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REPORT OF SPECTRAL GAMMA RAY SURVEYS ACQUIRED FOR
THE 200-UP-2 PROJECT

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Report of Spectral Gamma-Ray Surveys Acquired for the 200-UP-2 Project

S. E. Kos

Westinghouse Hanford Company, Richland, WA 99352

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Abstract: Ten boreholes were logged with the high-resolution, high-purity germanium (HPGe) passive gamma-ray tool, Radionuclide Logging System (RLS), for the 200-UP-2 project. The surveys were acquired during the period September, 1993 to March, 1994. All of the surveys identified the presence of gamma-emitting man-made radionuclides in the sediments surrounding the boreholes. In all of the wells, contamination occurred at or very near ground surface.

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TERMS

HPGe	high-purity germanium
KUT	potassium, uranium, and thorium
RLS	Radionuclide Logging System
SCA	surface contamination area

**REPORT OF SPECTRAL GAMMA-RAY SURVEYS
ACQUIRED FOR THE 200-UP-2 PROJECT**

1.0 INTRODUCTION

Logging with the high-resolution, high-purity germanium (HPGe) passive spectral gamma-ray radionuclide logging system (RLS) has been completed for 10 boreholes associated with the 200-UP-2 Project. The surveys were acquired during the period from September 1993 to March 1994. Table 1 summarizes the information determined from the surveys, including the completion date of the final survey, maximum survey depth, and radionuclides identified.

The report describes only the survey results for each borehole logged. Details regarding equipment configuration, calibration, logging procedures, casing and water correction factors, spectra analysis software, and data management have been excluded. These topics are covered in the papers cited at the end of this report. Appendix A describes the RLS and evaluates the limitations of the radioelement analyses.

The objectives of the borehole surveys were to identify the presence and species of synthetic gamma-ray-emitting radionuclides and their relative activity levels and to aid in subsurface stratigraphic correlation. The plots of the decay activities (concentrations) versus depth for the synthetic and natural radionuclides are presented for each survey. Decay activities are reported in picocuries per gram (pCi/g) of sample. The borehole survey reports, log headers, and plots for each well surveyed are provided in Appendix B. The borehole data packages are provided in Appendix C.

Metric measurements have not been used in this report. Conversions from inch/pound to metric units are provided in Appendix D.

1-1. Borehole Survey Summary.

Well	Date Survey Completed	Maximum Survey Depth (ft)	¹³⁷ Cs	⁶⁰ Co	¹⁵² Eu	¹⁵⁴ Eu	²³⁵ U	²³⁸ U
299-W19-2	Feb 09, 1994	239.5	X					
299-W19-70	Feb 07, 1994	81.5	X			X		X
299-W19-71	Feb 02, 1994	79.5	X				X	X
299-W19-94	Dec 10, 1993	197.0	X			X	X	X
299-W19-95	Sep 21, 1994	179.5	X					
299-W19-96	Jan 12, 1994	175.5	X	X	X	X	X	X
299-W19-97	Sep 23, 1993	176.5	X					
299-W19-98	Mar 23, 1994	192.5	X	X		X		
299-W22-78	Nov 04, 1993	233.5	X				X	X
299-W23-231	Mar 23, 1994	140.0	X					

2.0 LOCATION

All the boreholes drilled and logged in support of the 200-UP-2 Project were located in or around facilities associated with former U-Plant operations. Except for wells 299-W19-2, 299-W19-70, and 299-W19-71, which were preexisting wells, all boreholes were drilled specifically to acquire characterization data for the 200-UP-2 Project. The borings completed during the 200-UP-2 drilling activities have been backfilled and abandoned. All borings/wells surveyed for the 200-UP-2 project are referred to as boreholes. The boreholes were located as follows:

^ 299-W19-2	U-8 Crib
^ 299-W19-70	U-8 Crib
^ 299-W19-71	U-8 Crib
^ 299-W19-94	U-8 Crib
^ 299-W19-95	South of the U-1 Crib
^ 299-W19-96	U-1 Crib
^ 299-W19-97	North of the U-1 Crib
• 299-W19-98	U-4A Reverse well and French drain
^ 299-W22-78	U-12 Crib
^ 299-W23-231	U-10 Pond.

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3.0 LOGGING PARAMETERS

Borehole surveys were conducted in single casing strings in all boreholes. Short casing overlaps were surveyed, usually at the beginning of the second, third, or subsequent surveys within intervals logged at the end of the previous survey. The overlaps were conducted to verify depth control and to provide profile characteristics that aided in combining the individual surveys into a single survey at the completion of drilling. In December 1993, in accordance with revision to the borehole logging procedure, repeat sections of 2.5 ft were logged at the conclusion of each survey to verify equipment performance. These data are included on the plots.

All the data were acquired in the move-stop-acquire mode; stationary measurements were acquired every 0.5 ft in depth throughout the borehole. The acquisition time varied from 80 to 180 seconds real time. The longer acquisition time was applied when logging through thicker casing to account for the attenuating effects of the casing on gamma rays. Stationary measurements of 300 seconds real time were acquired in several boreholes to verify data.

Most of the casing used during borehole drilling was threaded joint carbon steel casing with a wall thickness of 0.5 in. The maximum correction factor determined during calibration of the RLS system is for casing with a wall thickness of 0.4 in. This is the maximum casing factor applied during the analyses of the data, and therefore the computed activities are underestimated.

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4.0 RESULTS

Cesium (^{137}Cs) was detected in all boreholes logged at or very near ground surface. ^{137}Cs was present in intermittent low concentrations as seen in borehole 299-W19-2, and in thick zones of high concentrations as seen in boreholes 299-W19-70, 299-W19-94, 299-W19-96, and 299-W19-98. In the intervals of high concentrations, the decay activity of ^{137}Cs saturated the detector and no information could be processed by the RLS system. As the detector recovered from saturation, radionuclides other than ^{137}Cs , such as the europium isotopes $^{152/154}\text{Eu}$ and the uranium isotopes $^{235/238}\text{U}$, were immediately identified. The first presence of these radionuclides cannot definitively be determined because it occurred in the saturation zone.

Cobalt (^{60}Co) is identified by two almost equally intense peaks at 1,173 and 1,333 keV, and was identified in boreholes 299-W19-96 and 299-W19-98. In borehole 299-W19-96 it occurred with ^{137}Cs , $^{152/154}\text{Eu}$ and $^{235/238}\text{U}$, and in borehole 299-W19-98 it occurred with ^{137}Cs and ^{154}Eu .

Europium (^{152}Eu) was identified in borehole 299-W19-96. It occurred as a thin zone of low activity within a thicker zone of higher activity ^{154}Eu . Europium (^{154}Eu) was identified in boreholes 299-W19-70, 299-W19-94, 299-W19-96, and 299-W19-98.

Uranium (^{235}U) was identified in boreholes 299-W19-71, 299-W19-94, 299-W19-96, 299-W22-78. In all occurrences it was found with ^{238}U , but at much lower concentrations and within the ^{238}U zones. ^{235}U is more difficult to identify than ^{238}U because it is identified by a gamma-ray photo peak at 186 keV. An activity of ^{137}Cs above 20 pCi/g will mask the 186 keV peak. Uranium (^{238}U) was detected in boreholes 299-W19-70, 299-W19-71, 299-W19-94, 299-W19-96, and 299-W22-78. The ^{238}U identified is probably related to U Plant operations and should not be confused with naturally occurring ^{238}U . Natural ^{238}U will be in secular equilibrium with all its daughter products. The ^{238}U radionuclide identified in these wells was not in secular equilibrium because the daughters below radium (^{226}Ra) were not identified on the gamma-ray spectra.

The activities of the naturally occurring radionuclides potassium, uranium, and thorium (KUT) were typical for Hanford Site sediments. The KUT activities have variations in the Hanford Site sediments as follows:

• Potassium	8-20 pCi/g
• Uranium	0.2-3 pCi/g
• Thorium	0.2-2 pCi/g.

An exception occurred during surveys conducted at boreholes 299-W19-94 and 299-W19-97. Elevated uranium activities were observed for data collected during days of low barometric pressure when radon was allowed to vent from the bottom of the well upward through the casing. The radon, a daughter of uranium, contributed to an increased calculated activity of uranium for the sediments surrounding the borehole where the radon was encountered.

The total gamma-ray plot is the count rate observed for all the gamma rays detected. No correction factors for casing or borehole fluids are

applied. The total gamma-ray profile is useful in determining casing overlap or casing shoe location as a decreased gamma-ray count rate is observed because of the attenuating effects of the metal on gamma rays. The casing shoe, because of its slightly greater wall thickness, is often easily identified on the total gamma-ray profile log by decreased count rate. Conditions of uncased sediments such as an open hole or the bottom of the borehole are indicated as an increase in the gamma-ray count rate. The casing of the logging tool has been shortened, allowing the detector to survey within 0.5 ft from the bottom of the borehole (previously within 2.5 ft). The change resulted in an increased count rate as the detector approached the bottom of the borehole.

