Lockheed Environmental Systems & Technologies Co.
Lockheed Analytical Services
975 Kelly Johnson Drive Las Vegas, Nevada 89119-3705
Telephone 702-361-0220 800-582-7605 Facsimile 702-361-8146

0044368

LK4467

LOCKHEED MARTIN

June 12, 1995

Ms. Joan Kessner
Bechtel Hanford, Inc.
345 Hills
P.O. Box 969
Richland, WA 99352

JUN 1996 RECEIVED EDMC

JUN 1995 RECEIVED Data Log In

RE:	Log-in No.:	L4467
	Quotation No.:	Q400000-B
	SAF:	B95-050
	Document File No.:	0509596
	BHI Document File No.:	220
	SDG No.:	LK4467

The attached data report contains the analytical results of samples that were submitted to Lockheed Analytical Services on 9 May 1995.

The temperature of the cooler upon receipt was 2°C. Sample containers received agree with the chain-of-custody documentation. Sample containers were received intact. Samples were received in time to meet the analytical holding time requirements.

The case narratives included in the following attachments provide a detailed description of all events that occurred during sample preparation, analysis, and data review specific to the samples and analytical methods requested.

A list of data qualifiers, chain-of-custody forms, sample receiving checklist, and log-in report are also enclosed representing the samples received within this group.

If you have any questions concerning the analysis or the data please call Kathleen Hall at (509) 943-4423.

Lockheed Analytical Services

Log-in No.: L4467
Quotation No.: Q400000-B
SAF: B95-050
Document File No.: 0509596
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SDG No.: LK4467
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Release of this data report has been authorized by the Laboratory Director or the Director's designee as evidenced by the following signature.

" I certify that this data package is in compliance with the SOW, both technically and for completeness, for other than the conditions detailed above. Release of the data contained in this hard copy data package has been authorized by the Laboratory Manger or a designee, as verified by the following signature."

Sincerely,

Karen Hermann for KMH

Kathleen M. Hall
Client Services Representative

cc: Client Services
Document Control

CASE NARRATIVE
RADIOCHEMICAL ANALYSES

The routine calibration and quality control analyses performed for this batch include as applicable: instrument calibration, initial and continuing calibration verification, quench monitoring standards, instrument background analysis, method blanks, yield tracer, laboratory control samples, matrix spike samples, duplicate samples.

Holding Time Requirements

All holding time requirements were met.

Chemical Recoveries and MDAs, where applicable, can be found on the preparation and calculation sheets of the attached raw data for each method.

Analytical Method

Gamma Spectrum Analysis

The gamma spectrum analysis was performed using LAL-91-SOP-0063. The second sample duplicate analysis for Cs-137 was out of limits; however, since the first duplicate was within limits, the data is considered acceptable, and all other QC criteria were met.

Technetium-99

The technetium-99 analysis was performed using LAL-91-SOP-0169. The second sample duplicate analysis was out of limits; however, since the first duplicate was within limits, the data is considered accetpable, and all other QC criteria were met.

Yvonne M. Jacoby
Prepared By

June 12, 1995
Date

Lockheed Analytical Services
DATA QUALIFIERS FOR RADIOCHEMICAL ANALYSES
[Revised 08/28/92]

For Use on the Analytical Data Reporting Forms	
B	Any constituent that was also detected in the associated blank whose concentration was greater than the reporting detection limit (RDL) and/or minimum detectable activity (MDA).
C	Presence of high TDS in sample required reduction of sample size which increased the MDA.
D	Constituent detected in the diluted sample.
E	Constituent concentration exceeded the calibration or attenuation curve range.
F	*For Alpha Spectrometry Only*-- FWHM exceeded acceptance limits.
H	Sample analysis performed outside of method-specified maximum holding time requirement.
Y	Chemical yield exceeded acceptance limits.
For Use on the QC Data Reporting Forms	
*	QC data (i.e., percent recovery data for laboratory control standard and matrix spike; and RPD for replicate analyses) exceeded acceptance limits.
a[1]	The spike recovery and/or RPD for matrix spike and duplicates cannot be evaluated due to insufficient spiking level compared to the elevated sample analyte concentration.
b[1]	The RPD cannot be computed because the sample and/or duplicate concentration was below the MDA.

[1] Used as foot note designations on the QC summary form.

LOGIN CHAIN OF CUSTODY REPORT (ln01)
May 09 1995, 10:58 am

Login Number: L4467
Account: 596 Bechtel Hanford, Inc. * Richland, WA
Project: BECHTEL-HANFORD Bechtel Hanford Project

