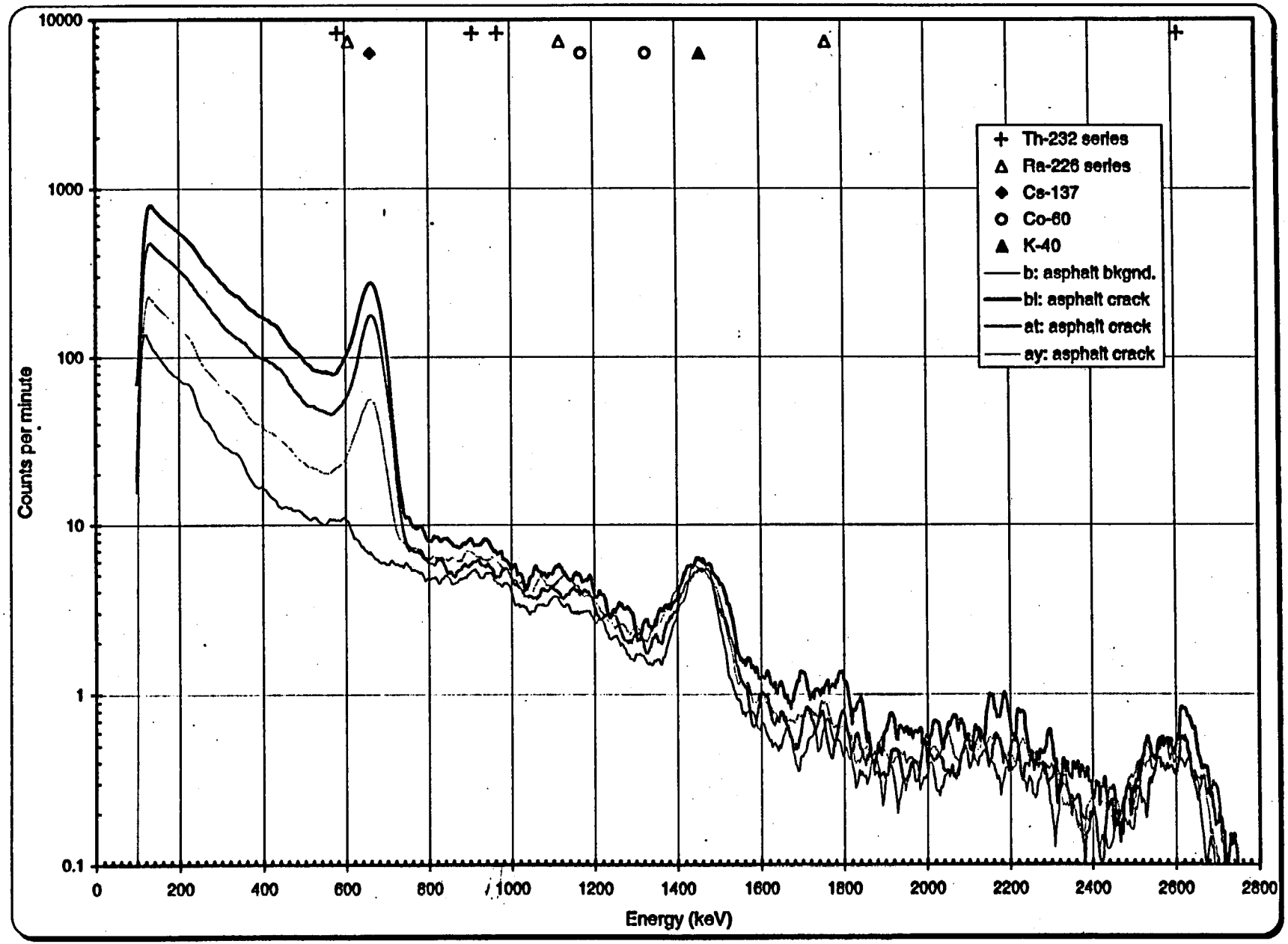
4-13a Chart 7


Counts per minute
10000
1000
100
10
1
0.1
0
200
400
600
800
1000
1200
1400
1600
1800
2000
2200
2400
2600
2800
Energy (keV)
Th-232 series
Ra-226 series
Cs-137
Co-60
K-40
e: Slab bkgr.
cs: Hole12: 5" deep
cu: Hole13: 6" deep
dl: Hole16: 8" deep

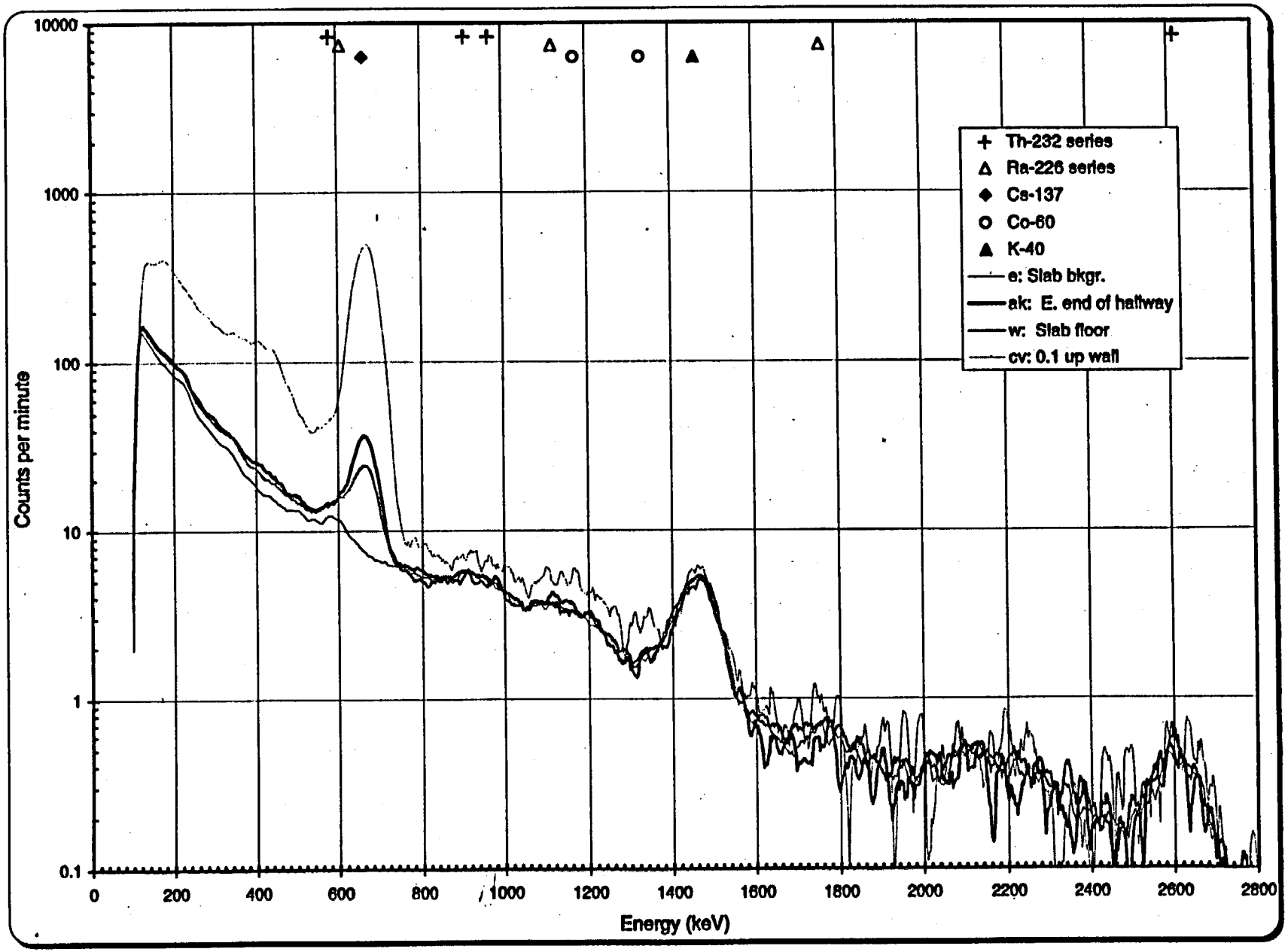
4-13a Chart 8


Th-232 series
Ra-226 series
Cs-137
Co-60
K-40
e: Slab bkgr.
dw: Hole17: 5.5" deep
ea: Hole18: 10" deep
dz: Hole19: 12" deep
cg: Hole32: 7" deep
Counts per minute
Energy (keV)
10000
1000
100
10
1
0.1
0
200
400
600
800
1000
1200
1400
1600
1800
2000
2200
2400
2600
2800