The total gamma-ray profile is a useful plot for identifying gross lithologic features and can be somewhat correlated with the borehole lithology logs. Because the total gamma profile usually duplicates other radionuclide profiles, correlations between lithology and contamination can often be made. Observations made in reviewing the borehole lithology reports are related in the following paragraphs.

Borehole 299-W19-94

The highest concentration of contamination occurs immediately beneath the crib gravels at 31 ft in sand sediments. Contamination from 45 to 80 ft is related to lenses of very fine sand, and at 85 to 90 ft is related to increasing silt content. Narrow peaks at 130 and 140 ft are silt lenses. The broad gamma-ray peak at 160 to 185 ft is silt of the early Palouse unit. The sharp contact with caliche results in a sharp decrease in gamma activity at 188 ft.

Borehole 299-W19-95

The ^{137}Cs contamination from 0 to 4 ft occurs in sand, possibly contamination deposited at the surface and driven downward by weather. The silt lensing observed during drilling is not well defined on the total gamma-ray profile, except for the thick silt from 150 to 165 ft. The caliche contact at 165 ft result in decreased gamma-ray activity. The count rate increase at 170 ft as the sand with gravel was encountered.

Borehole 299-W19-96

The most intensive activity occurs within the crib structure and immediately below. Deeper contamination at 45 and 55 ft is probably related to sand and silt interbedding, while the uranium contamination at 168 ft occurs at the top of the caliche horizon. The broad, total gamma-ray peak at 150 to 167 ft marks the early Palouse unit. The sharp contact with the caliche horizon results in decreased total gamma-ray activity, then an increase at the sands and sandy gravels of the upper Ringold.

Borehole 299-W19-97

^{137}Cs contamination occurs near the surface in gravelly sand. Sandy silts are encountered at 35 to 45 ft indicated by sharp gamma-ray peaks. No correlation is observed between lithology logs and total gamma-ray profiles until 155 to 169 ft, where the broad gamma-ray peak identifies the early

Palouse silt and sandy silt unit. The gamma-ray activity decreases at 168 ft at the contact with the caliche horizon, then increases as the contact with the upper Ringold gravels is encountered.

Borehole 299-W19-98

The first zone of contamination from 5 to 15 ft occurs in sandy gravel. A thicker zone occurs from 40 to 75 ft in gravelly sand, and sand with lenses of very fine sand. There are no distinguishable correlations between the lithology logs and total gamma-ray profiles until the contact with sand and silty sand at 170 ft. The count rate decreases abruptly at 180 ft at the contact with the caliche horizon, then increases as sands and sandy gravels are encountered.

Borehole 299-W22-78

Uranium contamination is identified at 20 ft in silt and sand sediments. For the most part, the sediments are sand to a depth of 158 ft when interbeds of silt are observed. Variations of sand and silty sand are encountered throughout the total depth of the borehole. Caliche is encountered at 186 ft.

Borehole 299-W23-231

¹³⁷Cs contamination was identified at the surface to 10 ft. The first 4 ft of sediment is fill material that was placed over the contaminated U-10 pond surface. Sands with silt interbeds were encountered to 114 ft where a sand/silt unit is identified by a broad gamma-ray peak. At 137 ft a sharp decrease in the gamma-ray activity responds to the sharp contact with the caliche. An increase in the gamma-ray activity is observed at 139 ft as the gravels of the upper Ringold are encountered.

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5.0 CONCLUSIONS

¹³⁷Cs contamination is widespread throughout the area of the 200-UP-2 Project; it was detected in all boreholes surveyed. Some boreholes were located outside fenced surface contamination areas (SCAs).

The U-1 crib area was stabilized over the past few years with clean fill material and was then revegetated. Near-surface occurrence of ¹³⁷Cs is representative of the previous ground surface, which was contaminated and located within a fenced SCA.

¹³⁷Cs was detected at the surface in borehole 299-W19-95, which was not located in an SCA. The activity was 0.3 pCi/g, which is below the detection limits of health physics technology (HPT) field instruments. ¹³⁷Cs contamination at low activity is widespread throughout the 200 East and 200 West Areas. The most intense activity was observed in or immediately below crib gravels. Because the detector was saturated with ¹³⁷Cs activity and became nonresponsive, the "first" presence of other contaminants could not be determined.

The presence of fine sediments, textural features such as graded and cross bedding, clastic dikes, and caliche are associated with the location of contamination. These features are subtle and often cannot be identified from the total gamma-ray or natural radionuclide surveys.

Gross features such as well-developed silt lenses, Palouse sediments, and sharp caliche contacts can be identified from the total gamma-ray survey and can be correlated between boreholes across the 200-UP-2 area.

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6.0 BIBLIOGRAPHY

- Brodeur, J. R., C. J. Koizumi, W. H. Ulbricht, and R. K. Price, 1991, *Calibration of a High-Resolution Passive Gamma-Ray Logging System for Nuclear Waste Assessment*, WHC-SA-1175-FP, Westinghouse Hanford Company, Richland, Washington.
- Brodeur, J. R., C. J. Koizumi, R. K. Price, and R. D. Wilson, 1992, *Gamma-Ray Logging results for the 200 Aggregate Area Management Study*, WHC-SD-EN-TI-021, Westinghouse Hanford Company, Richland, Washington.
- Koizumi, C. J., J. R. Brodeur, W. H. Ulbricht, and R. K. Price, 1991, *Calibration of the RLS HPGe Spectral Gamma-Ray Logging System*, WHC-EP-0464, Westinghouse Hanford Company, Richland, Washington.
- Koizumi, C. J., R. K. Price, 1992, *Calibration of the Radionuclide Logging System Germanium Detector*, WHC-SD-EN-TRP-004, Rev. 0, Westinghouse Hanford Company, Richland, Washington.
- Koizumi, C. J., R. K. Price, and R. D. Wilson, 1992, *Calibration of the RLS System for 200 Aggregate Area Management Study Screening Measurements*, WHC-SD-EN-TRP-001, Westinghouse Hanford Company, Richland, Washington.
- WHC-CM-7-7, *Environmental Investigations and Site Characterization Manual*, Westinghouse Hanford Company, Richland, Washington.

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APPENDIX A
SYSTEM DESCRIPTION

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APPENDIX A

SYSTEM DESCRIPTION

HPGe Logging System

The Westinghouse Hanford Company (WHC) radionuclide logging system (RLS) uses a high-purity germanium (HPGe) passive gamma-ray detector. Gamma-ray interactions with the HPGe crystal yield very sharp electrical charge pulses corresponding to energies of the impinging gamma ray resulting in excellent energy resolution. Precise energy resolution permits absolute identification of the gamma-emitting radionuclides and, with proper calibration, an accurate assay of their decay activity.

The HPGe detector is housed in the logging tool along with the high-voltage power supply, preamplifiers, and a cryogenic system to maintain the detector at liquid nitrogen temperatures. The nitrogen is vented to the atmosphere through a conduit in the logging cable.

The surface components of the system include gamma-ray spectroscopy amplifiers and counting electronics interfaced with a computer. The computer controls the hydraulic winch during logging and maintains accurate positioning and movement of the detector in the borehole.

System and Radioelement Analyses Limitations

Several limitations of the borehole survey equipment, calibration, and data acquisition objectives are described below.

The logging cable equipped on the RLS was specifically designed for the system. It suspends the detector in the well, conducts power to and receives electrical signals from the detector, and provides the conduit for venting the liquid nitrogen component of the detector. Errors in the depth measuring system of the RLS are mainly related to cable stretch, cable and sheave wheel contact, and electronic encoding components. The recorded depth of the detector is estimated to be accurate to 98.5 percent, with a precision (repeatability) of 99 percent. Comparisons with drilling measurements, other logging equipment, and secondary measurement systems have verified the accuracy.

Borehole environment correction factors have been determined for steel casing and water in the borehole. Correction factors for other borehole configurations have not been determined. Other configurations for which correction factors have not been determined, but which may be encountered at the Hanford Site include grout between multiple casing strings; formation seals containing grout, bentonite, or sand behind the casing; and drilling mud present in the borehole while logging. The calculated decay activities will be underestimated with these configurations.

Energy-dependent casing corrections have been established for steel casing thicknesses up to 0.40 in. Corrections for casings of different materials and/or cumulative thicknesses of greater than 0.40 in. have not been determined and therefore cannot be used in the data reduction process.

The calibration data were recorded with the detector centered in calibration zones that are uniform in density, water content, and gamma-ray source material. The dimensions of each zone are large enough that the detector always responded as though surrounded by a medium of infinite extent. Therefore, the use of the calibration results to calculate nuclide activity carries the assumption that the nuclide in the logged formation are also distributed in thick uniform layers.

Gamma-ray sources are not normally distributed in the earth in thick uniform layers. Source inhomogeneities are reflected to some degree by the fluctuations in the amplitudes of the log traces. A factor called the vertical spacial resolution quantifies the correlation between the intensity of the log fluctuation and the depth interval over which it extends and the intensity of the corresponding gamma-ray source and the thickness of the zone in which the source is embedded. The vertical spatial resolution of the RLS HPGe logging system is scheduled for investigation.