Laboratory Sample Number	Client Sample Number	Collect Date	Receive Date	Due PR Date
L4467-1	B0FBK3	06-MAY-95	09-MAY-95	13-JUN-95
temp 2; SAF# B95-050				
Location: 157				
Water 1 S SCREENING		Hold:02-NOV-95		
L4467-2	B0FBK3	06-MAY-95	09-MAY-95	13-JUN-95
temp 2; SAF# B95-050, GAMMA SPEC TO INCLUDE Co-60				
Location: 157				
Water 1 S GAMMA SPEC LAL-0063		Hold:02-NOV-95		
L4467-3	B0FBK3	06-MAY-95	09-MAY-95	13-JUN-95
temp 2; SAF# B95-050, GAMMA SPEC TO INCLUDE Co-60				
Location: 157				
L4467-4	B0FBK3	06-MAY-95	09-MAY-95	13-JUN-95
temp 2; SAF# B95-050, GAMMA SPEC TO INCLUDE Co-60				
Location: 157				
L4467-5	B0FBK3	06-MAY-95	09-MAY-95	13-JUN-95
temp 2; SAF# B95-050, GAMMA SPEC TO INCLUDE Co-60				
Location: 157				
L4467-6	B0FBK3	06-MAY-95	09-MAY-95	13-JUN-95
temp 2; SAF# B95-050				
Location: 157				
Water 1 S TC-99 LAL-0169		Hold:02-NOV-95		
L4467-7	B0FBK3	06-MAY-95	09-MAY-95	13-JUN-95
temp 2; SAF# B95-050				
Location: 157				
L4467-8	B0FBK3	06-MAY-95	09-MAY-95	13-JUN-95
temp 2; SAF# B95-050				
Location: 157				
L4467-9	B0FBK3	06-MAY-95	09-MAY-95	13-JUN-95
temp 2; SAF# B95-050				
Location: 157				
L4467-10	REPORT TYPE	09-MAY-95	09-MAY-95	13-JUN-95
Location:				
Water 1 S EDD - DISK DEL.				
Water 1 S RAD RPT TYPE 2				

007

Signature: [illegible]

Date: 5-9-95

C 5E9546

Bechtel Hanford, Inc.

L4467

CHAIN OF CUSTODY/SAMPLE ANALYSIS REQUEST

Page 1 of 1

Data Turnaround
☐ Priority
■ Normal

Collector: DAVE ST John	Company Contact: G.L. Kasza	Telephone: (509) 372-9675
Project Designation: 200-BP-5 Groundwater Round 3	Sampling Location: 200 East	SAF No.: B95-050
Ice Chest No.: GWS-141	Field Logbook No.: EFL-1125	Method of Shipment: Federal Express
Shipped To: Lockheed	Offsite Property No.: W95-0-0209-28	Bill of Lading/Air Bill No.: 2904627686

Possible Sample Hazards/Remarks	Preservation	HNO3	HCl	Cool 4°							
	Type of Container	5-6-95 P/~~G~~	P	P							
	No. of Container(s)	4	4	1							
Special Handling and/or Storage Maintain samples between 2°C and 6°C.	Volume	1L	1L	20mL							
SAMPLE ANALYSIS		Gamma Spec to include Co-60	Tc-99	Activity Scan							

Sample No.	Matrix*	Date Sampled	Time Sampled										
B0FBK3	W	5-6-95	1050	X	X	X							

CHAIN OF POSSESSION	Sign/Print Names		
Relinquished By: David St. John ERC	Date/Time: 05-08-95 0830	Received By: ERC B Whitten	Date/Time: 0830 5-8-95
Relinquished By: ERC B Whitten	Date/Time: 1000 5-8-95	Received By:	Date/Time:
Relinquished By:	Date/Time:	Received By:	Date/Time:
Relinquished By:	Date/Time:	Received By:	Date/Time:

SPECIAL INSTRUCTIONS

Matrix*
S = Soil
SE = Sediment
SO = Solid
SL = Sludge
W = Water
O = Oil
A = Air
DS = Drum Solids
DL = Drum Liquids
T = Tissue
WI = Wipe
L = Liquid
V = Vegetation
X = Other

LABORATORY SECTION	Received By: M Mattes	Title: Sample Custodian	Date/Time: 5-9-95 / 0830
FINAL SAMPLE DISPOSITION	Disposal Method	Disposed By	Date/Time

Environmental Restoration Contractor **ERC Team**

Interoffice Memorandum

Job No. 22192
Written Response Required: NO
CCN: N/A
OU: 200-BP-5
TSD: N/A
ERA: N/A
Subject Code: 1995 Round 3 Sampling

TO: W. S. Thompson N3-06 DATE: April 21, 1995

COPIES: D. B. Erb H6-01 FROM: S. K. De Mers
Radiological Controls
N3-06/376-2764

SUBJECT: **1995 Round 3 sampling for 200-BP-5**

There is no need to perform total activities prior to offsite shipment to NRC licensed labs of samples taken from the attached list of wells.

The wells listed in the attachment were reviewed for radiological content based on the previous 4 years of sampling data. No well listed has a β activity in excess of 100,000 pCi/l (<.1 uCi/sample based on a 1 liter sample size) nor any α activity in excess of 10,000 pCi/l (<.01 uCi/l based on a 1 liter sample). All wells show activities < 2,000 pCi/gm (< 2 nCi/gm D.O.T. limit). The highest activity in recent samples is 17,000 pCi/l β and 170 pCi/l α.

Radiological monitoring during sampling will only be required if the wells are located in radiological areas or if the wells themselves are labeled with radiological stickers. Monitoring requirements for down hole work such as pump removal will be determined based on the history of each well on a case by case basis.

skd

C5C9591

Sample Login

Login Review Checklist

Lot Number L4467

The login review should be conducted by that person logging in the samples as well as a peer. Please use this checklist to ensure that such reviews occur in a uniform basis. Please sign and date below to verify that a login review has occurred. This checklist should be affixed to each login package prior to distribution.