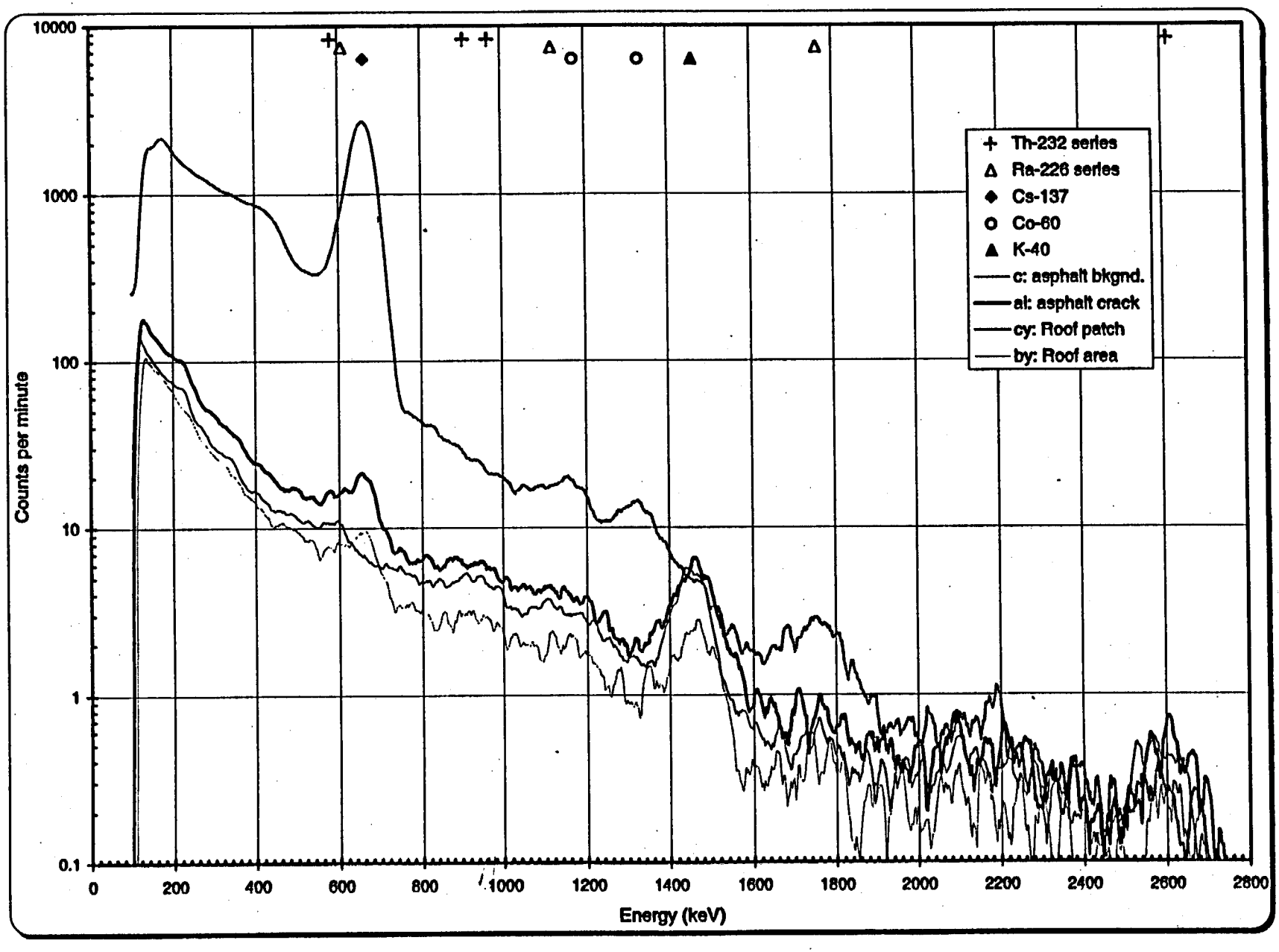
4-13a Chart 9



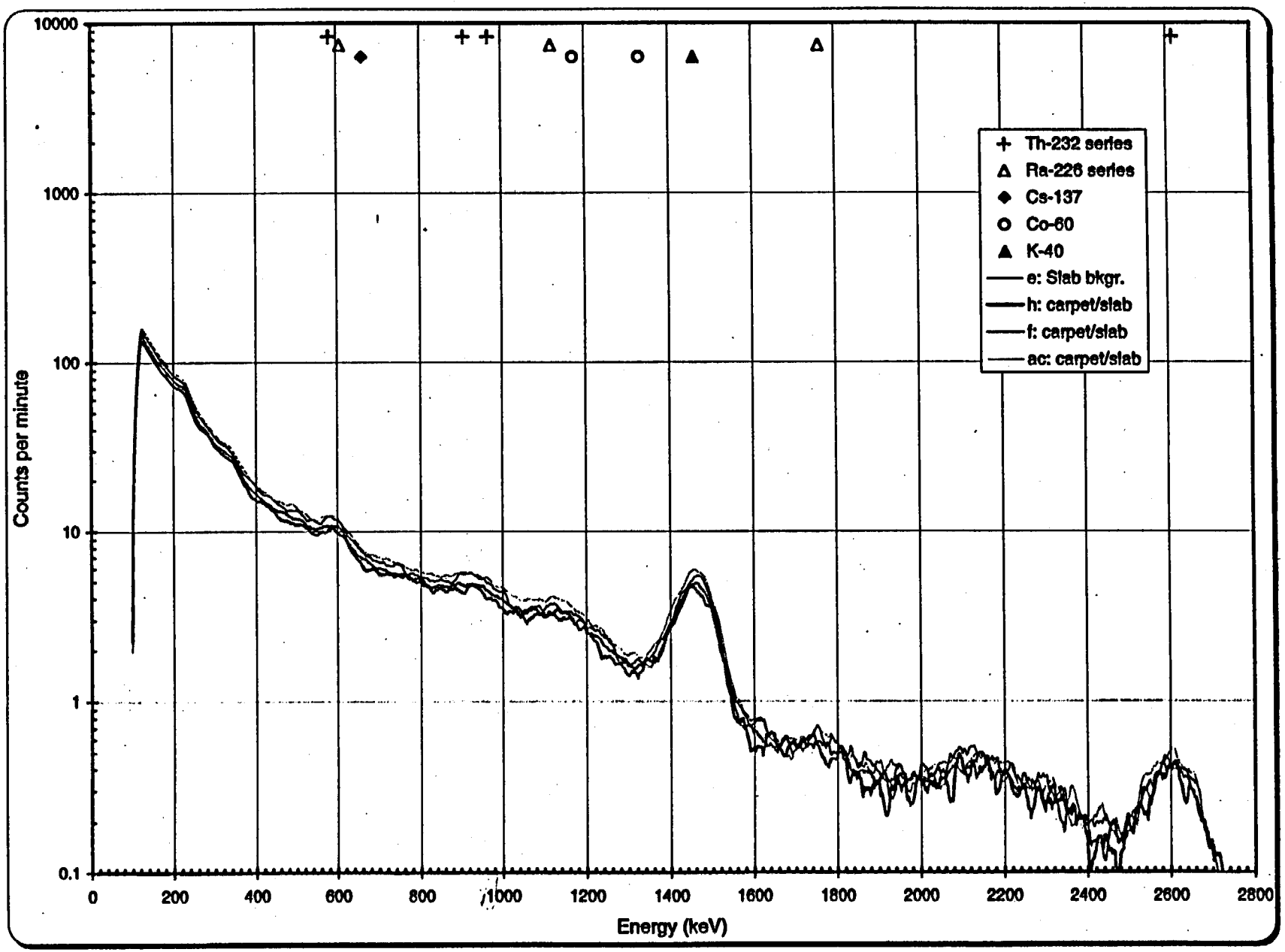
4-13a Chart 10


Counts per minute
10000
1000
100
10
1
0.1
0
200
400
600
800
1000
1200
1400
1600
1800
2000
2200
2400
2600
2800
Energy (keV)
Th-232 series
Ra-226 series
Cs-137
Co-60
K-40
e: Slab bkgr.
ak: E. end of hallway
w: Slab floor
cv: 0.1 up wall

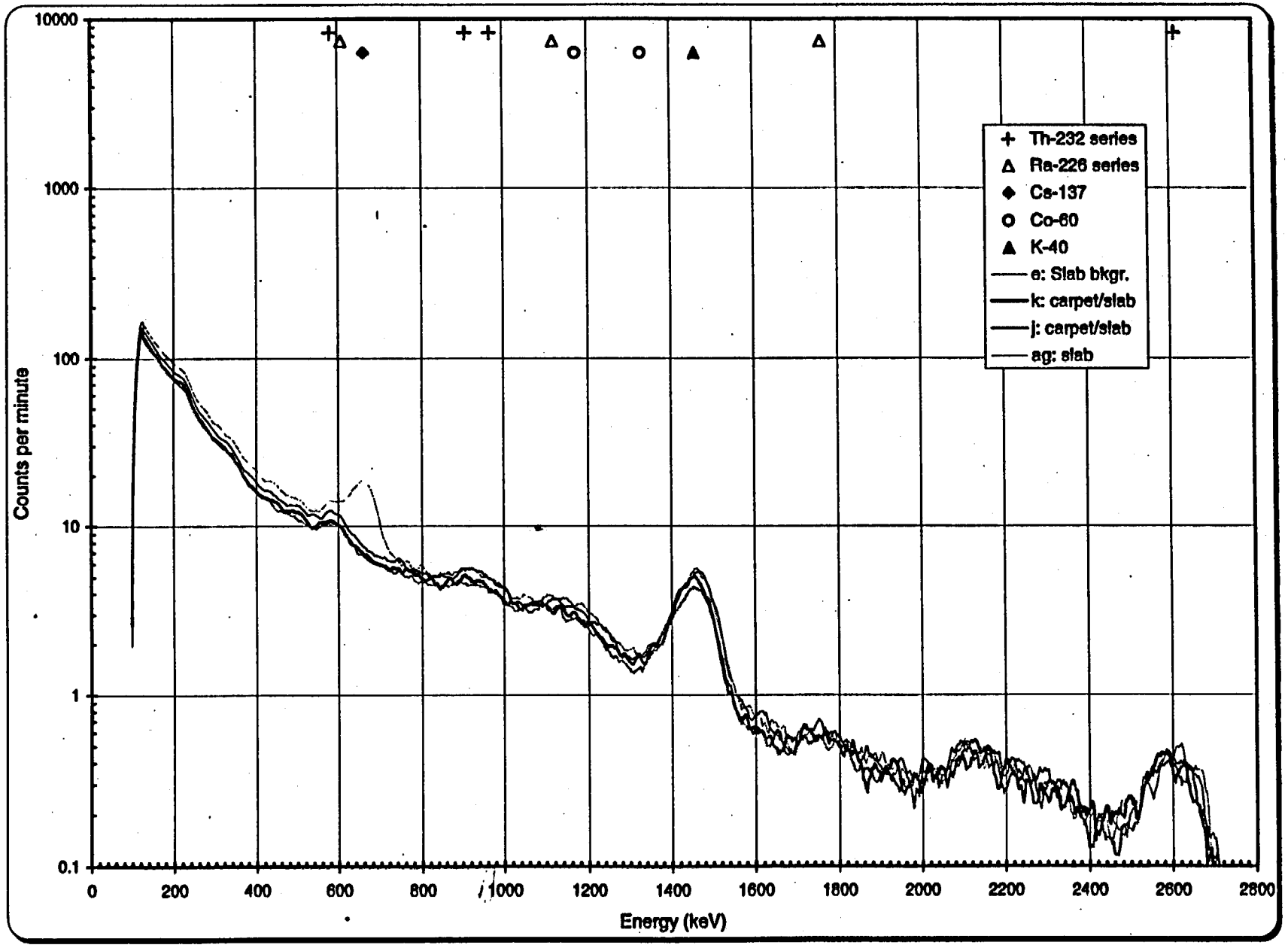
4-13b Chart 7


Th-232 series
Ra-226 series
Cs-137
Co-60
K-40
c: asphalt bkgnd.
al: asphalt crack
cy: Roof patch
by: Roof area
Counts per minute
10000
1000
100
10
1
0.1
0
200
400
600
800
1000
1200
1400
1600
1800
2000
2200
2400
2600
2800
Energy (keV)