Radionuclide decay activities are determined from the net area of the gamma-ray peaks. Radionuclides that do not emit a gamma ray when they decay, such as strontium-90, will not be identified or quantified by the spectral analyses process. However, the decay of strontium-90 results in a high-energy beta particle that can excite surrounding elements to emit gamma-ray radiation that can be identified by the HPGe detector. This type of radiation is called "bremsstrahlung" radiation. A method to obtain estimates of the concentration of strontium-90 is under consideration.

APPENDIX B
BOREHOLE SURVEY DATA DESCRIPTION

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APPENDIX B

BOREHOLE SURVEY DATA DESCRIPTION

The report for each borehole survey by the radionuclide logging system (RLS) contains the following three types of information.

LOG HEADER

This form is titled "RLS Spectral Gamma-Ray Borehole Survey Log Header" and summarizes the borehole and survey information. The form contains the project name, borehole number, coordinates, and elevation and a description of the borehole environment, including casing size, wall thickness, depths, and water level (if present). This information is used during data reduction.

RLS survey information is presented and includes logging engineers' names, survey dates, file names, logging mode, and survey depths.

Data reduction information, including calibration date and report number, analyst name and analysis date, is provided. A line is included for notes and synthetic radionuclide identification.

RADIONUCLIDE PLOTS

The plots of individual radionuclide activity responses versus depth are titled "RLS Spectral Gamma-Ray Borehole Survey." They are contained on one or more pages depending on the number of radionuclide species encountered and/or depth of the borehole. A uniform depth scale of 20 ft/in. is used for all plots. Four plot tracks are usually presented for uniformity, however improvements in plotting capabilities are forthcoming.

The "Total Gamma" is the count rate for all gamma rays detected by the RLS detector with no discrimination of the source of gamma-ray energy. The total gamma is equivalent to the gross gamma log used at the Hanford Site for many years. The count rate data values are plotted on two linear scales. The scale of the narrow line is usually 0 to 1000 counts per second (c/s); the scale of the wide line is 0 to 100,000 c/s. An expanded total gamma plot is provided with the 200-UP-1 data that has a single scale of 0 to 200 c/s.

Generally the natural radionuclides, potassium, uranium, and thorium (KUT) will be plotted separately.

The remaining plot tracks contain the results of the spectra analyses. The computed activity values are generally plotted on two linear scales and, similar to the total gamma plot, the thin-line scale is indicated at the top of the plot, the wide-line scale at the bottom.

**RADIONUCLIDE LOGGING SYSTEM (RLS)
BOREHOLE SURVEY REPORT**

The RLS Borehole Survey Report describes the borehole conditions, unusual logging conditions, and possible limitations with the data and/or results. The species of radionuclides encountered, as well as their depth ranges and maximum activities, are reported.

APPENDIX C
BOREHOLE DATA PACKAGES

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Westinghouse Hanford Company

RLS Spectral Gamma-Ray Borehole Survey Log Header

Project: 200-UP-2

Borehole	<u>299-W19-02</u>		
Coordinates	<u>36849.0 N</u>	<u>-73000.0W</u>	Feet (Hanford System)
Elevation	<u>694.04</u>	ft	Top of casing

Borehole Environment Information

Borehole liquid depth <u>None</u> (ft) from zero (0.0) depth reference of log			
Casing size (in.)	Casing thickness (in.)	Top depth (ft)	Base depth (ft)
8	0.375	0.0	285

RLS Passive Spectral Gamma Survey Information

Logging Engineers <u>R. V. Cram</u> <u>J. P. Kiesler</u>			
Log depth reference at zero (0.0) depth is <u>ground level</u>			
Log Date	Archive file names	Log mode speed	Depth interval (ft) Top Base Incr
Feb 08, 1994	H2W19002\A518	MSA 80sec RT	0.0 119.5 0.5
Feb 09, 1994	H2W19002\A519	MSA 80sec RT	118.5 239.5 0.5

MSA: Move-Stop-Acquire

RT: Real time

Calibration and Analysis Information

RLS Calibration Date: Nov. 21, 1991	
Calibration Report: WHC-SD-EN-TRP-001	
Analyst Names: <u>S. E. Kos</u>	<u>R. K. Price</u>
Analysis Date: <u>Dec 09, 1993</u>	
Analysis Notes: <u>Single casing</u>	
Radionuclides Identified: <u>Cs-137</u>	

RLS Spectral Gamma-Ray Borehole Survey

Project: 200-UP-2

Log Date: Feb 09, 1994

Borehole: 299-W19-2

Anal Date: Feb 16, 1994

RLS Spectral Gamma-Ray Borehole Survey

Project: 200-UP-2

Log Date: Feb 09, 1994

Borehole: 299-W19-2

Anal Date: Feb 16, 1994

RLS Spectral Gamma-Ray Borehole Survey

Project: 200-UP-2

Log Date: Feb 09, 1994

Borehole: 299-W19-2

Analysis Date: Feb 16, 1994

RLS Borehole Survey Report

Borehole: 299-W19-2

Casing	Depth: 0.0' - 285'	Size: 8"	Thickness: 0.375"
Water	237.6'		
Survey	Interval: 0.0' - 119.5'	Date: Feb 08, 1994	
	118.5' - 239.5'	Feb 09, 1994	

General Notes:

The RLS survey of well 299-W19-2 was acquired in single 8-inch-diameter casing at an acquisition time of 80 seconds RT. The well is located at the U-8 crib in the 200-W area.

The plot of the naturally occurring radionuclides potassium, uranium and thorium shows normal Hanford sediment concentrations throughout the surveyed interval. Repeat sections were conducted in each survey and are included on the plots.

Man-made Radionuclides:

Cs-137 was identified intermittently from 1.5'-41.0', and at 115.0'. The maximum thickness observed was 1.0'; all activity was less than 1 pCi/g.

Westinghouse Hanford Company
RLS Spectral Gamma-Ray Borehole Survey Log Header

Project: 200-UP-2

Borehole	<u>299-W19-70</u>		
Coordinates	<u>36860.0 N</u>	<u>-73100.0 W</u>	Feet (Hanford System)
Elevation	<u>692.0</u>	ft	Top of casing

Borehole Environment Information

Borehole liquid depth <u>None</u> (ft) from zero (0.0) depth reference of log			
Casing size (in.)	Casing thickness (in.)	Top depth (ft)	Base depth (ft)
8	0.375	0.0	105.0

RLS Passive Spectral Gamma Survey Information

Logging Engineers <u>R. Cram</u> <u>J. Kiesler</u>			
Log depth reference at zero (0.0) depth is <u>ground level</u>			
Log Date	Archive file names	Log mode speed	Depth interval (ft) Top Base Incr
Feb 07, 1994	H2W19070\A517	MSA 80sec RT	0.0 81.5 0.5

MSA: Move Stop Acquire
RT: Real Time

Calibration and Analysis Information

RLS Calibration Date: Nov. 21, 1991	
Calibration Report: WHC-SD-EN-TRP-001	
Analyst Names: <u>S. E. Kos</u>	<u>R. K. Price</u>
Analysis Date: <u>Feb 10, 1994</u>	
Analysis Notes: <u>Detector saturated 30.0 to 35.5 feet</u>	
Radionuclides Identified: <u>Cs-137, U-238, EU-154</u>	

RLS Spectral Gamma-Ray Borehole Survey

Project: 200-UP-2

Log Date : Feb 07, 1994

Borehole: 299-W19-70

Anal Date: Feb 10, 1994

RLS Spectral Gamma-Ray Borehole Survey

Project: 200-UP-2

Log Date: Feb 07, 1994

Borehole: 299-W19-70

Anal. Date: Feb 10, 1994

RLS Spectral Gamma-Ray Borehole Survey

Project: 200-UP-2
Borehole: 299-W19-70

Log Date: Feb 07, 1994
Anal. Date: Feb 10, 1994

RLS Borehole Survey Report

Borehole: 299-W19-70

Casing	Depth: 0.0' - 105'	Size: 8"	Thickness: 0.375"
Water	None		
Survey	Interval: 0.0' - 81.5'	Date: Feb 10, 1994	

General Notes:

The RLS survey of well 299-W19-71 was acquired in single 8-inch-diameter casing at an acquisition time of 80 seconds RT. The well is located at the U-8 crib in the 200-W area. The Hanford Wells directory reports the depth of the well at 105', however the pre-survey swab would not pass 81.6'.

The plot of the naturally occurring radionuclides potassium, uranium and thorium shows normal Hanford sediment concentrations throughout the surveyed interval. Excessive variation in the potassium concentration between 35.0 to 37.0 feet is due to the high count rate encountered in this interval. A repeat section was conducted from 78.5'-81.0', and is included on the plot.

The detector was saturated in the interval 30.0'-34.0'.