For an effective login review, at a minimum, five reports from the login process are required. These are the chain of custody (or equivalent), the login chain of custody report, the sample summary report, the sample receiving checklist, and the login quotation. Before beginning a review, ensure that these five components are available. For jobs with single component samples, the sample summary report may be ommitted.

Sample Summary Report N/A		Yes	No
1.	Are all sample IDs correct?	X	
2.	Are all samples present?	X	
3.	Are all matrices correct? (e.g., TCLP analyses should be on a TCLP leachate, field blanks should be water)	X	
4.	Are all analyses on the chain of custody/login quotation included?	X	
5.	Are analyses logged in for the correct container? (e.g., analyses requiring preservation logged in for a preserved container and vice versa)	X	
6.	Are samples logged in according to laboratory batching procedures? (e.g., TCLP regular leaching and associated metals/semivolatile organics should be logged in on the same bottle)	X	

Login Chain of Custody Report			
1.	Are the Collect, Receive , and Due dates correct for every sample?	X	
2.	Have appropriate sample comments been included? (e.g., MS/MSD designation, comments from the client concerning method modifications)	X	

Sample Receiving Checklist			
1.	Are any discrepancies between the chain of custody and the login noted? (e.g., client IDs different on chains of custody and bottle labels, samples not sent, samples lost from breakage)		N/A

[signature] 5-9-95 [signature] 5-09-95

Primary review signature Date Secondary review signature Date

010

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WHC/BHI SAMPLE CHECK-IN LIST

Date/Time Received: 5-9-95/0830 SDG #: Behind - Hanford

Work Order Number: NA SAF #: B95-050

Shipping Container ID: GWS-141 Chain of Custody # NA

1. Custody Seals on shipping container intact? Yes [X] No [ ]
2. Custody Seals dated and signed? Yes [X] No [ ]
3. Chain-of-Custody record present? Yes [X] No [ ]
4. Cooler temperature 2°C
5. Vermiculite/packing materials is Wet [ ] Dry [X]
6. Number of samples in shipping container: 9
7. Sample holding times exceeded: Yes [ ] No [X]
8. Samples have: ___ tape ___ hazard labels
   X custody seals X appropriate sample labels
9. Samples are: X in good condition ___ leaking
   ___ broken ___ have air bubbles
10. Were any anomalies identified in sample receipt? Yes [ ] No [X]
11. Description of anomalies (include sample numbers): _____

Sample Custodian: A Miller On: 5-9-95/1100

Telephoned To: Kathleen Hall On 5-9-95/1100 By Anthony Miller

011

FORM NO. LS-042, Rev. 1, 2/95

C529596

Lockheed Analytical Services
Sample Receiving Checklist

Client Name: Bechtel - Hanford Job No. L4467 Cooler ID: ~~AP-1~~ 5-2-95 GWS-141

COOLER CONDITION UPON RECEIPT

Temperature of cooler upon receipt: 2°C

temperature of temp. blank upon receipt:

	Yes	No	* Comments/Discrepancies
custody seals intact	X		
chain of custody present	X		
blue ice (or equiv.) present/frozen	X		
rad survey completed	X		

SAMPLE CONDITION UPON RECEIPT

	Yes	No	* Comments/Discrepancies
all bottles labeled	X		
samples intact	X		
proper container used for sample type	X		
sample volume sufficient for analysis	X		
proper pres. indicated on the COC	X		
VOA's contain headspace			N/A
are samples bi-phasic (if so, indicate sample ID'S):			N/A

MISCELLANEOUS ITEMS

	Yes	No	* Comments/Discrepancies
samples with short holding times		X	
samples to subcontract		X	

ADDITIONAL COMMENTS/DISCREPANCIES

Completed by / date: [signature] 5-9-95

Sent to the client (date/initials): ** Client's signature upon receipt:

*Notes: * = contact the appropriate CSR of any discrepancies immediately upon receipt*

*** = please review this information and return via facsimile to the appropriate CSR (702) 361-8146*

012

version 2.0 (11/11/94)

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Lockheed Analytical Laboratory
SAMPLE SUMMARY REPORT (su02)
Bechtel Hanford, Inc. * Richland, WA

Client Sample Number	LAL Sample Number	SDG Number	Matrix	Method
B0FBK3	L4467-1		Water	SCREENING
	L4467-2		Water	GAMMA SPEC LAL-0
	L4467-6		Water	TC-99 LAL-0169
REPORT TYPE	L4467-10		Water	EDD - DISK DEL.
	L4467-10		Water	RAD RPT TYPE 2

0 52.959

LOCKHEED ANALYTICAL SERVICES

RAD DATA REPORT (ra01)

Bechtel Hanford, Inc. * Richland, WA

Bechtel Hanford Project (Project BECHTEL-HANFORD)