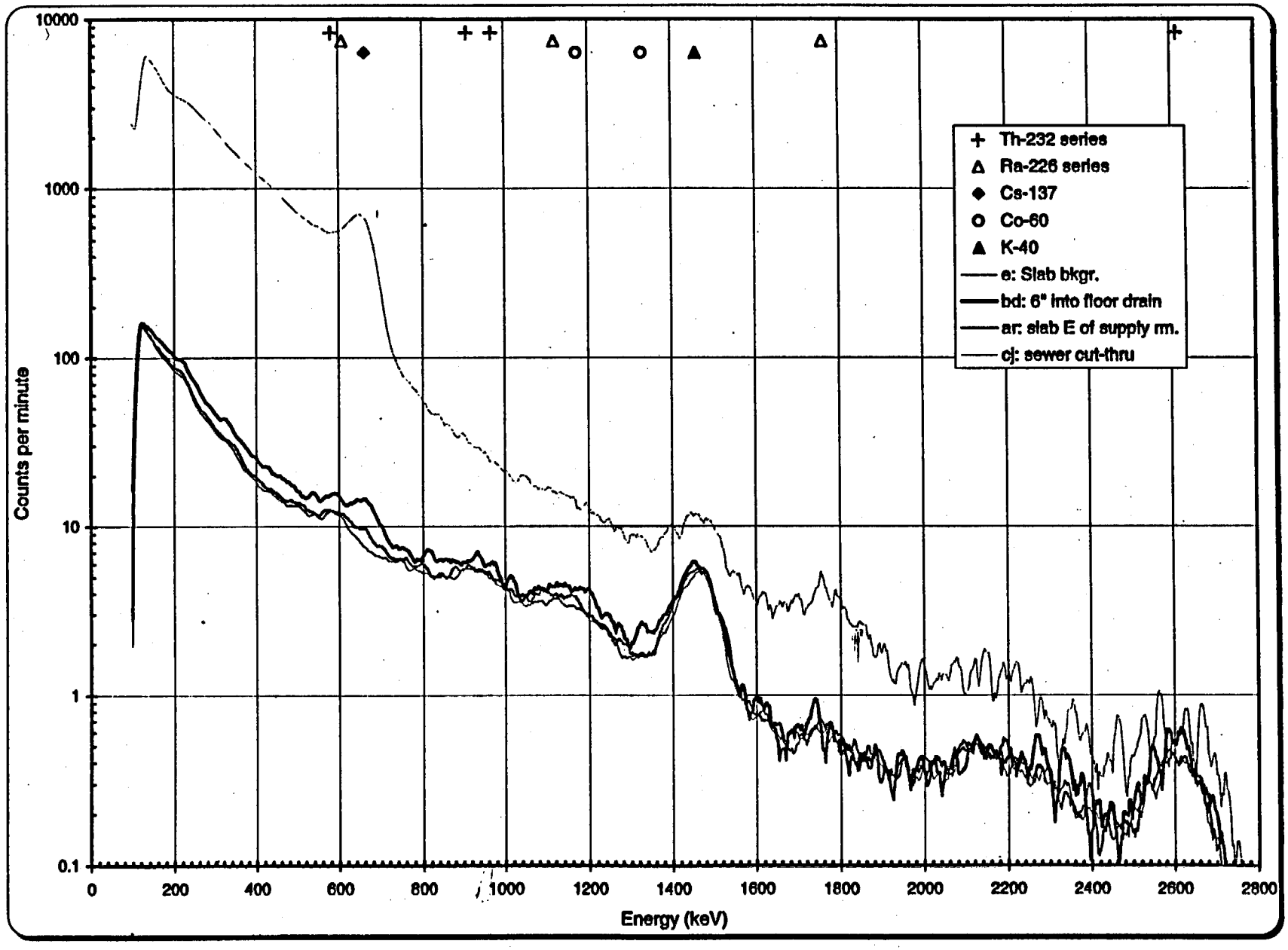
4-13b Chart 8


Th-232 series
Ra-226 series
Cs-137
Co-60
K-40
e: Slab bkgr.
h: carpet/slab
f: carpet/slab
ac: carpet/slab
Counts per minute
10000
1000
100
10
1
0.1
0
200
400
600
800
1000
1200
1400
1600
1800
2000
2200
2400
2600
2800
Energy (keV)

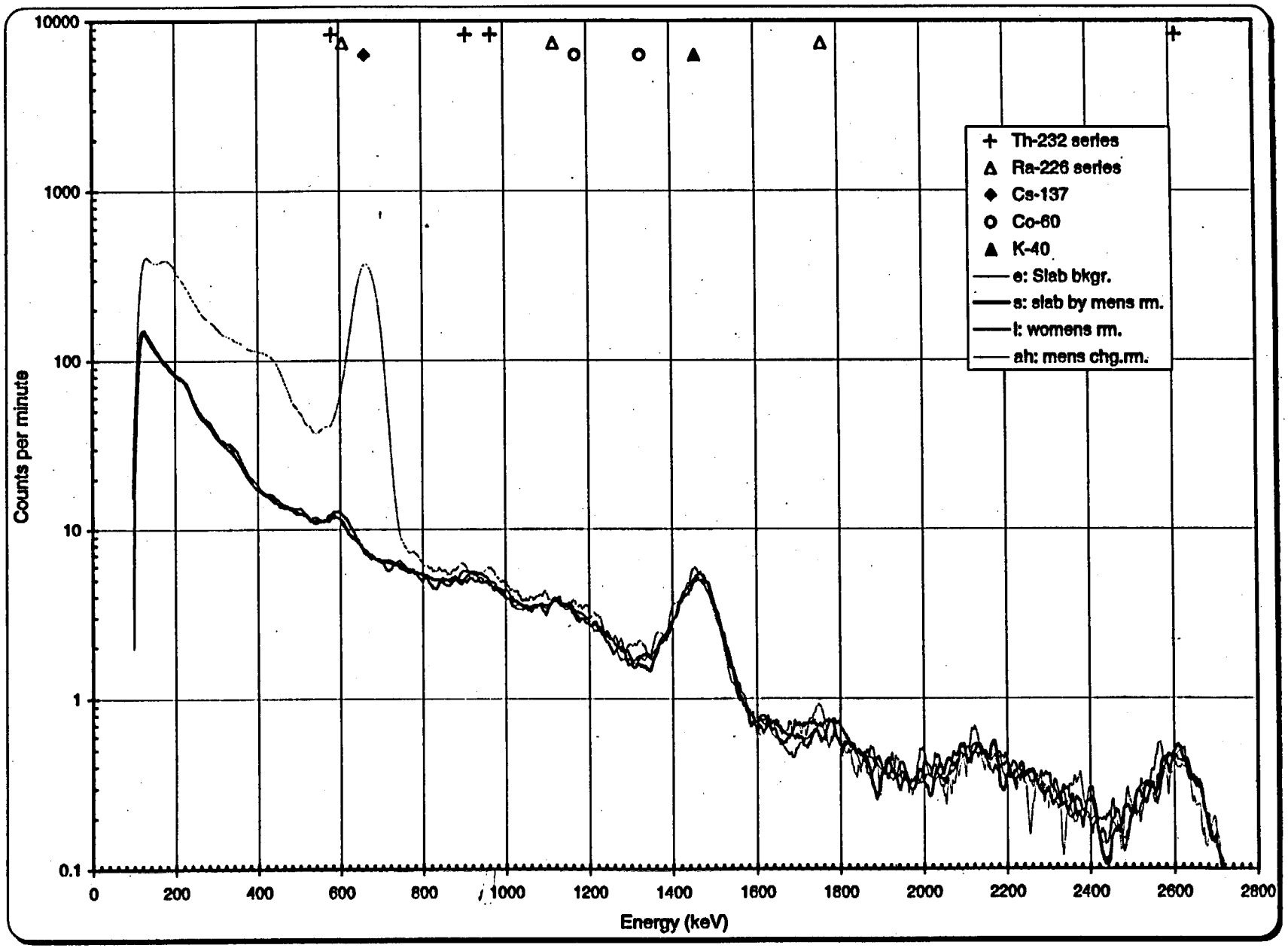
4-14 Chart 7


Counts per minute
10000
1000
100
10
1
0.1
0
200
400
600
800
1000
1200
1400
1600
1800
2000
2200
2400
2600
2800
Energy (keV)
Th-232 series
Ra-226 series
Cs-137
Co-60
K-40
e: Slab bkgr.
k: carpet/slab
j: carpet/slab
ag: slab

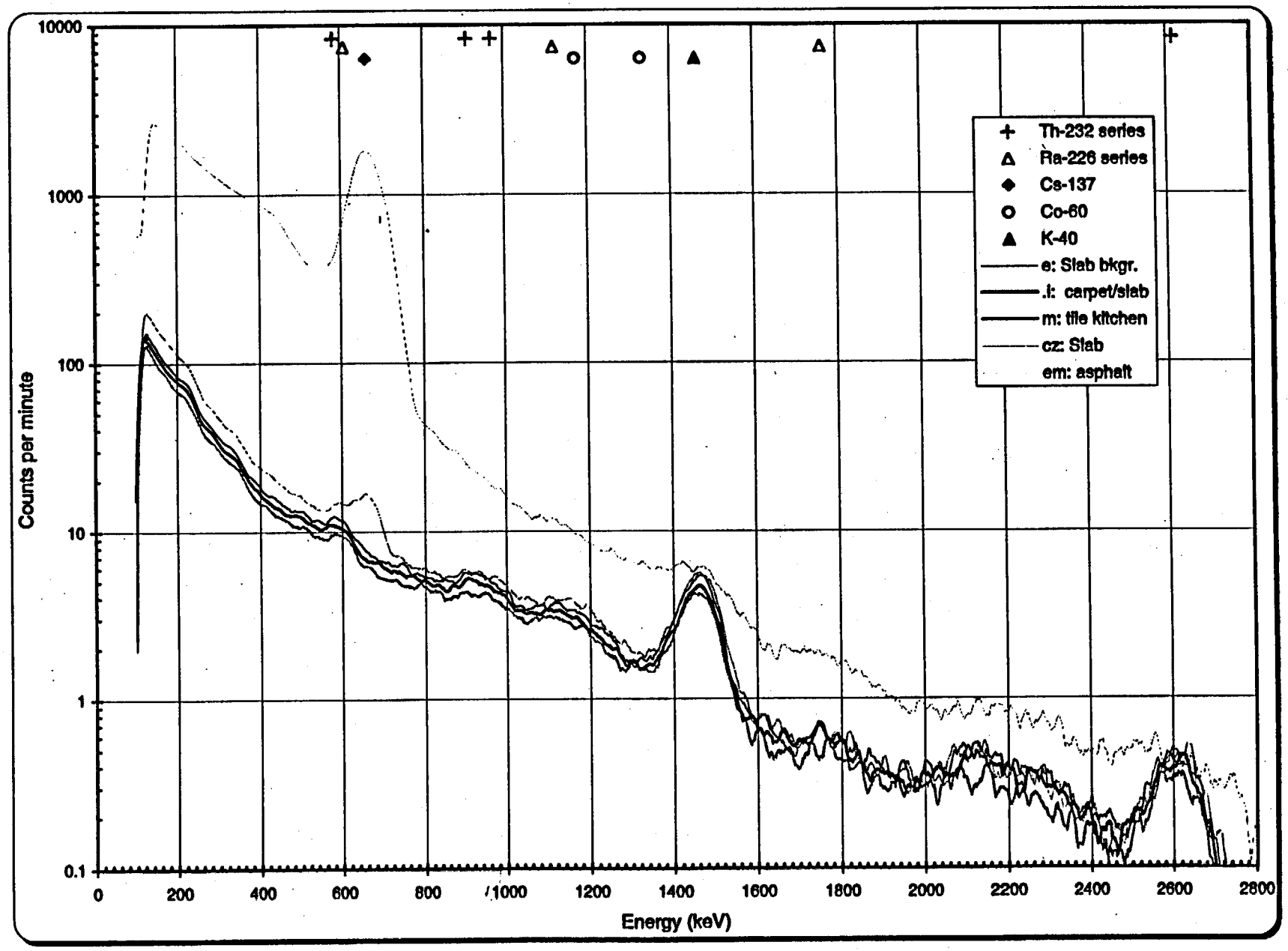
4-14 Chart 8


Counts per minute
10000
1000
100
10
1
0.1
0
200
400
600
800
1000
1200
1400
1600
1800
2000
2200
2400
2600
2800
Energy (keV)
Th-232 series
Ra-226 series
Cs-137
Co-60
K-40
e: Slab bkgr.
bd: 6" into floor drain
ar: slab E of supply rm.
cj: sewer cut-thru