Man-made Radionuclides:

Cs-137 was identified in the intervals 2.5'-24.5' (intermittently), and 25.5'-81.5', the maximum survey depth. Activity exceeded 200 pCi/g from 29.0'-66.5', and from 69.5'-70.0'. The maximum activity of 16156 pCi/g was observed at 34.0' at the base of the saturation zone.

Co-60 was included in the analyses but was not identified. The Co-60 plot track is included on the plot for uniformity in presentation.

U-235 was included in the analyses but was not identified. The most prominent energy peak for U-235 at 186 KeV is unidentifiable in the spectrum when the Cs-137 concentration is greater than 20 pCi/g. The U-235 plot track is included on the plot for uniformity in presentation.

U-238 was identified in the interval 36.5'-44.5', intermittently from 47.0'-59.5', from 61.5'-67.0', intermittently from 72.0'-77.5', and from 78.5'-81.5', the maximum survey depth. Activity exceeded 200 pCi/g from 36.5'-38.5'. The maximum activity of 1806 pCi/g was observed at 37.0'.

Eu-154 was identified at 34.5', and from 36.5'-39.5'. The maximum activity detected was 12.1 pCi/g at 34.5', immediately below the base of the zone of saturation.

Eu-152 was included in the analysis but was not identified. The Eu-152 plot track is included on the plot for uniformity in presentation.

Westinghouse Hanford Company

RLS Spectral Gamma-Ray Borehole Survey Log Header

Project: 200-UP-2

Borehole	<u>299-W19-71</u>		
Coordinates	<u>36800 N</u>	<u>73100 W</u>	Feet (Hanford System)
Elevation	<u>692</u> ft		Top of casing

Borehole Environment Information

Borehole liquid depth <u>None</u> (ft) from zero (0.0) depth reference of log			
Casing size (in.)	Casing thickness (in.)	Top depth (ft)	Base depth (ft)
8	0.375	0.0	107.0

RLS Passive Spectral Gamma Survey Information

Logging Engineers <u>R. Cram</u> <u>J. Kiesler</u>			
Log depth reference at zero (0.0) depth is <u>ground level</u>			
Log Date	Archive file names	Log mode speed	Depth interval (ft) Top Base Incr
Feb 02, 1994	H2W19071\A514	MSA 80sec RT	0.0 79.5 0.5

MSA: Move Stop Acquire
RT: Real Time

Calibration and Analysis Information

RLS Calibration Date: Nov. 21, 1991	
Calibration Report: WHC-SD-EN-TRP-001	
Analyst Names: <u>S. E. Kos</u>	<u>R. K. Price</u>
Analysis Date: <u>Feb 04, 1994</u>	
Analysis Notes: <u>Detector saturated 30.0-37.0 feet</u>	
Radionuclides Identified: <u>Cs-137, U-235, U-238</u>	

RLS Spectral Gamma-Ray Borehole Survey

Project: 200-UP-2

Log Date : Feb 02, 1994

Borehole: 299-W19-71

Anal Date: Feb 04, 1994

RLS Spectral Gamma-Ray Borehole Survey

Project: 200-UP-2

Log Date: Feb 02, 1994

Borehole: 299-W19-71

Anal. Date: Feb 04, 1994

RLS Borehole Survey Report

Borehole: 299-W19-71

Casing	Depth: 0.0' - 107'	Size: 8"	Thickness: 0.375"
Water	None		
Survey	Interval: 0.0' - 79.5'	Date: Feb 02, 1994	

General Notes:

The RLS survey of well 299-W19-71 was acquired in single 8-inch-diameter casing at an acquisition time of 80 seconds RT. The well is located at the U-8 crib in the 200-W area.

The Hanford Wells directory reports the depth of the well at 107', however the pre-survey swab would not pass 78.6'. The plot of the naturally occurring radionuclides potassium, uranium and thorium shows normal Hanford sediment concentrations throughout the surveyed interval. A repeat section was conducted from 77.0'-79.5', and is included on the plot.

The detector was saturated in the interval 30.0'-37.0'.

Man-made Radionuclides:

Cs-137 was identified in the intervals 0'-7.0', 26.5'-30.0', and 36.5'-79.5', the maximum survey depth. Activity exceeded 200 pCi/g from 29.5'-30.0', and from 36.5'-47.0'. The maximum activity of >5000 pCi/g was observed at 30.0', and from 36.5' to 37.0'.

Co-60 was included in the analyses but was not identified. The Co-60 track is included on the plot for uniformity in presentation.

U-235 was identified in the intervals 48.5'-51.0', 73.5'-78.0', and at 79.0'. The maximum activity of 6.2 pCi/g was observed at 74.0'. The most prominent energy peak for U-235 at 186 KeV is unidentifiable when the CS-137 concentration is >20 pCi/g.

U-238 was identified in the intervals 37.5'-46.5', 48.0'-51.5', intermittently from 58.0'-61.0', and 73.5'-78.0'. Activity exceeded 200 pCi/g at 37.5'-38.5'. The maximum activity of 779 pCi/g was observed at 37.5', the bottom of the detector saturation zone. Detector saturation prevented observation of the initial occurrence of U-238.

Westinghouse Hanford Company

RLS Spectral Gamma-Ray Borehole Survey Log Header

Project: 200-UP-2

Borehole	<u>299-W19-94</u>			
Coordinates	<u>NA</u>	<u>N</u>	<u>NA</u>	<u>W</u>
Elevation	<u>NA</u>	ft	Top of casing	

Borehole Environment Information

Borehole liquid depth <u>None</u> (ft) from zero (0.0) depth reference of log			
Casing size (in.)	Casing thickness (in.)	Top depth (ft)	Base depth (ft)
12	0.500	0	37.62
10	0.500	0	97.56
8	0.500	0	195.42

RLS Passive Spectral Gamma Survey Information

Logging Engineers <u>R. V. Cram</u> <u>J. P. Kiesler</u>					
Log depth reference at zero (0.0) depth is <u>ground level</u>					
Log Date	Archive file names	Log mode	speed	Depth interval (ft)	
				Top	Base
Dec 10, 1993	H2W19094\A485	MSA	180sec RT	0.0	36.0
		Stat.	500sec RT	36.0	0.5
Dec 17, 1993	H2W19094\A489	MSA	180sec RT	35.0	94.5
		Stat.	500sec RT	94.5	0.5
Jan 18, 1994	H2W19094\A505	MSA	180sec RT	93.5	194.0
Jan 19, 1994	H2W19094\A506	MSA	180sec RT	190.0	197.0
		Stat.	300sec RT	197.0	0.5

MSA: Move-Stop-Acquire

RT: Real time

Calibration and Analysis Information

RLS Calibration Date: <u>Nov. 21, 1991</u>
Calibration Report: <u>WHC-SD-EN-TRP-001</u>
Analyst Names: <u>S. E. Kos</u> <u>R. K. Price</u>
Analysis Date: <u>Feb 03, 1994</u>
Analysis Notes: <u>Exceeded maximum casing correction factor</u>
Radionuclides Identified: <u>Cs-137, U-235, U-238, Eu-154</u>

RLS Spectral Gamma-Ray Borehole Survey

Project: 200-UP-2

Log Date : Jan 19, 1994

Borehole: 299-W19-94

Anal Date: Feb 02, 1994

RLS Spectral Gamma-Ray Borehole Survey

Project: 200-UP-2
Borehole: 299-W19-94

Log Date : Jan 19, 1994
Anal Date: Feb 02, 1994

RLS Spectral Gamma-Ray Borehole Survey

Project: 200-UP-2

Log Date: Jan 19, 1994

Borehole: 299-W19-94

Anal. Date: Feb 03, 1994

RLS Spectral Gamma-Ray Borehole Survey

Project: 200-UP-2
Borehole: 299-W 19-94

Log Date: Jan 19, 1994
Anal. Date: Feb 03, 1994

RLS Spectral Gamma-Ray Borehole Survey

Project: 200-UP-2

Log Date: Jan 19, 1994

Borehole: 299-W19-94

Anal. Date: Feb 03, 1994

RLS Borehole Survey ReportBorehole: 299-W19-94

Casing	Depth: 0.0' - 37.62'	Size: 12"	Thickness: 0.50"
Casing	Depth: 0.0' - 97.56'	Size: 10"	Thickness: 0.50"
	Depth: 0.0' - 195.42'	Size: 8"	Thickness: 0.50"
Water	None		
Survey	Depth: 0.0' - 36.0'	Date: Dec 10, 1993	
	Depth: 35.0' - 94.5'	Date: Dec 17, 1993	
	Depth: 93.5' - 194.0'	Date: Jan 18, 1994	
	Depth: 190.0' - 197.0'	Date: Jan 19, 1994	

General Notes:

The well was surveyed four times during drilling; each survey was conducted in a single-casing zone. The first survey spanned the interval 0.0' to 36.0' in 12-inch-diameter carbon steel casing. The second survey spanned the interval 35.0' to 94.5' in 10-inch-diameter threaded-joint carbon steel casing. The third survey spanned the interval 93.5' to 194.0' in 8-inch-diameter threaded-joint carbon steel casing. A fourth survey was necessary because the liquid nitrogen became depleted at the end of the third survey, and the equipment had to be shut down. All surveys were performed at an acquisition time of 180 seconds real time at a .5' sample interval. Stationary measurements were also acquired at 300 and 500-second acquisition times. The location of stationary measurements are noted on the log header. The detector was saturated from 30.0' to 35.5'.