Client Sample ID: BOFBK3 | LAL Sample ID: L4467-2

Date Collected: 06-MAY-95 | Date Received: 09-MAY-95

Matrix: Water | Login Number: L4467

SDG: LK4467

Constituent	Analyzed	Batch	Activity	Error	MDA	DataQual	Units
Ac-228(Ra-228)	30-MAY-95	GAMMA SPEC LAL-0063_23211	15.	26.	40.		pCi/L
Co-58	30-MAY-95	GAMMA SPEC LAL-0063_23211	3.9	5.3	8.7		pCi/L
Co-60	30-MAY-95	GAMMA SPEC LAL-0063_23211	1.4	5.1	8.1		pCi/L
Cs-137	30-MAY-95	GAMMA SPEC LAL-0063_23211	2.9	8.1	10.		pCi/L
Eu-152	30-MAY-95	GAMMA SPEC LAL-0063_23211	1.	12.	41.		pCi/L
Eu-154	30-MAY-95	GAMMA SPEC LAL-0063_23211	-2.	13.	34.		pCi/L
Eu-155	30-MAY-95	GAMMA SPEC LAL-0063_23211	-6.7	6.3	19.		pCi/L
Fe-59	30-MAY-95	GAMMA SPEC LAL-0063_23211	8.	10.	22.		pCi/L
Pb-212	30-MAY-95	GAMMA SPEC LAL-0063_23211	2.	11.	16.		pCi/L
Pb-214(Ra-226)	30-MAY-95	GAMMA SPEC LAL-0063_23211	9.	14.	19.		pCi/L
Ra-226(GAMMA)	30-MAY-95	GAMMA SPEC LAL-0063_23211	10	140	200		pCi/L
U-235(GAMMA)	30-MAY-95	GAMMA SPEC LAL-0063_23211	-20.	23.	45.		pCi/L

LOCKHEED ANALYTICAL SERVICES

RAD DATA REPORT (ra01)

Bechtel Hanford, Inc. * Richland, WA

Bechtel Hanford Project (Project BECHTEL-HANFORD)

Client Sample ID: BOFBK3 | LAL Sample ID: L4467-6

Date Collected: 06-MAY-95 | Date Received: 09-MAY-95

Matrix: Water | Login Number: L4467

SDG: LK4467

Constituent	Analyzed	Batch	Activity	Error	MDA	DataQual	Units
Tc-99	31-MAY-95	TC-99 LAL-0169_23139	45.4	8.8	6.0		pCi/L

016

420

Client	BECHTEL	
Client ID	B0FBK3	
Filename	232111.CHN	
LAL parent ID	23211DUP1	
Batch	6323211	
Live Time	10800	
Detector	1	LAS Detector 1, GMX-30200-P, Ser. No. 30-TN10223A
Geometry	N	
Aliquot (gms/L)	0.475	
Count date	5/31/95 10:49	
Collection Date	5/6/95	
delta T to midpoint of count	26.1	days
Efficiency data file	N194	
Background, Library files	WBKG1149	whc

V94093

Nuclide	keV	halflife (days)	chnl	GROSS	BKG	NET	Hand Calc NET	Sample cnts/sec	1 sig % err
Ra-226	186.1	5.84E+05	372	218	76	142		0.0131636	12.1
U-235	185.7	2.57E+11	372	218	76	142		0.0131636	12.1
	143.8	2.57E+11	288	161	123	38		0.0035185	44.3
	163.3	2.57E+11	327	133	106	27		0.0025	57.3
Pb-214(Ra-226)	351.9	5.84E+05	704	103	55	48		0.0044444	26.2
	295.1	5.84E+05	591	89	89	0		3.086E-05	3998.7
Fe-59	1099.2	4.51E+01	2198	14	8	6		0.0005401	80.7
	1291.6	4.51E+01	2583	10	16	-6		-0.000586	81.0
Co-58	810.8	7.08E+01	1622	18	23	-5		-0.000494	120.5
Ac-228(Ra-228)	911.2	2.10E+03	1822	41	21	20		0.0018171	40.2
	969	2.10E+03	1938	20	26	-6		-0.000556	113.0
Pb-212	238.6	5.11E+12	478	144	80	65		0.0059722	23.2
	300.1	5.11E+12	600	68	72	-4		-0.00037	295.8
Co-60	1332.5	1924	2665	12	15	-3		-0.000278	173.2
	1173.3	1924	2347	16	26	-10		-0.00088	67.8
Cs-137	661.7	10950	1324	39	33	6		0.0005247	150.1
Eu-155	105.3	1810	211	142	140	2		0.0001852	839.6
Eu-152	1408.1	4.64E+03	2816	11	14	-3		-0.000278	166.7
	344.3	4.64E+03	689	55	60	-5		-0.000417	237.8
Eu-154	723.3	3.11E+03	1447	32	33	-1		-6.17E-05	1206.2
	1004.8	3.11E+03	2009	11	28	-17		-0.001574	36.7
	1274.5	3.11E+03	2549	13	14	-1		-9.26E-05	519.6

025

Client	BECHTEL
Client ID	B0FBK3
Filename	232111.CHN
LAL parent ID	23211DUP1
Batch	6323211
Live Time	10800
Detector	1
Geometry	N
Aliquot (gms/L)	0.475
Count date	5/31/95 10:49
Collection Date	5/6/95
delta T to midpoint of count	26.1
Efficiency data file	N194
Background, Library files	WBKG1149