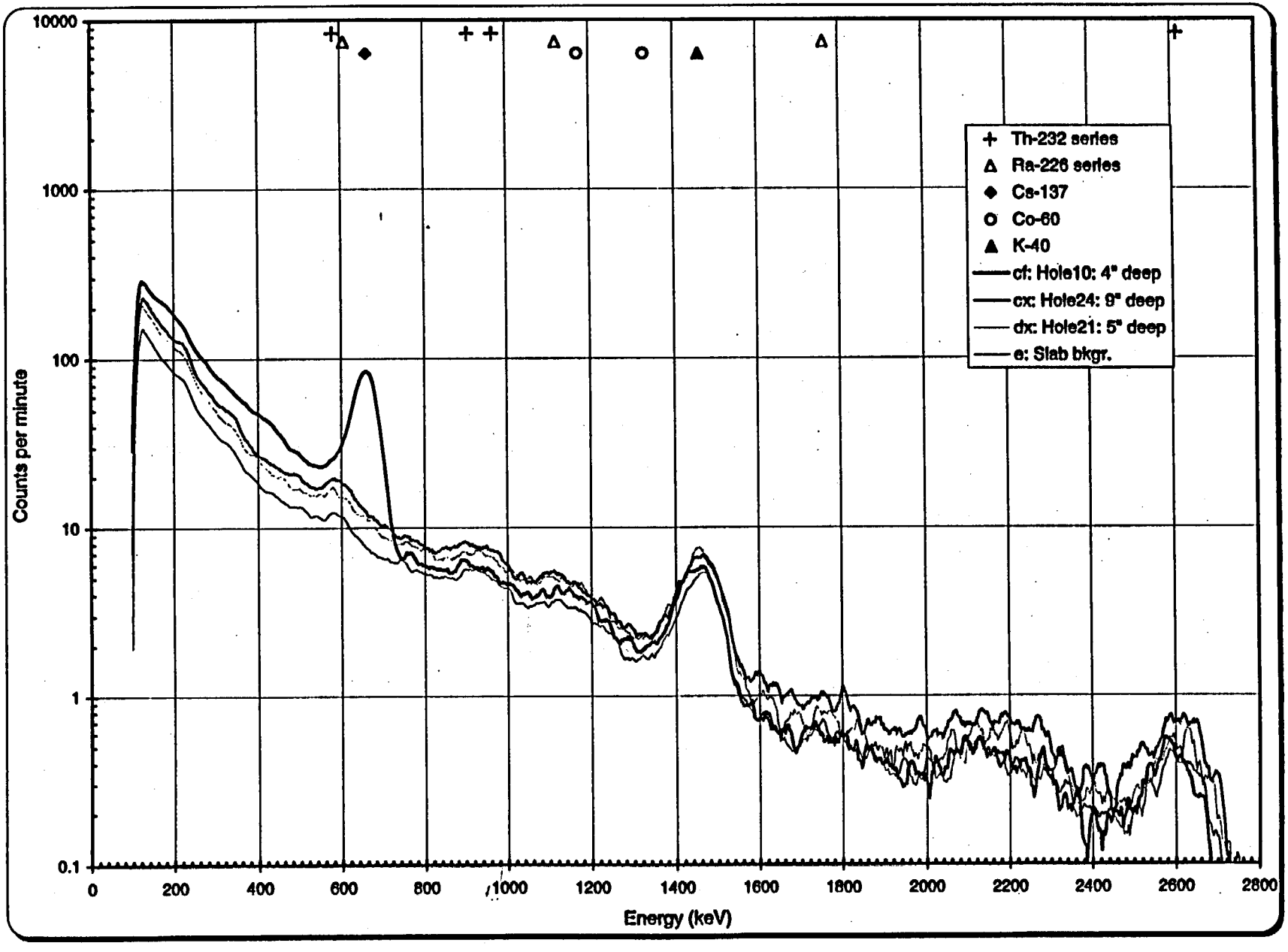
4-14 Chart 9


Th-232 series
Ra-226 series
Cs-137
Co-60
K-40
e: Slab bkgr.
s: slab by mens rm.
l: womens rm.
ah: mens chg.rm.
Counts per minute
10000
1000
100
10
1
0.1
0
200
400
600
800
1000
1200
1400
1600
1800
2000
2200
2400
2600
2800
Energy (keV)

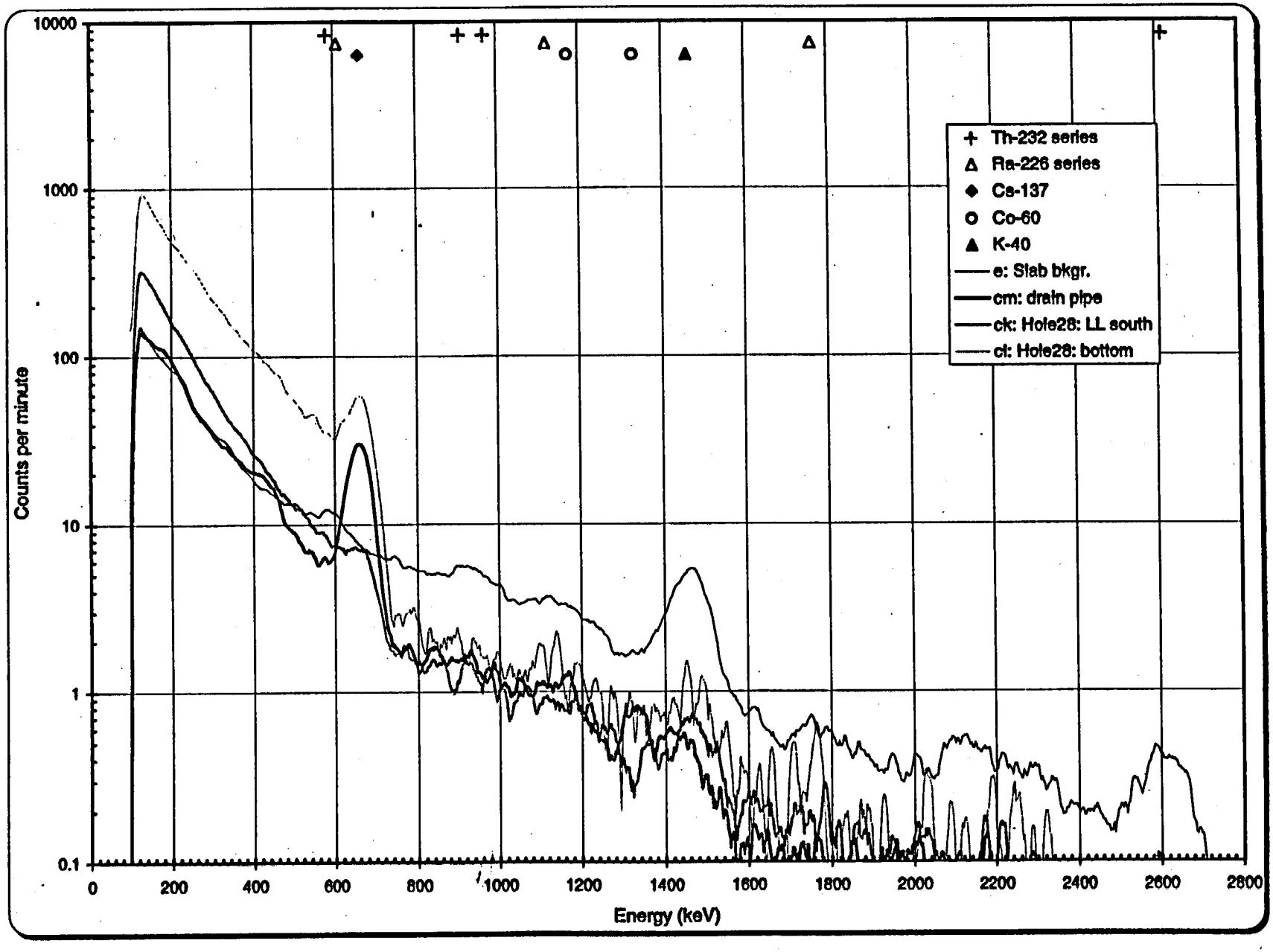
4-14 Chart 10


Counts per minute
10000
1000
100
10
1
0.1
0
200
400
600
800
1000
1200
1400
1600
1800
2000
2200
2400
2600
2800
Energy (keV)
Th-232 series
Ra-226 series
Cs-137
Co-60
K-40
e: Slab bkgr.
.l: carpet/slab
m: tile kitchen
cz: Slab
em: asphalt