The plot tracks for the naturally occurring radionuclides show the depth profile for the total gamma count rate and the radionuclides potassium, uranium and thorium. The calculated activities for the naturally occurring radionuclides for all intervals surveyed are typical for Hanford sediments.

Man-made Radionuclides:

Cesium (Cs-137) was identified from 0.0' to 99.5', and at 132.0'. The Cs-137 activity exceeded 200 pCi/g from 29.0' to 30.0', and from 35.5' to 42.5'. Cs-137 was observed immediately above and below the interval of detector saturation.

Uranium-235 was identified from 129.5' to 130.5', at 143.0' and 155.0', from 186.0' to 188.0', and at 189.5'. The maximum observed activity of 2.6 pCi/g occurred at 186.5'.

Uranium-238 was identified at 10.5', from 36.5' to 41.0', intermittently from 43.0' to 182.0', and from 184.0' to 188.5'. The maximum activity of 831 pCi/g was observed at 37.5'.

Co-60 was analyzed but was not identified. The Co-60 plot track is included for uniformity in plot presentation.

Eu-152 was analyzed but was not identified. The Eu-152 plot track is included for uniformity in plot presentation.

Eu-154 was identified from 37.5' to 40.5'. The maximum activity of 2.9 pCi/g occurred at 38.0'.

Westinghouse Hanford Company

RLS Spectral Gamma-Ray Borehole Survey Log Header

Project: 200-UP-2

Borehole	<u>299-W19-95</u>		
Coordinates	<u>NA</u>	N	<u>NA</u> W
Elevation	<u>NA</u>	ft	Top of casing

Borehole Environment Information

Borehole liquid depth <u>None</u> (ft) from zero (0.0) depth reference of log			
Casing size (in.)	Casing thickness (in.)	Top depth (ft)	Base depth (ft)
10	0.50	0	101.0
8	0.50	0	180.2

RLS Passive Spectral Gamma Survey Information

Logging Engineers <u>R. V. Cram</u> <u>S. E. Kos</u> <u>J. P. Kiesler</u>						
Log depth reference at zero (0.0) depth is <u>ground level</u>						
Log Date	Archive file names	Log mode	speed	Depth interval (ft)		
				Top	Base	Incr
Sep 13, 1993	H2W1995\A434	MSA	120sec RT	0	100.0	0.5
Sep 21, 1993	H2W1995\A436	MSA	120sec RT	99.0	179.5	0.5

MSA: Move-Stop-Acquire

RT: Real time

Calibration and Analysis Information

RLS Calibration Date: Nov. 21, 1991	
Calibration Report: WHC-SD-EN-TRP-001	
Analyst Names: <u>S. E. Kos</u>	<u>R. K. Price</u>
Analysis Date: <u>Nov 19, 1993</u>	
Analysis Notes: <u>Double casing- exceeds max. correction factor</u>	
Radionuclides Identified: <u>Cs-137</u>	

RLS Spectral Gamma-Ray Borehole Survey

Project: 200-UP-2

Log Date : Sep 21, 1993

Borehole: 299-W19-95

Anal Date: Nov 19, 1993

RLS Spectral Gamma-Ray Borehole Survey

Project: 200-UP-2

Log Date : Sep 21, 1993

Borehole: 299-W19-95

Anal Date: Nov 19, 1993

RLS Spectral Gamma-Ray Borehole Survey

Project: 200-UP-2

Log Date: Sep 21, 1993

Borehole: 299-W19-95

Analysis Date: Nov 19, 1993

RLS Borehole Survey ReportBorehole: 299-W19-95

Casing	Depth: 0.0'-101.0'	Size: 10"	Thickness: 0.50"
Casing	Depth: 0.0'-180.2'	Size: 8"	Thickness: 0.50"
Water	None		
Survey	Depth: 0.0'-100.0'	Date: Sep 13, 1993	
	Depth: 99.0'-179.5'	Date: Sep 21, 1993	

General Notes:

The well was surveyed twice during drilling; each survey was conducted in a single-casing zone. The first survey spanned the interval 0.0' to 100.0' in 10-inch-diameter threaded-joint carbon steel casing. The second survey spanned the interval 99.0' to 179.5' in 8-inch-diameter threaded-joint carbon steel casing. There was no fill material between the casing strings. The thickness of each casing was .500 inch, exceeding the maximum correction factor. A casing overlap during the second survey for the interval 99.0' to 101.0' resulted in a lower calculated activity than actually present. All measurements were acquired at 120 seconds real time.

The plot tracks for the naturally occurring radionuclides shows the depth profile for the total gamma count rate and the radionuclides potassium, uranium and thorium. The maximum total gamma count rate of slightly above 100 cps (111cps at 164.5') occurs in three zones; 150.5'-151.5'; 162.5'-164.5'; and 170.0'-171.0'. The higher count rates in these zones are consistent with the concentrations of the naturally occurring radionuclides. The calculated activities for the naturally occurring radionuclides throughout the interval surveyed are typical for Hanford soils.

Man-made Radionuclides:

Cesium (Cs-137) was detected from 0.0' to 4.0' with a maximum calculated activity of less than 1 pCi/g. Analyses were performed for U-235 and U-238; neither of these radionuclides was identified. The Cs-137 results are plotted along with total gamma cps; the additional tracks are plotted for plot consistency.

Westinghouse Hanford Company
RLS Spectral Gamma-Ray Borehole Survey Log Header

Project: 200-UP-2

Borehole	<u>299-W19-96</u>		
Coordinates	<u>NA</u> N	<u>NA</u> W	Feet (Hanford System)
Elevation	<u>NA</u> ft	Top of casing	

Borehole Environment Information

Borehole liquid depth <u>none</u> (ft) from zero (0.0) depth reference of log			
Casing size (in.)	Casing thickness (in.)	Top depth (ft)	Base depth (ft)
12	0.500	0.0	38.0
10	0.500	0.0	99.5
8	0.500	0.0	173.0

RLS Passive Spectral Gamma Survey Information

Logging Engineers <u>R. V. Cram</u> <u>J. P. Kiesler</u>						
Log depth reference at zero (0.0) depth is <u>around level</u>						
Log Date	Archive file names	Log mode speed	Depth interval (ft)			
			Top	Base	Incr	
Nov 23, 1993	H2W19096\A476	MSA 180sec RT	0.0	26.0	0.5	
		80sec RT	26.5	38.5	0.5	
		Stat.300sec RT	38.52			
Dec 21, 1993	H2W19096\A490	MSA 180sec RT	37.0	99.5	0.5	
		Stat.300sec RT	99.89			
Jan 06, 1994	H2W19096\A498	MSA 180sec RT	99.0	166.5	0.5	
Jan 12, 1994	H2W19096\A502	MSA 180sec RT	155.0	175.5	0.5	
		Stat.300sec RT	175.0			

MSA: Move-Stop-Acquire

RT: Real time

Calibration and Analysis Information

RLS Calibration Date: <u>Nov. 21, 1991</u>	
Calibration Report: <u>WHC-SD-EN-TRP-001</u>	
Analyst Names: <u>S. E. Kos</u>	<u>R. K. Price</u>
Analysis Date: <u>Apr 06, 1994</u>	
Analysis Notes: <u>Casing exceeds max. correction factor</u>	
Radionuclides Identified: <u>Cs-137, Co-60, Eu-152/154, U-235/238</u>	

RLS Spectral Gamma-Ray Borehole Survey

Project: 200-UP-2

Log Date : Jan 12, 1994

Borehole: 299-W19-96

Anal Date: Apr 06, 1994

RLS Spectral Gamma-Ray Borehole Survey

Project: 200-UP-2

Log Date : Jan 12, 1994

Borehole: 299-W19-96

Anal Date: Apr 06, 1994

RLS Spectral Gamma-Ray Borehole Survey

Project: 200-UP-2
Borehole: 299-W19-96

Log Date: Jan 12, 1994
Anal. Date: Apr 06, 1994

RLS Spectral Gamma-Ray Borehole Survey

Project: 200-UP-2

Log Date: Jan 12, 1994

Borehole: 299-W19-96

Anal. Date: Apr 06, 1994

RLS Spectral Gamma-Ray Borehole Survey

Project: 200-UP-2

Log Date: Jan 12, 1994

Borehole: 299-W19-96

Anal. Date: Apr 06, 1994

RLS Borehole Survey ReportBorehole: 299-W19-96

Casing	Depth:	0.0' - 38.0'	Size: 12"	Thickness: 0.500"
		0.0' - 99.5'	10"	0.500"
		0.0' - 173.0'	8"	0.500"
Water	None			
Survey	Depth:	0.0' - 38.5'	Date: Nov 23, 1993	
		37.0' - 99.9'	Dec 21, 1993	
		99.0' - 166.5'	Jan 06, 1994	
		155.0' - 175.0'	Jan 12, 1994	

General Notes:

The well was surveyed four times during drilling in three different casing sizes. Essentially all of the surveys were conducted in single-casing strings. Casing overlaps occurred at 37.0 to 38.0 feet during the second survey, and from 99.0 to 99.5 feet during the third survey. The overlaps did not impair the quality of the data collected. The data was collected at an acquisition time of 180 seconds real time with the exception of the interval 26.5 to 38.5 feet which was collected at 80 seconds real time. Stationary measurements were acquired at 300 seconds real time. Repeat sections were performed at the end of the surveys to monitor equipment performance, and the data is included on the plots.