Nuclide	keV	WBKG cnts/sec	1 sig % err	NET Sample cnts/sec	NET 1 sig % err	Efficiency	1 sigma % Eff err	Branch
Ra-226	186.1	0.012097	5.6	-0.00967	23.36	0.055308	5	0.035
U-235	185.7	0.012097	5.6	0.00107	211.83	0.055389	5	0.575
	143.8	0.002617	23.1	0.00090	240.14	0.063815	5	0.109
	163.3	0.000867	65.4	0.00163	122.36	0.059981	5	0.05
Pb-214(Ra-226)	351.9	0.0016	27.7	0.00284	56.51	0.03237	5	0.358
	295.1	0.001333	36.4	-0.00130	132.06	0.037986	5	0.185
Fe-59	1099.2	3.06E-05	771.7	0.00051	131.83	0.011918	5	0.565
	1291.6	0.000208	91.7	-0.00079	35.74	0.010338	5	0.432
Co-58	810.8	-0.00024	110.1	-0.00049	120.55	0.015465	5	0.9945
Ac-228(Ra-228)	911.2	0.001046	30.0	0.00077	135.54	0.014001	5	0.266
	969	0.00045	65.7	-0.00101	33.04	0.013285	5	0.1617
Pb-212	238.6	0.006375	9.3	-0.00040	490.99	0.045721	5	0.4365
	300.1	0.0001	430.1	-0.00047	141.47	0.037416	5	0.03344
Co-60	1332.5	0.000267	79.1	-0.00054	49.65	0.010051	5	0.999
	1173.3	0.000317	72.0	-0.00120	30.81	0.011258	5	0.999
Cs-137	661.7	-0.00023	143.3	0.00052	150.09	0.018405	5	0.8521
Eu-155	105.3	0.000581	95.8	-0.00040	533.92	0.06833	5	0.218
Eu-152	1408.1	0.000225	75.7	-0.00050	58.19	0.009557	5	0.212
	344.3	-0.00014	304.6	-0.00042	237.79	0.033022	5	0.27
Eu-154	723.3	-0.00037	84.1	-0.00006	1206.23	0.017049	5	0.197
	1004.8	-0.00018	134.0	-0.00157	36.74	0.012878	5	0.176
	1274.5	-9.4E-05	200.9	-0.00009	519.62	0.010462	5	0.355

Client	BECHTEL
Client ID	B0FBK3
Filename	232111.CHN
LAL parent ID	23211DUP1
Batch	6323211
Live Time	10800
Detector	1
Geometry	N
Aliquot (gms/L)	0.475
Count date	5/31/95 10:49
Collection Date	5/6/95
delta T to midpoint of count	26.1
Efficiency data file	N194
Background, Library files	WBKG1149

Nuclide	keV	Bq	pCi/L	MDA pCi/L	Decay factor	Corrected pCi/L	error 1 sigma	Corrected MDA pCi/L
Ra-226	186.1	-4.995864	-283.9754	189.04	1.000031	-283.98	67.83	189.05
U-235	185.7	0.033482	1.903199	11.49	1	1.903	4.03	11.49
	143.8	0.129653	7.369749	45.32	1	7.370	17.70	45.32
	163.3	0.544616	30.95712	92.40	1	30.957	37.91	92.40
Pb-214(Ra-226)	351.9	0.245458	13.95237	19.19	1.000031	13.953	7.92	19.19
	295.1	-0.185343	-10.53527	37.39	1.000031	-10.536	13.92	37.39
Fe-59	1099.2	0.075674	4.301494	12.71	1.492975	6.422	8.47	18.98
	1291.6	-0.177957	-10.11544	26.82	1.492975	-15.102	5.45	40.04
Co-58	810.8	-0.032109	-1.825116	8.17	1.290933	-2.356	2.84	10.54
Ac-228(Ra-228)	911.2	0.207099	11.77192	41.39	1.008644	11.874	16.10	41.75
	969	-0.468105	-26.60809	69.93	1.008644	-26.838	8.97	70.53
Pb-212	238.6	-0.020182	-1.147198	15.65	1	-1.147	5.63	15.65
	300.1	-0.375943	-21.36939	178.62	1	-21.369	30.25	178.62
Co-60	1332.5	-0.054221	-3.082048	11.73	1.009439	-3.1111	1.55	11.84
	1173.3	-0.106366	-6.046055	12.97	1.009439	-6.1031	1.90	13.09
Cs-137	661.7	0.033456	1.901698	9.58	1.001652	1.9048	2.86	9.60
Eu-155	105.3	-0.026542	-1.508704	20.83	1.010036	-1.524	8.136	21.037
Eu-152	1408.1	-0.248155	-14.10565	56.00	1.003904	-14.16	8.27	56.22
	344.3	-0.046733	-2.656375	22.50	1.003904	-2.67	6.34	22.59
Eu-154	723.3	-0.018379	-1.044687	43.29	1.005838	-1.05	12.68	43.54
	1004.8	-0.694482	-39.47583	61.40	1.005838	-39.71	14.72	61.76
	1274.5	-0.02493	-1.417077	27.58	1.005838	-1.43	7.41	27.74