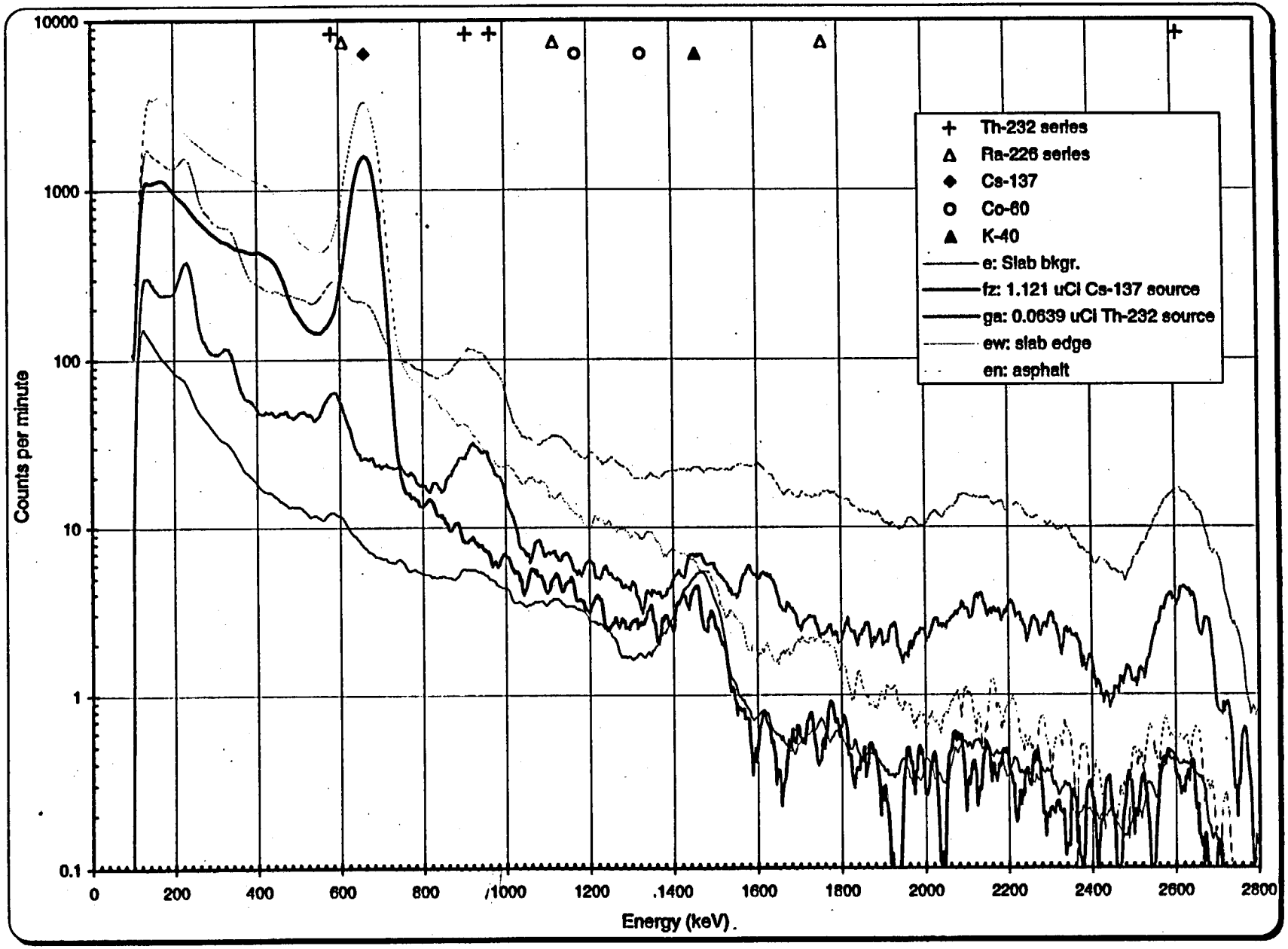
4-15a Chart 7


Th-232 series
Ra-226 series
Cs-137
Co-60
K-40
cf: Hole10: 4" deep
cx: Hole24: 9" deep
dx: Hole21: 5" deep
e: Slab bkgr.
Counts per minute
Energy (keV)
10000
1000
100
10
1
0.1
0
200
400
600
800
1000
1200
1400
1600
1800
2000
2200
2400
2600
2800

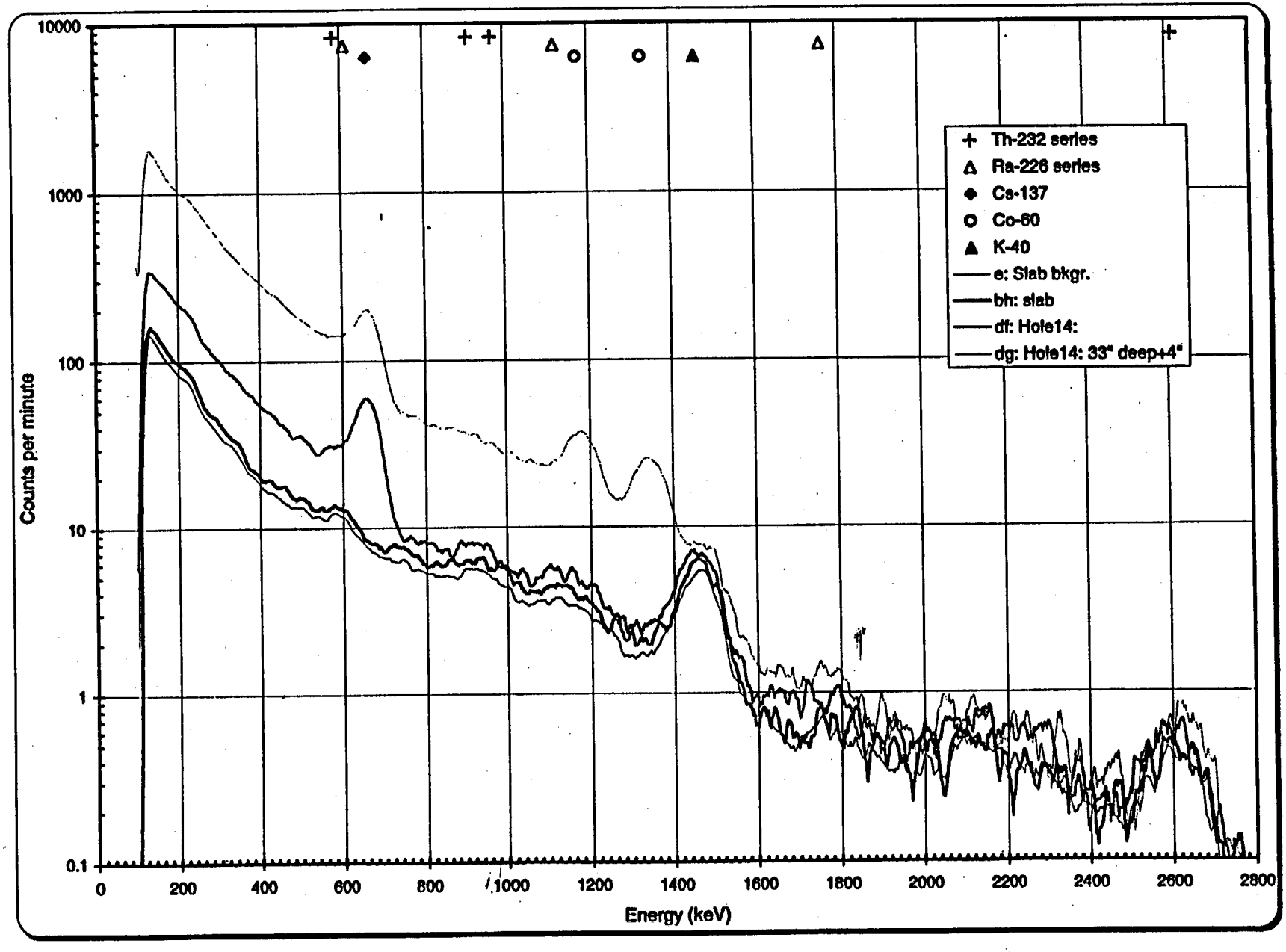
4-15a Chart 8


Th-232 series
Ra-226 series
Cs-137
Co-60
K-40
e: Slab bkgr.
cm: drain pipe
ck: Hole28: LL south
cl: Hole28: bottom
Counts per minute
10000
1000
100
10
1
0.1
0
200
400
600
800
1000
1200
1400
1600
1800
2000
2200
2400
2600
2800
Energy (keV)

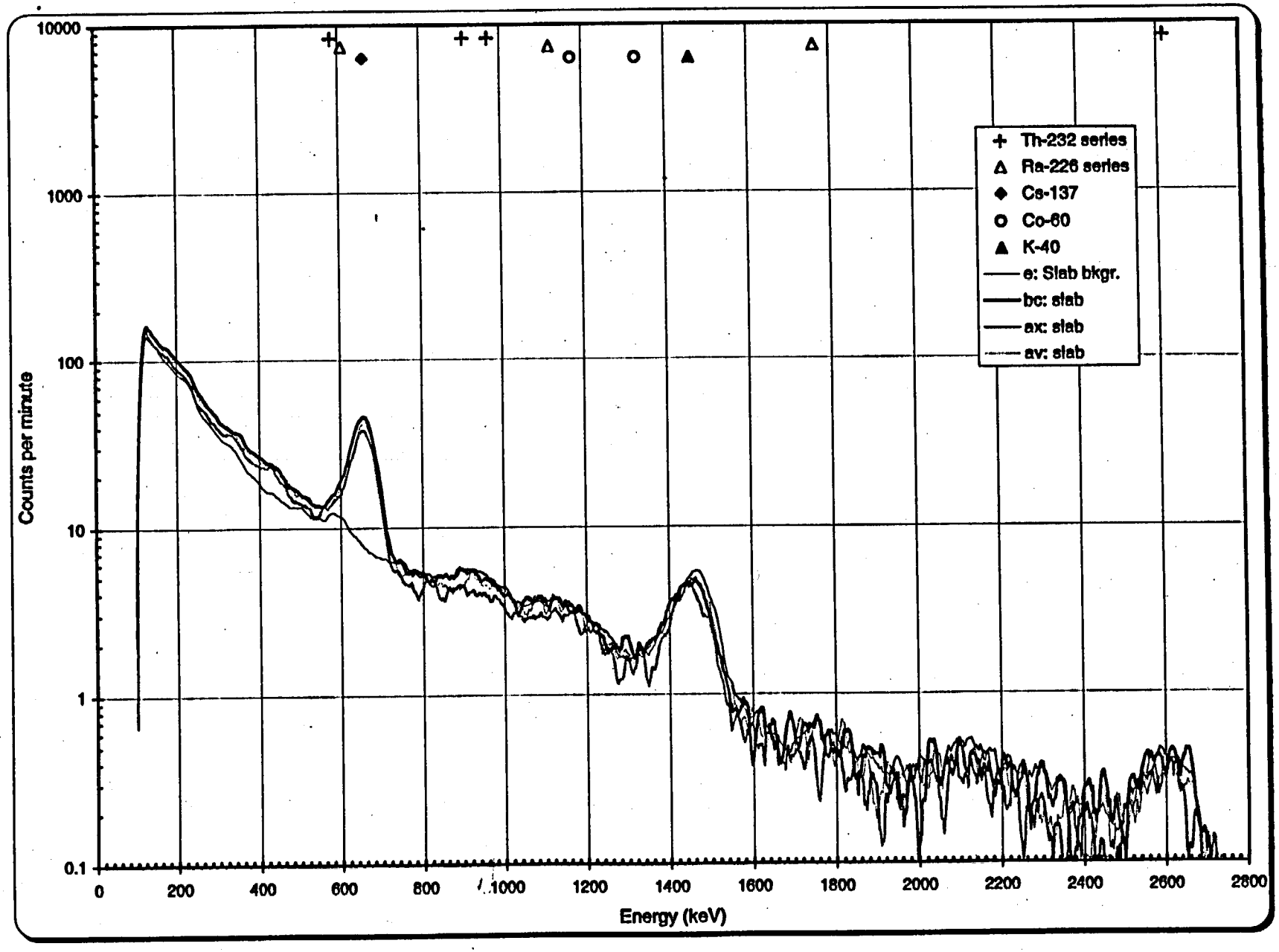
4-15b Chart 7


Th-232 series
Ra-226 series
Cs-137
Co-60
K-40
e: Slab bkgr.
fz: 1.121 uCi Cs-137 source
ga: 0.0639 uCi Th-232 source
ew: slab edge
en: asphalt
Counts per minute
10000
1000
100
10
1
0.1
0
200
400
600
800
1000
1200
1400
1600
1800
2000
2200
2400
2600
2800
Energy (keV)