The plots of the naturally occurring radionuclides of potassium, uranium, and thorium are typical for sediments of the Hanford site. The total gamma-ray log in intervals of overlap show decreased count rate. Elevated count rate is observed where the detector is directly exposed to sediments such as at the bottom of the borehole and in open, uncased hole. In the final survey, approximately 2.5 feet of open hole was surveyed.

The detector was saturated between 11.5 and 35.5 feet. Cobalt-60, europium 152/154, and uranium 235/238 were identified at the base of the saturation zone. The first presence of these radionuclides could not be determined, as it most likely occurred within the saturated zone.

Man-made Radionuclides:

Cesium (Cs-137) was identified from 0.0 to 11.5 feet, and from 35.5 to 48.5 feet. The maximum observed cesium activity of 19534 pCi/g occurred at 35.5 feet.

Cobalt (Co-60) was identified from 38.0 to 43.0 feet. The maximum cobalt activity of 1.8 pCi/g occurred at 40.0 feet.

Europium (Eu-152) was identified from 38.0 to 42.5 feet. The maximum Eu-152 activity of 1.9 pCi/g occurred at 39.5 feet.

Europium (Eu-154) was identified from 37.5 to 44.0 feet. The maximum Eu-154 activity of 951 pCi/g occurred at 39.5 feet.

Uranium (U-235) was identified from 38.5 to 44.5 feet, and from 167.0 to 168.5 feet. The maximum U-235 activity of 246 pCi/g occurred at 39.5 feet.

Uranium (U-238) was identified from 37.5 to 47.0 feet, at 49.5 feet and 52.5 feet, from 54.0 to 56.0 feet, at 165.0 feet, and from 166.5 to 169.0 feet. The maximum activity of over 5000 pCi/g occurred at 39.5 feet.

Westinghouse Hanford Company

RLS Spectral Gamma-Ray Borehole Survey Log Header

Project: 200-UP-2

Borehole	<u>299-W19-97</u>		
Coordinates	<u>NA</u>	N <u>NA</u>	W <u>NA</u>
Elevation	<u>NA</u>	ft	Top of casing

Borehole Environment Information

Borehole liquid depth <u>None</u> (ft) from zero (0.0) depth reference of log			
Casing size (in.)	Casing thickness (in.)	Top depth (ft)	Base depth (ft)
10	0.50	0.0	100.0
8	0.50	0.0	175.0

RLS Passive Spectral Gamma Survey Information

Logging Engineers <u>R. V. Cram</u> <u>S. E. Kos</u> <u>J. P. Kiesler</u>					
Log depth reference at zero (0.0) depth is <u>ground level</u>					
Log Date	Archive file names	Log mode	speed	Depth interval (ft)	
				Top	Base
Sep 14, 1993	H2W1997\A435	MSA	120sec RT	0.0	100.0
Sep 22, 1993	H2W1997\A437	MSA	120sec RT	99.0	146.5
Sep 23, 1993	H2W1997\A438	MSA	120sec RT	145.5	176.5

MSA: Move-Stop-Acquire
RT: Real time

Calibration and Analysis Information

RLS Calibration Date: <u>Nov. 21, 1991</u>	
Calibration Report: <u>WHC-SD-EN-TRP-001</u>	
Analyst Names: <u>S. E. Kos</u>	<u>R. K. Price</u>
Analysis Date: <u>Dec 09, 1993</u>	
Analysis Notes: <u>Double casing- exceeds max. correction factor</u>	
Radionuclides Identified: <u>Cs-137</u>	

RLS Spectral Gamma-Ray Borehole Survey

Project: 200-UP-2

Log Date : Sep 23, 1993

Borehole: 299-W19-97

Anal Date: Dec 09, 1993

RLS Spectral Gamma-Ray Borehole Survey

Project: 200-UP-2

Log Date : Sep 23, 1993

Borehole: 299-W19-97

Anal Date: Dec 09, 1993

RLS Spectral Gamma-Ray Borehole Survey

Project: 200-UP-2

Log Date: Sep 23, 1993

Borehole: 299-W19-97

Analysis Date: Dec 09, 1993

RLS Borehole Survey ReportBorehole: 299-W19-97

Casing	Depth: 0.0'-100.0'	Size: 10"	Thickness: 0.50"
Casing	Depth: 0.0'-175.0'	Size: 8"	Thickness: 0.50"
Water	None		
Survey	Depth: 0.0'-100.0'		Date: Sep 14, 1993
	99.0'-146.5'		Sep 22, 1993
	145.5'-176.5'		Sep 23, 1993

General Notes:

The well was surveyed three times during drilling; each survey was conducted in a single-casing zone. The first survey spanned the interval 0.0' to 100.0' in 10-inch-diameter threaded-joint carbon steel casing. The second survey spanned the interval 99.0' to 146.5'. The survey was interrupted at 146.5' when the liquid nitrogen cooling the detector became depleted, requiring immediate equipment shutdown. The RLS returned to the 400 Area laboratory, and the cooling system was inspected and the detector was cooled. Logging continued the following day, and the survey from 145.5' to 176.5' was completed. Both the second and third surveys were completed in 8-inch-diameter threaded-joint carbon steel casing. There was no fill material between the casing strings. The thickness of each casing was .500 inch, exceeding the maximum correction factor. A casing overlap during the second survey for the interval 99.0' to 100.0' resulted in a lower calculated activity than actually present. All measurements were acquired at 120 seconds real time.

The plot tracks for the naturally occurring radionuclides shows the depth profile for the total gamma count rate and the radionuclides potassium, uranium and thorium. The calculated activities for the naturally occurring radionuclides throughout the interval surveyed are typical for Hanford soils. The higher concentrations of naturally occurring uranium from 0.0' to 100.0', as compared with the data acquired from 99.0' to 146.5', are common for data acquired on days when low barometric pressure permits radon gas (a decay daughter of uranium) to enter the casing at the bottom of the well and migrate upward.

Man-made Radionuclides:

Cesium (Cs-137) was detected from 0.5' to 7.5'. The maximum calculated activity of 20 pCi/g occurred at 5.5'. Analyses were performed for U235 and U238; neither of these radionuclides was identified. The Cs-137 results are plotted along with total gamma cps; the additional tracks are plotted for plot consistency.

Westinghouse Hanford Company
RLS Spectral Gamma-Ray Borehole Survey Log Header

Project: 200-UP-2

Borehole	<u>299-W19-98</u>			
Coordinates	<u>NA</u>	N	<u>NA</u>	W Feet (Hanford System)
Elevation	<u>NA</u>	ft	Top of casing	

Borehole Environment Information

Borehole liquid depth <u>none</u> (ft) from zero (0.0) depth reference of log			
Casing size (in.)	Casing thickness (in.)	Top depth (ft)	Base depth (ft)
12	0.375	0.0	9.88
10	0.500	0.0	96.56
8	0.500	0.0	191.95

RLS Passive Spectral Gamma Survey Information

Logging Engineers <u>R. V. Cram</u> <u>J. P. Kiesler</u>					
Log depth reference at zero (0.0) depth is <u>ground level</u>					
Log Date	Archive file names	Log mode speed	Depth interval (ft)		
			Top	Base	Incr
Mar 02, 1994	H2W19098\A532	MSA 120sec RT	0.0	9.1	0.5
Mar 11, 1994	H2W19098\A539	MSA 120sec RT	8.0	96.51	0.5
Mar 18, 1994	H2W19098\A543	MSA 120sec RT	95.5	145.0	0.5
Mar 21, 1994	H2W19098\A544	MSA 120sec RT	144.0	183.0	0.5
Mar 23, 1994	H2W19098\A545	MSA 120sec RT	181.5	192.5	0.5

MSA: Move-Stop-Acquire

RT: Real time

Calibration and Analysis Information

RLS Calibration Date: Nov. 21, 1991	
Calibration Report: WHC-SD-EN-TRP-001	
Analyst Names: <u>S. E. Kos</u>	<u>R. K. Price</u>
Analysis Date: <u>Mar 24, 1994</u>	
Analysis Notes: <u>Casing exceeds max. correction factor</u>	
Radionuclides Identified: <u>Cs-137, Co-60, Eu-154</u>	