Client	BECHTEL
Client ID	B0FBK3
Filename	232111.CHN
LAL parent ID	23211DUP1
Batch	6323211
Live Time	10800
Detector	1
Geometry	N
Aliquot (gms/L)	0.475
Count date	5/31/95 10:49
Collection Date	5/6/95
delta T to midpoint of count	26.1
Efficiency data file	N194
Background, Library files	WBKG1149

Nuclide	keV	Counting Error pCi/L	FINAL RESULT pCi/L	Total Error 2 sigma	MDA pCi/L
Ra-226	186.1	132.66	-283.98	135.67	189.05
U-235	185.7	8.06	1.90	8.07	11.49
	143.8	25.28	11.59	32.08	45.32
	163.3				92.40
Pb-214(Ra-226)	351.9	8.28	7.97	13.76	19.19
	295.1				37.39
Fe-59	1099.2	6.07	-8.80	9.17	18.98
	1291.6				40.04
Co-58	810.8	5.68	-2.36	5.69	10.54
Ac-228(Ra-228)	911.2	11.35	-17.68	15.67	41.75
	969				70.53
Pb-212	238.6	3.12	-1.15	11.27	15.65
	300.1		-21.37	60.50	178.62
Co-60	1332.5	2.25	-4.31	2.41	11.84
	1173.3				13.09
Cs-137	661.7	5.72	1.90	5.72	9.60
Eu-155	105.3	16.27	-1.52	16.27	21.04
Eu-152	1408.1	7.83	-6.92	10.07	56.22
	344.3				22.59
Eu-154	723.3	5.44	-7.42	11.73	43.54
	1004.8				61.76
	1274.5				27.74

027

RER:

Cs-137 → $\left|\frac{2.94 - 1.90}{8.14 + 5.72}\right| = .08$

Pb-214 → $\left|\frac{8.79 - 7.97}{13.65 + 13.76}\right| = .03$

FJR 6/1/95

Client	BECHTEL	
Client ID	B0FKH6	
Filename	232112.CHN	
LAL parent ID	23211DUP2	
Batch	6323211	
Live Time	7200	
Detector	1	LAS Detector 1, GMX-30200-P, Ser. No. 30-TN10223A
Geometry	N	
Aliquot (gms/L)	0.5	
Count date	5/30/95 18:25	
Collection Date	5/9/95	
delta T to midpoint of count	22.2	days
Efficiency data file	N194	
Background, Library files	WBKG1149	whc

V94093

Nuclide	keV	halflife (days)	chnl	GROSS	BKG	NET	Hand Calc NET	Sample cnts/sec	1 sig % err
Ra-226	186.1	5.84E+05	372	171	63	108		0.0149537	14.2
U-235	185.7	2.57E+11	372	171	63	108		0.0149537	14.2
	143.8	2.57E+11	288	118	86	32		0.0044444	44.6
	163.3	2.57E+11	327	63	63	0		0	0.0
Pb-214(Ra-226)	351.9	5.84E+05	704	53	31	22		0.0030556	41.7
	295.1	5.84E+05	591	55	41	14		0.0019676	69.1
Fe-59	1099.2	4.51E+01	2198	9	12	-3		-0.00037	170.5
	1291.6	4.51E+01	2583	10	2	8		0.0010648	45.8
Co-58	810.8	7.08E+01	1622	16	16	0		-4.63E-05	1705.9
Ac-228(Ra-228)	911.2	2.10E+03	1822	21	23	-2		-0.000208	439.7
	969	2.10E+03	1938	19	18	1		0.0001389	608.3
Pb-212	238.6	5.11E+12	478	114	56	59		0.008125	22.3
	300.1	5.11E+12	600	45	28	17		0.0023611	50.3
Co-60	1332.5	1924	2665	41	8	34		0.0046528	20.8
	1173.3	1924	2347	39	14	26		0.0035417	28.4
Cs-137	661.7	10950	1324	34	24	10		0.0013889	76.2
Eu-155	105.3	1810	211	84	80	4		0.0005556	320.2
Eu-152	1408.1	4.64E+03	2816	5	7	-2		-0.000278	173.2
	344.3	4.64E+03	689	39	46	-7		-0.000903	141.4
Eu-154	723.3	3.11E+03	1447	32	37	-5		-0.000741	156.1
	1004.8	3.11E+03	2009	13	19	-6		-0.000787	99.3
	1274.5	3.11E+03	2549	11	7	4		0.0005556	106.1

028

Client	BECHTEL
Client ID	B0FKH6
Filename	232112.CHN
LAL parent ID	23211DUP2
Batch	6323211
Live Time	7200
Detector	1
Geometry	N
Aliquot (gms/L)	0.5
Count date	5/30/95 18:25
Collection Date	5/9/95
delta T to midpoint of count	22.2
Efficiency data file	N194
Background, Library files	WBKG1149