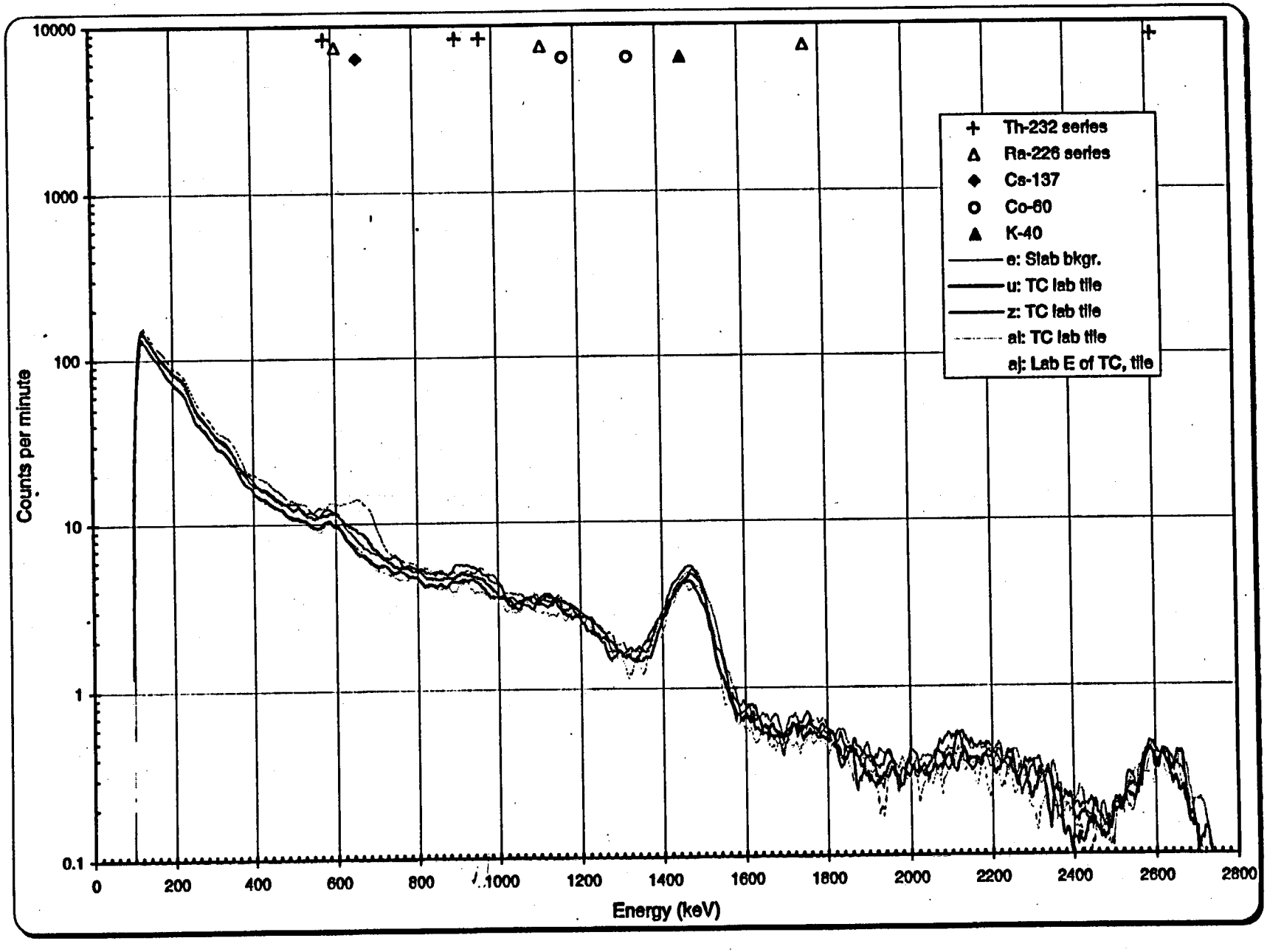
4-15b Chart 8


Th-232 series
Ra-226 series
Cs-137
Co-60
K-40
e: Slab bkgr.
bh: slab
df: Hole14:
dg: Hole14: 33" deep+4"
Counts per minute
Energy (keV)
10000
1000
100
10
1
0.1
0
200
400
600
800
1000
1200
1400
1600
1800
2000
2200
2400
2600
2800

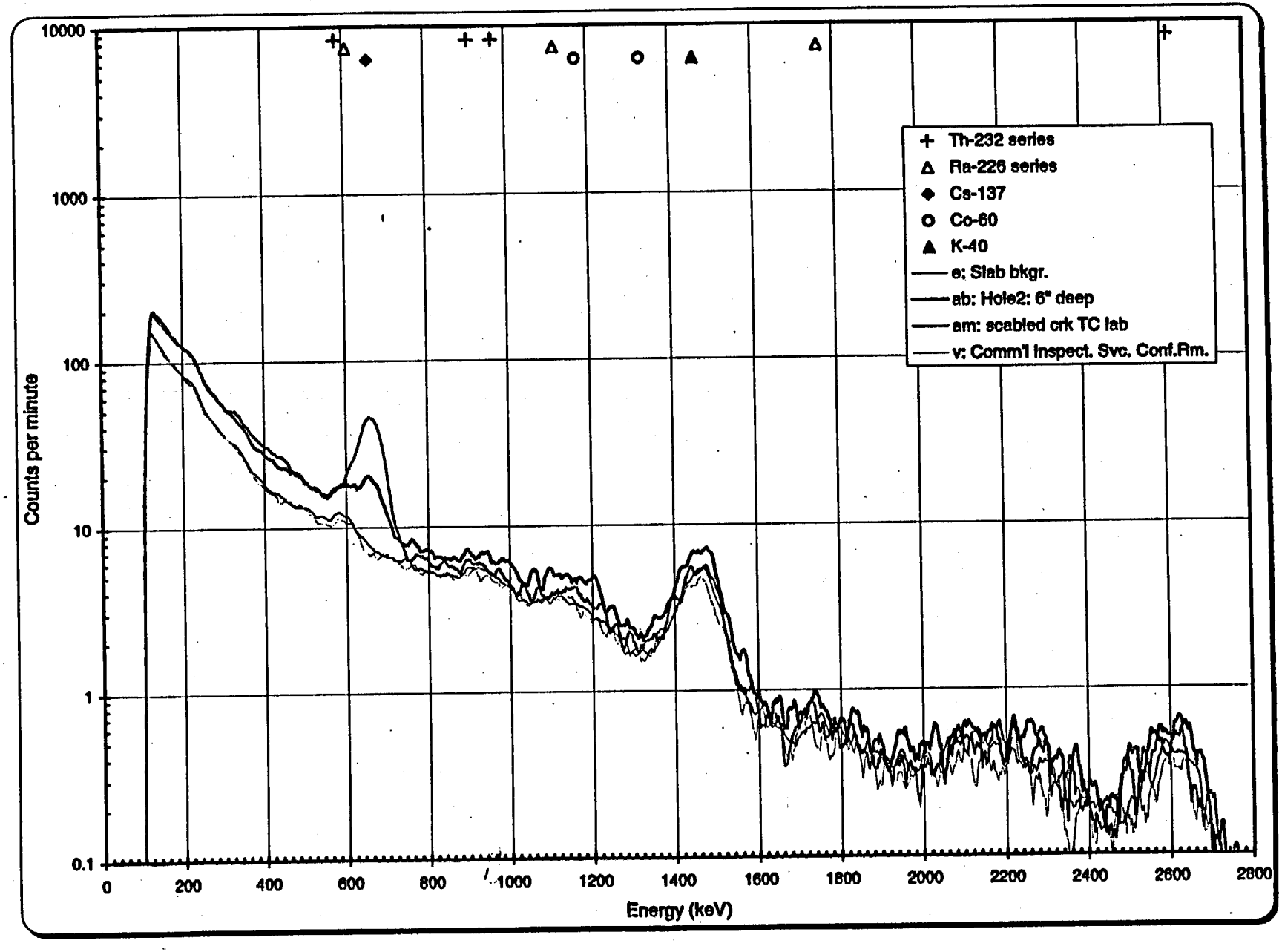
4-15b Chart 9



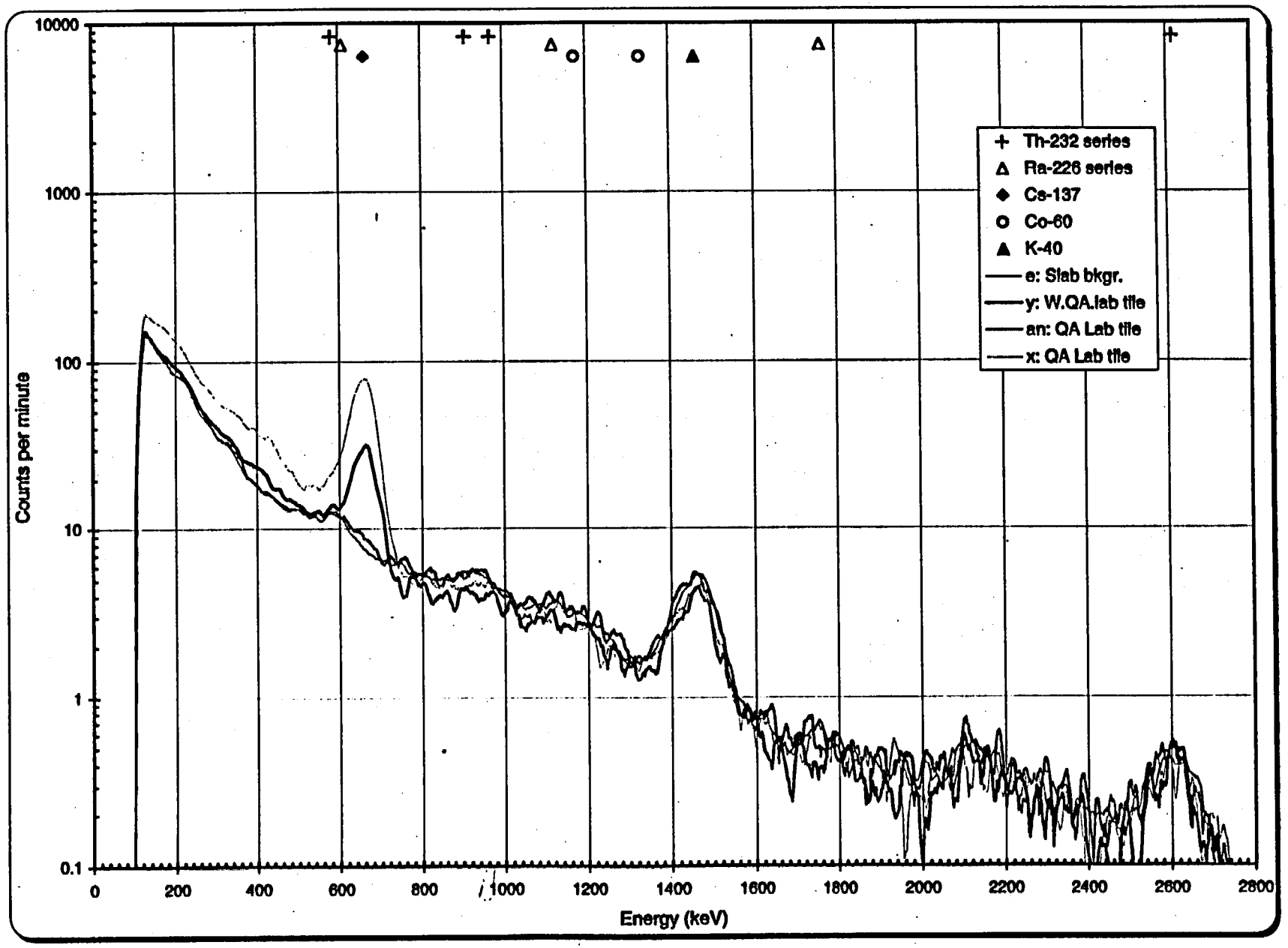
4-15b Chart 10


Th-232 series
Ra-226 series
Cs-137
Co-60
K-40
e: Slab bkgr.
u: TC lab tile
z: TC lab tile
al: TC lab tile
aj: Lab E of TC, tile
Counts per minute
10000
1000
100
10
1
0.1
0
200
400
600
800
1000
1200
1400
1600
1800
2000
2200
2400
2600
2800
Energy (keV)