RLS Spectral Gamma-Ray Borehole Survey

Project: 200-UP-2

Log Date : Mar 23, 1994

Borehole: 299-W19-98

Anal Date: Mar 24, 1994

RLS Spectral Gamma-Ray Borehole Survey

Project: 200-UP-2

Log Date : Mar 23, 1994

Borehole: 299-W19-98

Anal Date: Mar 24, 1994

RLS Spectral Gamma-Ray Borehole Survey

Project: 200-UP-2
Borehole: 299-W19-98

Log Date: Mar 23, 1994
Anal. Date: Mar 24, 1994

RLS Borehole Survey ReportBorehole: 299-W19-98

Casing	Depth:	0.0' - 9.88'	Size: 12"	Thickness: 0.375"
		0.0' - 96.56'	10"	0.500"
		0.0' - 191.95'	8"	0.500"
Water	None			
Survey	Depth:	0.0' - 9.1'	Date: Mar 02, 1994	
		8.0' - 96.5'	Mar 11, 1994	
		95.5' - 145.0'	Mar 18, 1994	
		144.0' - 183.0'	Mar 21, 1994	
		181.5' - 192.5'	Mar 23, 1994	

General Notes:

The well was surveyed five times during drilling in three different casing sizes. Essentially all of the surveys were conducted in single casing strings. Casing overlaps occurred at 8.0 to 9.88 feet, and from 95.0 to 96.56 feet; the overlaps did not impair the quality of the surveys. All data were collected at an acquisition time of 120 seconds real time.

The plots of the naturally occurring radionuclides of potassium, uranium, and thorium are typical for sediments of the Hanford site. Repeat sections were conducted at the end of each survey to verify equipment performance and the data are included on the plots.

Man-made Radionuclides:

Cesium (Cs-137) was identified from 0.0 to 16.5 feet, intermittently from 18.5 to 35.5 feet, from 37.5 to 77.5 feet, and intermittently from 80.5 to 95.5 feet. The maximum observed cesium concentration of 1460 pCi/g occurred at 61.5 feet.

Cobalt (Co-60) was identified from 5.0 to 8.5 feet, from 41.5 to 57.5 feet, and from 59.0 to 66.5 feet. The maximum cobalt activity of 2.5 pCi/g occurred at 54.0 feet. The cobalt is found in conjunction with the cesium contamination.

Europium (Eu-154) was identified from 6.0 to 7.0 feet, and from 47.0 to 55.0 feet. The maximum Eu-154 activity of 5 pCi/g occurred at 51.5 feet. The Eu-154 is found in the same contamination zone with the cesium and cobalt.

Europium (Eu-152) was analyzed but was not identified. The Eu-152 plot track is included for uniformity in plot presentation.

Westinghouse Hanford Company
RLS Spectral Gamma-Ray Borehole Survey Log Header

Project: 200-UP-2

Borehole	<u>299-W22-78</u>		
Coordinates	<u>NA</u> N	<u>NA</u> W	Feet (Hanford System)
Elevation	<u>NA</u> ft	Top of casing	

Borehole Environment Information

Borehole liquid depth <u>None</u> (ft) from zero (0.0) depth reference of log			
Casing size (in.)	Casing thickness (in.)	Top depth (ft)	Base depth (ft)
12	0.50	0.0	37.01
10	0.50	0.0	91.24
8	0.50	0.0	184.63
6	0.50	0.0	233.36

RLS Passive Spectral Gamma Survey Information

Logging Engineers <u>R. V. Cram</u> <u>S. E. Kos</u> <u>J. P. Kiesler</u>					
Log depth reference at zero (0.0) depth is <u>ground level</u>					
Log Date	Archive file names	Log mode speed	Depth interval (ft)		
			Top	Base	Incr
Oct 13, 1993	H2W2278\A451	MSA 120sec RT	0.0	39.1	0.5
Oct 19, 1993	H2W2278\A456	MSA 120sec RT	36.0	40.5	0.5
		MSA 180sec RT	40.5	51.5	0.5
		Stat. 300sec RT	39.1		
Oct 20, 1993	H2W2278\A457	MSA 180sec RT	50.5	93.0	0.5
		Stat. 300sec RT	93.0		
Oct 26, 1993	H2W2278\A461	MSA 180sec RT	92.0	144.0	0.5
Oct 27, 1993	H2W2278\A462	MSA 180sec RT	143.0	184.02	0.5
Nov 04, 1993	H2W2278\A465	MSA 180sec RT	184.0	233.5	0.5
		Stat. 300sec RT	184.0		

MSA: Move-Stop-Acquire
RT: Real time

Westinghouse Hanford Company
RLS Spectral Gamma-Ray Borehole Survey Log Header

Calibration and Analysis Information

RLS Calibration Date: Nov. 21, 1991
Calibration Report: WHC-SD-EN-TRP-001

Analyst Names: S. E. Kos R. K. Price
Analysis Date: Jan 03, 1994

Analysis Notes: Casing exceeds max. correction factor
Radionuclides Identified: Cs-137, U-235, U-238

RLS Spectral Gamma-Ray Borehole Survey

Project: 200-UP-2

Log Date : Nov 04, 1993

Borehole: 299-W22-78

Anal Date: Jan 03, 1994

RLS Spectral Gamma-Ray Borehole Survey

Project: 200-UP-2

Log Date : Nov 04, 1993

Borehole: 299-W22-78

Anal Date: Jan 03, 1994

RLS Spectral Gamma-Ray Borehole Survey

Project: 200- UP-2

Log Date: Nov 04, 1993

Borehole: 299-W22-78

Anal. Date: Jan 03, 1994

RLS Borehole Survey ReportBorehole: 299-W22-78

Casing	Depth:	0.0' - 37.01'	Size: 12"	Thickness: 0.50"
		0.0' - 91.24'	10"	0.50"
		0.0' - 184.63'	8"	0.50"
		0.0' - 233.36'	6"	0.50"
Water	None			
Survey	Interval:	0.0' - 39.1'	Date:	Oct 13, 1993
		36.0' - 51.5'		Oct 19, 1993
		50.5' - 93.0'		Oct 20, 1993
		92.0' - 144.0'		Oct 26, 1993
		143.0' - 184.02'		Oct 27, 1993
		184.0' - 233.5'		Nov 04, 1993

General Notes:

The well was surveyed six times during drilling; each survey was conducted in a single-casing zone. All casings were threaded-joint carbon steel; there was no fill material between the casing strings. The wall thickness of each casing was .50 inch, exceeding the maximum correction factor. The data acquisition time was increased from 120 seconds RT to 180 seconds RT at 40.5' to improve detection capabilities. Multiple surveys were required because of the extended acquisition time, the long survey intervals, and the limited access to the well.

The plot tracks for the naturally occurring radionuclides shows the depth profile for the total gamma count rate and the radionuclides potassium, uranium and thorium. The calculated activities for the naturally occurring radionuclides throughout the well are typical for Hanford soils. The higher calculated concentrations of naturally occurring uranium from 0.0' to 39.1', and from 143.0' to 184.02', are common for data acquired on days when low barometric pressure permits radon gas (a decay daughter of uranium) to enter the casing at the bottom of the well and migrate upward. Decreased activity is observed at 36.0' where the second survey was conducted for 3' in an overlap of 12-inch-diameter and 10-inch-diameter casings. Increased total gamma activity is observed at approximately 40.0' and 93.0' where open (uncased) borehole was logged.

Man-made Radionuclides:

Cesium (Cs-137) was detected at 0.5' at a concentration of less than 1 pCi/g. Because of the low concentration, the data were not plotted on the Cs-137 plot. The plot is included for uniformity in presentation.

Uranium-235(U-235) was detected at 19.0' at a concentration of 3 pCi/g. The U-235 data did not plot since each occurrence was a single data point. The U-235 plot is included for uniformity in presentation.

Uranium-238(U-238) was detected in two intervals, 18.0' to 20.0', and 22.0' to 23.5'. The maximum calculated activity of 66 pCi/g occurred at 19.0'.

Cobalt (Co-60) was not detected in the well. The Co-60 plot is included for uniformity in presentation.