Nuclide	keV	WBKG cnts/sec	1 sig % err	NET Sample cnts/sec	NET 1 sig % err	Efficiency	1 sigma % Eff err	Branch
Ra-226	186.1	0.012097	5.6	0.00286	97.95	0.055308	5	0.035
U-235	185.7	0.012097	5.6	0.00286	97.95	0.055389	5	0.575
	143.8	0.002617	23.1	0.00183	141.65	0.063815	5	0.109
	163.3	0.000867	65.4	-0.00087	65.44	0.059981	5	0.05
Pb-214(Ra-226)	351.9	0.0016	27.7	0.00146	117.92	0.03237	5	0.358
	295.1	0.001333	36.4	0.00063	290.98	0.037986	5	0.185
Fe-59	1099.2	3.06E-05	771.7	-0.00040	98.67	0.011918	5	0.565
	1291.6	0.000208	91.7	0.00086	79.26	0.010338	5	0.432
Co-58	810.8	-0.00024	110.1	-0.00005	1705.87	0.015465	5	0.9945
Ac-228(Ra-228)	911.2	0.001046	30.0	-0.00125	47.99	0.014001	5	0.266
	969	0.00045	65.7	-0.00031	366.63	0.013285	5	0.1617
Pb-212	238.6	0.006375	9.3	0.00175	137.23	0.045721	5	0.4365
	300.1	0.0001	430.1	0.00226	71.50	0.037416	5	0.03344
Co-60	1332.5	0.000267	79.1	0.00439	26.86	0.010051	5	0.999
	1173.3	0.000317	72.0	0.00323	38.27	0.011258	5	0.999
Cs-137	661.7	-0.00023	143.3	0.00139	76.16	0.018405	5	0.8521
Eu-155	105.3	0.000581	95.8	-0.00003	9338.86	0.06833	5	0.218
Eu-152	1408.1	0.000225	75.7	-0.00050	61.81	0.009557	5	0.212
	344.3	-0.00014	304.6	-0.00090	141.42	0.033022	5	0.27
Eu-154	723.3	-0.00037	84.1	-0.00074	156.12	0.017049	5	0.197
	1004.8	-0.00018	134.0	-0.00079	99.31	0.012878	5	0.176
	1274.5	-9.4E-05	200.9	0.00056	106.07	0.010462	5	0.355

030

Client	BECHTEL
Client ID	B0FKH6
Filename	232112.CHN
LAL parent ID	23211DUP2
Batch	6323211
Live Time	7200
Detector	1
Geometry	N
Aliquot (gms/L)	0.5
Count date	5/30/95 18:25
Collection Date	5/9/95
delta T to midpoint of count	22.2
Efficiency data file	N194
Background, Library files	WBKG1149

Nuclide	keV	Bq	pCi/L	MDA pCi/L	Decay factor	Corrected pCi/L	error 1 sigma	Corrected MDA pCi/L
Ra-226	186.1	1.475626	79.68383	231.47	1.000026	79.69	78.15	231.47
U-235	185.7	0.08969	4.843242	14.07	1	4.843	4.75	14.07
	143.8	0.262767	14.18941	54.26	1	14.189	20.11	54.26
	163.3	-0.28898	-15.60492	103.54	1	-15.605	10.24	103.54
Pb-214(Ra-226)	351.9	0.125606	6.782707	21.38	1.000026	6.783	8.01	21.38
	295.1	0.090256	4.873813	38.14	1.000026	4.874	14.18	38.14
Fe-59	1099.2	-0.05954	-3.215178	20.87	1.406284	-4.521	4.47	29.36
	1291.6	0.191779	10.35605	19.84	1.406284	14.564	11.57	27.90
Co-58	810.8	-0.00301	-0.162549	9.98	1.242654	-0.202	3.45	12.40
Ac-228(Ra-228)	911.2	-0.336753	-18.18465	56.77	1.007349	-18.318	8.84	57.19
	969	-0.144828	-7.82072	84.28	1.007349	-7.878	28.89	84.90
Pb-212	238.6	0.087688	4.735158	18.62	1	4.735	6.50	18.62
	300.1	1.807191	97.5883	165.62	1	97.588	69.95	165.62
Co-60	1332.5	0.436813	23.58789	12.68	1.008024	23.7772	6.50	12.79
	1173.3	0.286743	15.48413	14.12	1.008024	15.6084	6.02	14.24
Cs-137	661.7	0.088559	4.782211	11.81	1.001405	4.7889	3.65	11.83
Eu-155	105.3	-0.001678	-0.090628	22.85	1.008532	-0.091	8.536	23.040
Eu-152	1408.1	-0.248155	-13.40037	60.57	1.00332	-13.44	8.34	60.77
	344.3	-0.101254	-5.467704	28.37	1.00332	-5.49	7.76	28.46
Eu-154	723.3	-0.220545	-11.90943	67.21	1.004965	-11.97	18.70	67.55
	1004.8	-0.347241	-18.75102	73.09	1.004965	-18.84	18.74	73.45
	1274.5	0.14958	8.077341	29.08	1.004965	8.12	8.62	29.22

232112.XLS

Client	BECHTEL
Client ID	B0FKH6
Filename	232112.CHN
LAL parent ID	23211DUP2
Batch	6323211
Live Time	7200
Detector	1
Geometry	N
Aliquot (gms/L)	0.5
Count date	5/30/95 18:25
Collection Date	5/9/95
delta T to midpoint of count	22.2
Efficiency data file	N194
Background, Library files	WBKG1149