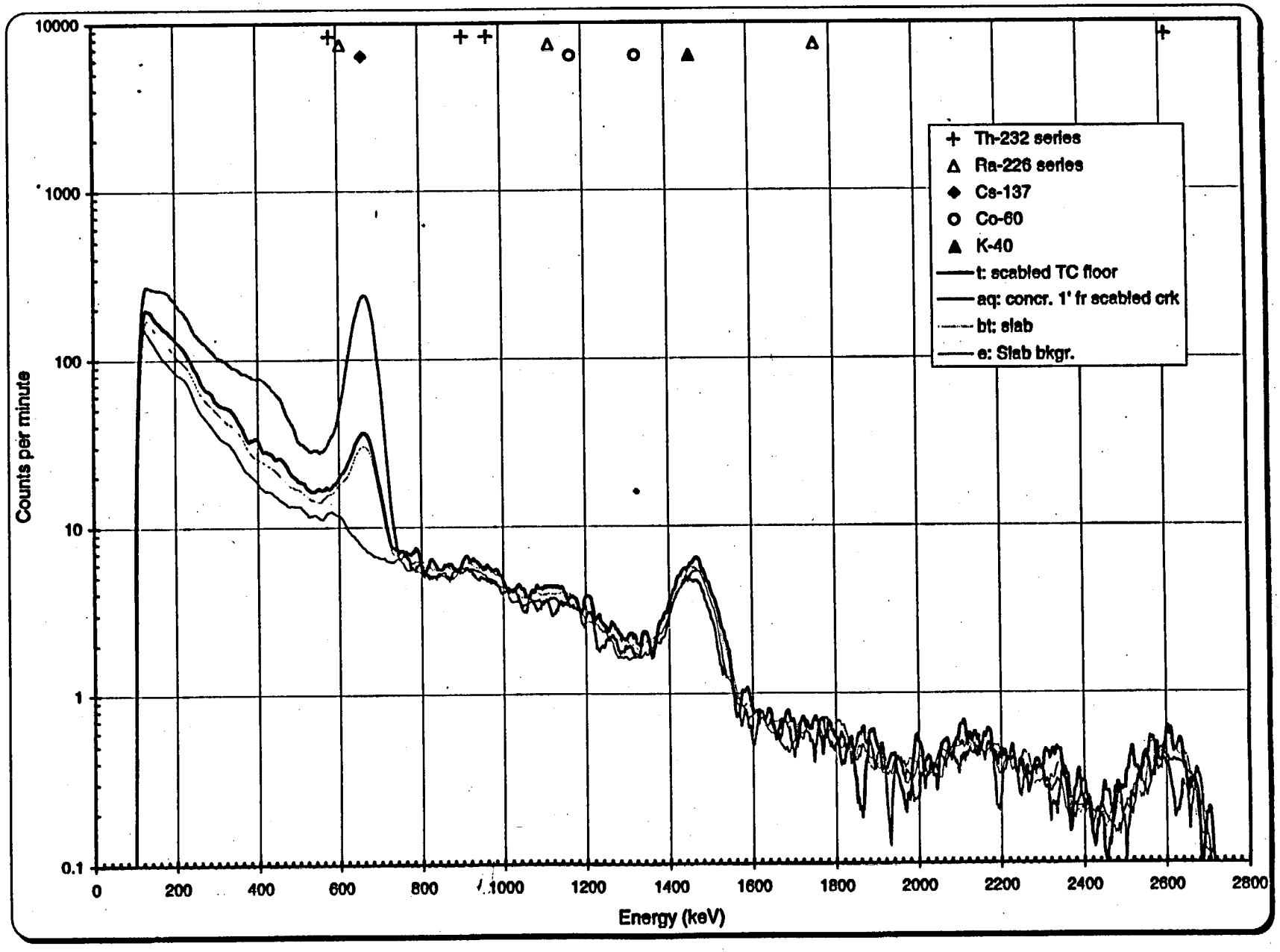
4-16 Chart 7


Th-232 series
Ra-226 series
Cs-137
Co-60
K-40
e: Slab bkgr.
ab: Hole2: 6" deep
am: scabled crk TC lab
v: Comm'l Inspect. Svc. Conf.Rm.
Counts per minute
10000
1000
100
10
1
0.1
0
200
400
600
800
1000
1200
1400
1600
1800
2000
2200
2400
2600
2800
Energy (keV)

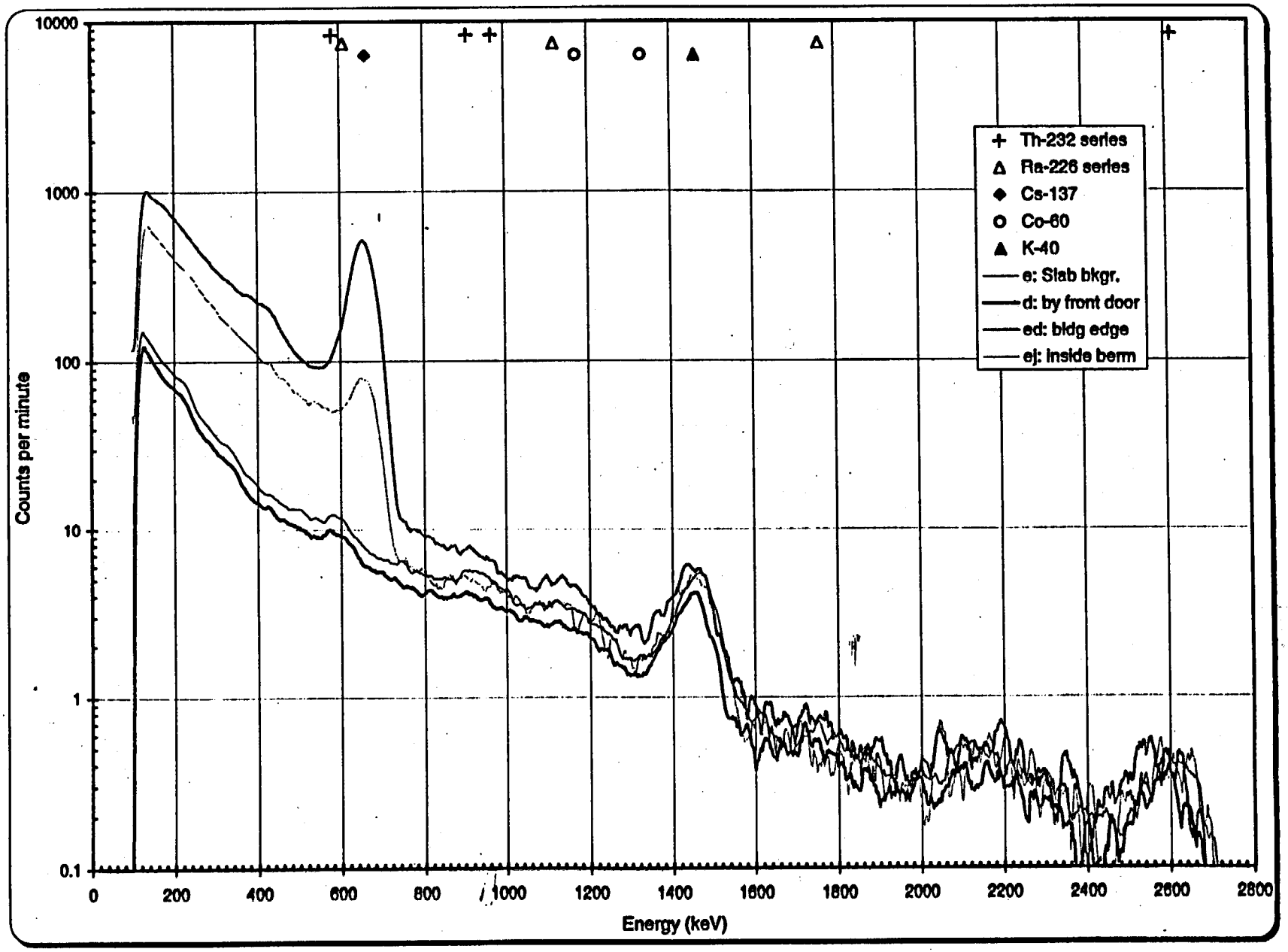
4-16 Chart 8


Counts per minute
10000
1000
100
10
1
0.1
0
200
400
600
800
1000
1200
1400
1600
1800
2000
2200
2400
2600
2800
Energy (keV)
Th-232 series
Ra-226 series
Cs-137
Co-60
K-40
e: Slab bkgr.
y: W.QA.lab tile
an: QA Lab tile
x: QA Lab tile