Westinghouse Hanford Company

RLS Spectral Gamma-Ray Borehole Survey Log Header

Project: 200-UP-2

Borehole	<u>299-W23-231</u>		
Coordinates	<u>NA</u> N	<u>NA</u> W	Feet (Hanford System)
Elevation	<u>NA</u> ft	Top of casing	

Borehole Environment Information

Borehole liquid depth <u>None</u> (ft) from zero (0.0) depth reference of log			
Casing size (in.)	Casing thickness (in.)	Top depth (ft)	Base depth (ft)
12	0.375	0	13.3
10	0.500	0	82.3
8	0.500	0	140.5

RLS Passive Spectral Gamma Survey Information

RL Passive Spectral Gamma Survey Information

Logging Engineers <u>R. V. Cram</u> <u>J. P. Kiesler</u>					
Log depth reference at zero (0.0) depth is <u>ground level</u>					
Log Date	Archive file names	Log mode speed	Depth interval (ft)		
			Top	Base	Incr
Mar 14, 1994	H2W23231\A540	MSA 120sec RT	0.0	11.5	0.5
Mar 17, 1994	H2W23231\A542	MSA 120sec RT	10.5	79.0	0.5
Mar 24, 1994	H2W23231\A547	MSA 80sec RT	78.0	140.0	0.5

MSA: Move-Stop-Acquire

RT: Real time

Calibration and Analysis Information

RLS Calibration Date: <u>Nov. 21, 1991</u>	
Calibration Report: <u>WHC-SD-EN-TRP-001</u>	
Analyst Names: <u>S. E. Kos</u>	<u>R. K. Price</u>
Analysis Date: <u>Mar 25, 1994</u>	
Analysis Notes: <u>Casing exceeds max. correction factor</u>	
Radionuclides Identified: <u>Cs-137</u>	

RLS Spectral Gamma-Ray Borehole Survey

Project: 200-UP-2

Log Date : Mar 24, 1994

Borehole: 299-W23-231

Anal Date: Mar 25, 1994

RLS Spectral Gamma-Ray Borehole Survey

Project: 200-UP-2

Log Date : Mar 24, 1994

Borehole: 299-W23-231

Anal Date: Mar 25, 1994

RLS Spectral Gamma-Ray Borehole Survey

Project: 200-UP-2
Borehole: 299-W23-231

Log Date: Mar 24, 1994
Anal. Date: Mar 25, 1994

RLS Borehole Survey ReportBorehole: 299-W23-231

Casing	Depth:	0.0' - 13.3'	Size:	12"	Thickness:	0.375"
		0.0' - 82.3'		10"		0.500"
		0.0' - 140.5'		8"		0.500"
Water	None					
Survey	Depth:	0.0' - 11.5'	Date:	Mar 14, 1994		
		10.5' - 79.0'		Mar 17, 1994		
		78.0' - 140.0'		Mar 24, 1994		

General Notes:

The well was surveyed three times during drilling in three casing sizes. Essentially all of the surveys were conducted in single casing strings. Casing overlap occurred from 10.5 to 13.3 feet during the second survey, and from 78.0 to 82.3 feet during the third survey; the overlaps did not impair the quality of the surveys. The data were collected at an acquisition time of 120 seconds real time for the first and second surveys, and at 80 seconds real time for the third survey.

The plots of the naturally occurring radionuclides of potassium, uranium, and thorium are typical for sediments of the Hanford site. Zones of increased count rate are observed at 11.0 feet and 75.0 feet where the detector encountered uncased sediments, either in open hole or at the bottom of the borehole. Repeat sections were conducted at the end of each survey to verify equipment performance, and the repeat data are included on the plots.

Man-made Radionuclides:

Cesium (Cs-137) was identified from 0.0 to 10.0 feet. The maximum observed activity of 440 pCi/g occurred at 3.0 feet.

Cobalt (Co-60) was analyzed but was not identified. The cobalt plot track is presented for uniformity in presentation.

Europium (Eu-152 and Eu-154) was not analyzed. The europium plot tracks are included for uniformity in plot presentation.

APPENDIX D
METRIC CONVERSIONS

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To Convert	Multiply By	To Convert	Multiply By
LINEAR MEASURE (LENGTH)			
inches to millimeters	25.4	millimeters to inches	0.0394
inches to centimeters	2.54	centimeters to inches	0.394
feet to meters	0.305	meters to feet	3.281
yards to meters	0.914	meters to yards	1.094
miles to kilometers	1.609	kilometers to miles	0.621
SQUARE MEASURE (AREA)			
square inches to square centimeters	6.452	square centimeters to square inches	0.155
sq feet to sq meters	0.0929	sq meters to sq feet	10.764
sq yards to sq meters	0.836	sq meters to sq yards	1.196
acres to hectares	0.405	hectares to acres	2.471
CUBIC MEASURE (VOLUME)			
cubic inches to cubic centimeters	16.387	cubic centimeters to cubic inches	0.0610
cu feet to cu meters	0.0283	cu meters to cu feet	35.315
cu yards to cu meters	0.765	cu meters to cu yards	1.308
LIQUID MEASURE (CAPACITY)			
fluid ounces to liters	0.0296	liters to fluid ounces	33.814
quarts to liters	0.946	liters to quarts	1.057
gallons to liters	3.785	liters to gallons	0.264
imperial gallons to liters	4.546	liters to imperial gallons	0.220
WEIGHTS (MASS)			
ounces avoirdupois to grams	28.35	grams to ounces avoirdupois	0.0353
pounds avoirdupois to kilograms	0.454	kilograms to pounds avoirdupois	2.205
tons to metric tons	0.907	metric tons to tons	1.102
TEMPERATURE			
32 °F (freezing point of water)		0 °C	
212 °F (boiling point of water)		100 °C	
98.6 °F (body temperature)		37 °C	
To find degrees Celsius, subtract 32 degrees Fahrenheit and divide by 1.8. To find degrees Fahrenheit, multiply degrees Celsius by 1.8 and add 32.			

To convert from >> to <<	to >> To convert from <<	multiply by divide by
PRESSURE and STRESS		
pounds force per square inch (lbf/in ² or psi)	kilopascals (kPa)	6.895
thousand pounds force per square inch (kip/in ² or ksi)	megapascals (MPa)	6.895
inches of water (60 °F)	pascals (Pa)	248.8
millimeters of mercury (0 °C)	pascals (Pa)	133.3
ENERGY and WORK		
British thermal units (Btu), International Table	kilojoules (kJ)	1.055
Calories (kilocalories), Int'l	kilojoules (kJ)	4.187
electronvolts (eV)	joules (J)	1.602×10^{-19}
kilowatt hours (kW·h)	megajoules (MJ)	3.600
POWER		
British thermal units (Int'l) per hour (Btu/h)	watts (W)	0.293
horsepower (electric)	watts (W)	746.0
horsepower (boiler)	kilowatts (kW)	9.81
tons of refrigeration	kilowatts (kW)	3.517
TORQUE and BENDING MOMENT		
ounce force inches (ozf·in) ("inch-ounces")	millinewton meters (mN·m)	7.062
pound force inches (lbf·in) ("inch-pounds")	newton meters (N·m)	0.113
pound force feet (lbf·ft) ("foot-pounds")	newton meters (N·m)	1.356
FLOW RATES		
cubic feet per minute (ft ³ /min or cfm)	liters per second (L/s)	0.472
cubic feet per minute (ft ³ /min or cfm) [flow > 20,000 cfm]	cubic meters per second (m ³ /s)	0.000 472
gallons per minute (gpm) [flow rate < 30 gpm]	milliliters per second (mL/s)	63.1
gallons per minute (gpm)	liters per second (L/s)	0.063 1
pounds mass per hour (lbm/h)	kilograms per second (kg/s)	0.000 126

To convert from >> to <<	to >> To convert from <<	multiply by divide by
NUCLEAR and RADIATION UNITS		
barns (b) [neutron absorption cross-section]	square meters (m ²)	1.00 x 10 ⁻²⁸
curies (Ci)	becquerels (Bq)	3.70 x 10 ¹⁰
microcuries (μCi)	becquerels (Bq)	3.70 x 10 ⁴
picocuries (pCi)	becquerels (Bq)	0.037 0
rad ^	gray (Gy) *	0.010 0
rad ^	centigray (cGy) ^	1.000
millirad (mrad) ^	microgray (μGy) ^	10.000
rem ^	sievert (Sv) *	0.010 0
rem *	millisievert (mSv) ^	10.0
millirem (mrem) *	millisievert (mSv) ^	0.010 0
millirem (mrem) ^	microsievert (μSv) ^	10.000
roentgen (R) ^	coulombs per kilogram ^ (C/kg)	0.000 258
milliroentgen (mR) *	microcoulombs per kilogram (μC/kg) *	0.258
* The same "per unit time" (e.g., per hour, per year) may be added to obtain rate units with the same multipliers. For example, 1 rem per year is equal to 10 millisieverts per year .		
ELECTRICITY and MAGNETISM		
NOTE: The following units of electricity and magnetism, including their multiples and submultiples, are SI units needing no conversion.		
ampere (A) candela (cd) [1 cd = 1 candlepower] coulomb (C) farad (F) henry (H) hertz (Hz) [1 Hz = 1 cycle per second] lumen (lm) ohm (Ω) siemens (S) [1 S = 1 mho] tesla (T) volt (V) watt (W) weber (Wb)		

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DISTRIBUTION SHEET

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WHC-SD-EN-TI-298, Report of Spectral Gamma-Ray Surveys Acquired for the 200-UP-2 Project, Rev 0		ECN No. N/A

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