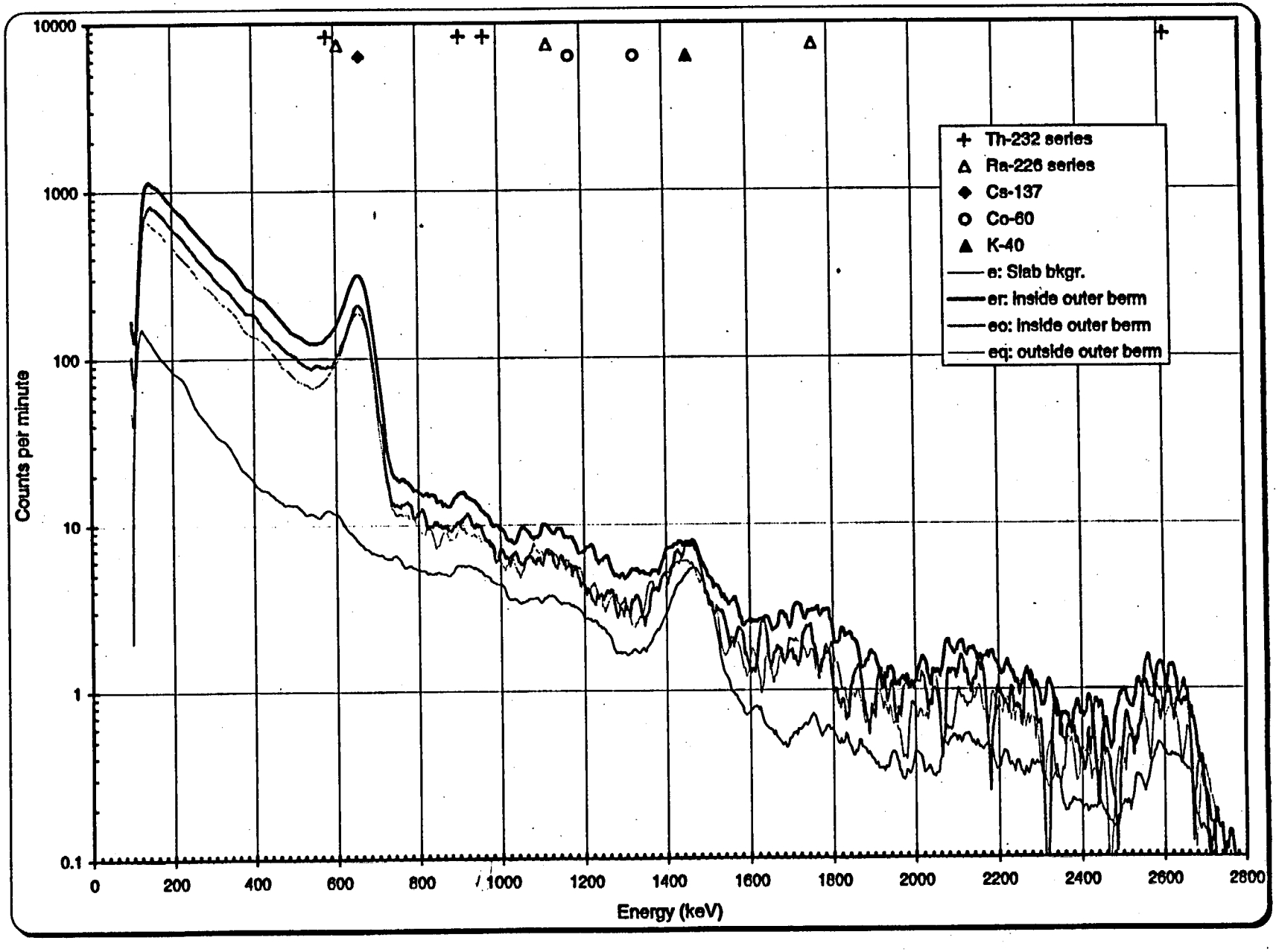
4-16 Chart 9


Counts per minute
10000
1000
100
10
1
0.1
0
200
400
600
800
1000
1200
1400
1600
1800
2000
2200
2400
2600
2800
Energy (keV)
Th-232 series
Ra-226 series
Cs-137
Co-60
K-40
t: scabled TC floor
aq: concr. 1' fr scabled crk
bt: slab
e: Slab bkgr.

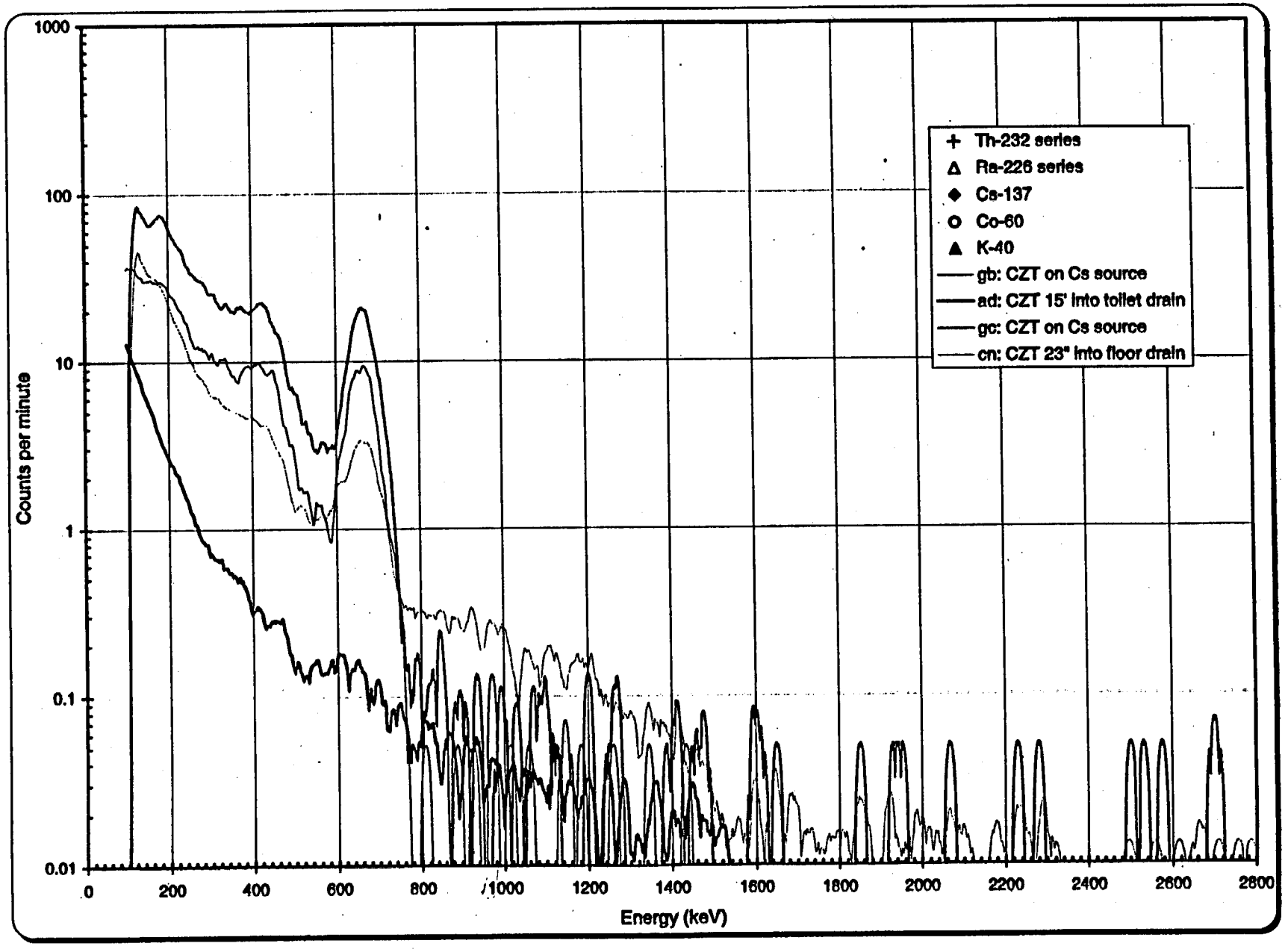
4-16 Chart 10


Th-232 series
Ra-226 series
Cs-137
Co-60
K-40
e: Slab bkgr.
d: by front door
ed: bldg edge
ej: inside berm
Counts per minute
10000
1000
100
10
1
0.1
0
200
400
600
800
1000
1200
1400
1600
1800
2000
2200
2400
2600
2800
Energy (keV)

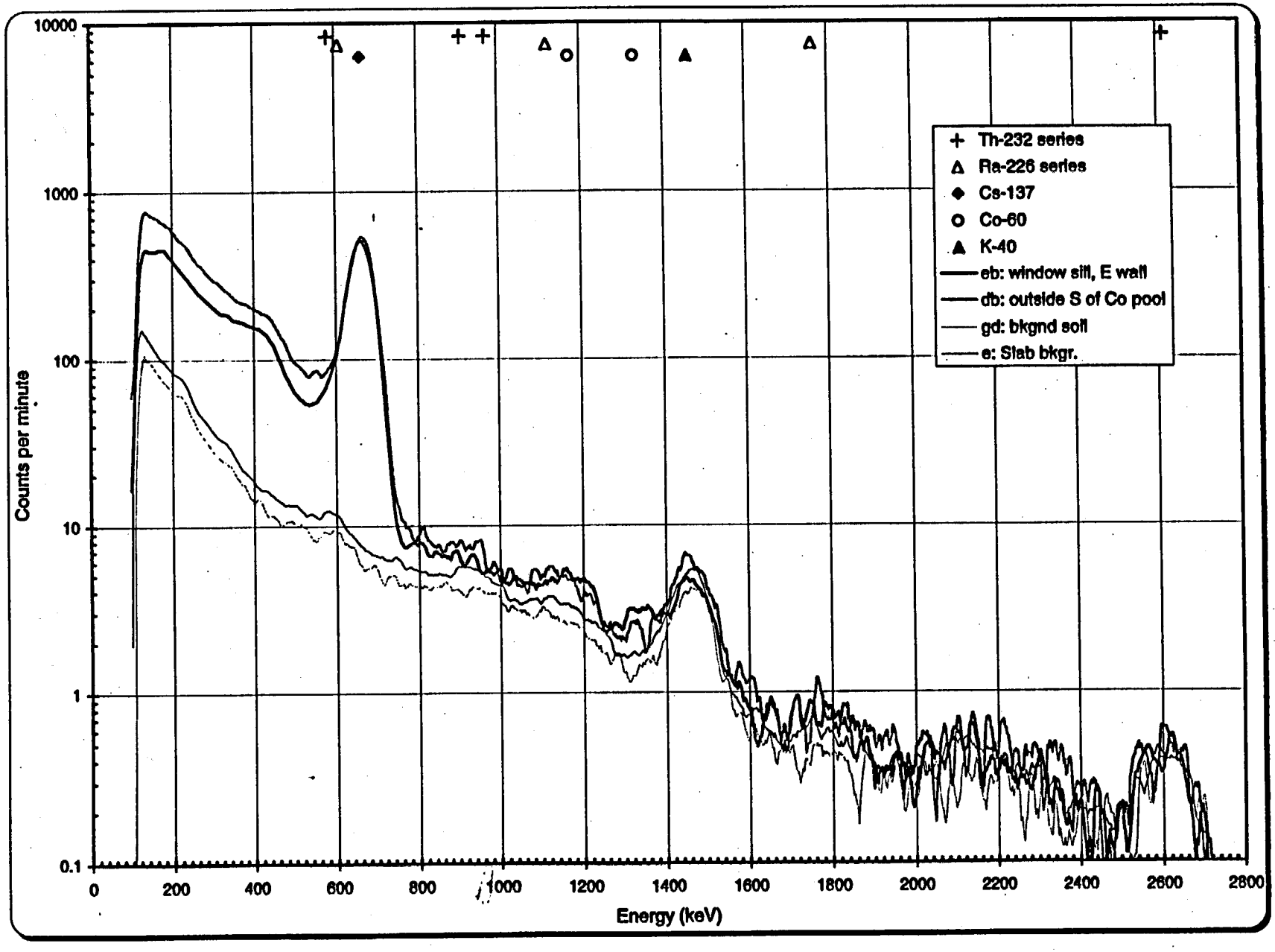
4-17 Chart 7


Th-232 series
Ra-226 series
Cs-137
Co-60
K-40
e: Slab bkgr.
er: inside outer berm
eo: inside outer berm
eq: outside outer berm
Counts per minute
Energy (keV)
10000
1000
100
10
1
0.1
0
200
400
600
800
1000
1200
1400
1600
1800
2000
2200
2400
2600
2800

4-17 Chart 8


Th-232 series
Ra-226 series
Cs-137
Co-60
K-40
gb: CZT on Cs source
ad: CZT 15' into toilet drain
gc: CZT on Cs source
cn: CZT 23" into floor drain
Counts per minute
1000
100
10
1
0.1
0.01
0
200
400
600
800
1000
1200
1400
1600
1800
2000
2200
2400
2600
2800
Energy (keV)

4-17 Chart 9


Th-232 series
Ra-226 series
Cs-137
Co-60
K-40
eb: window sill, E wall
db: outside S of Co pool
gd: bkgnd soil
e: Slab bkgr.
Counts per minute
10000
1000
100
10
1
0.1
0
200
400
600
800
1000
1200
1400
1600
1800
2000
2200
2400
2600
2800
Energy (keV)

4-17 Chart 10

Appendix D

Bound as Separate Volume