Nuclide	keV	Counting Error pCi/L	FINAL RESULT pCi/L	Total Error 2 sigma	MDA pCi/L
Ra-226	186.1	156.10	79.69	156.30	231.47
U-235	185.7	9.49	4.84	9.50	14.07
	143.8	11.25	-9.47	18.25	54.26
	163.3				103.54
Pb-214(Ra-226)	351.9	13.82	6.32	13.94	21.38
	295.1				38.14
Fe-59	1099.2	2.53	-2.04	8.33	29.36
	1291.6				27.90
Co-58	810.8	6.89	-0.20	6.89	12.40
Ac-228(Ra-228)	911.2	16.58	-17.42	16.90	57.19
	969				84.90
Pb-212	238.6	6.01	4.74	13.01	18.62
	300.1		97.59	139.90	165.62
Co-60	1332.5	8.52	19.39	8.83	12.79
	1173.3				14.24
Cs-137	661.7	7.29	4.79	7.31	11.83
Eu-155	105.3	17.07	-0.09	17.07	23.04
Eu-152	1408.1	10.40	-9.18	11.36	60.77
	344.3				28.46
Eu-154	723.3	1.46	1.11	14.45	67.55
	1004.8				73.45
	1274.5				29.22

RER%

Pb-214 → $\left|\frac{12.27 - 6.32}{13.22 + 13.94}\right| = 0.22$

Cs-137 → $\left|\frac{-7.17 - 4.79}{3.96 + 7.31}\right| = 1.06$

JK 6/1/95

040

Client	BECHTEL	
Client ID	BOFBK3	
Filename	232115.CHN	
LAL parent ID	L4467-2	
Batch	6323211	
Live Time	10800	
Detector	2	LAS Detector 2, GMX-30200-P, Ser. No. 30-TN10348
Geometry	N	
Aliquot (gms/L)	0.475	
Count date	5/30/95 18:36	
Collection Date	5/6/95	
delta T to midpoint of count	25.4	days
Efficiency data file	N294	
Background, Library files	WBKG2149	whc

V94093

Nuclide	keV	halflife (days)	chnl	GROSS	BKG	NET	Hand Calc NET	Sample cnts/sec	1 sig % err
Ra-226	186.1	5.84E+05	372	241	94	147		0.0135957	12.5
U-235	185.7	2.57E+11	372	241	94	147		0.0135957	12.5
	143.8	2.57E+11	288	138	115	23		0.0021296	69.2
	163.3	2.57E+11	327	113	114	-1		-9.26E-05	1506.7
Pb-214(Ra-226)	351.9	5.84E+05	704	89	59	30		0.0027778	40.6
	295.1	5.84E+05	591	106	77	29		0.0026852	46.6
Fe-59	1099.2	4.51E+01	2198	19	14	5		0.000463	114.9
	1291.6	4.51E+01	2583	13	7	6		0.0005556	74.5
Co-58	810.8	7.08E+01	1622	23	14	9		0.0008333	67.6
Ac-228(Ra-228)	911.2	2.10E+03	1822	41	23	19		0.001713	43.1
	969	2.10E+03	1938	27	14	13		0.0012037	49.3
Pb-212	238.6	5.11E+12	478	154	74	81		0.0074537	18.7
	300.1	5.11E+12	600	67	72	-5		-0.000463	235.8
Co-60	1332.5	1924	2665	11	5	7		0.0006019	60.6
	1173.3	1924	2347	22	14	9		0.000787	70.1
Cs-137	661.7	10950	1324	46	32	14		0.0012963	63.1
Eu-155	105.3	1810	211	104	118	-14		-0.00125	110.2
Eu-152	1408.1	4.64E+03	2816	12	4	9		0.000787	46.3
	344.3	4.64E+03	689	62	63	-1		-9.26E-05	1118.0
Eu-154	723.3	3.11E+03	1447	32	26	6		0.0005864	119.9
	1004.8	3.11E+03	2009	17	30	-13		-0.001235	51.6
	1274.5	3.11E+03	2549	9	8	1		7.716E-05	497.2

Client	BECHTEL
Client ID	BOFBK3
Filename	232115.CHN
LAL parent ID	L4467-2
Batch	6323211
Live Time	10800
Detector	2
Geometry	N
Aliquot (gms/L)	0.475
Count date	5/30/95 18:36
Collection Date	5/6/95
delta T to midpoint of count	25.4
Efficiency data file	N294
Background, Library files	WBKG2149

Nuclide	keV	WBKG cnts/sec	1 sig % err	NET Sample cnts/sec	NET 1 sig % err	Efficiency	1 sigma % Eff err	Branch
Ra-226	186.1	0.013392	5.0	0.00020	1156.50	0.055571	5	0.035
U-235	185.7	0.013392	5.0	0.00020	1156.50	0.055656	5	0.575
	143.8	0.003317	18.4	-0.00119	175.41	0.064542	5	0.109
	163.3	0.0015	37.2	-0.00159	52.57	0.060486	5	0.05
Pb-214(Ra-226)	351.9	0.001383	33.1	0.00139	113.62	0.032285	5	0.358
	295.1	0.000822	58.8	0.00186	93.21	0.03788	5	0.185
Fe-59	1099.2	-0.00011	200.0	0.00046	114.89	0.012002	5	0.565
	1291.6	-0.0005	39.2	0.00056	74.54	0.010402	5	0.432
Co-58	810.8	-3.9E-05	720.1	0.00083	67.59	0.01556	5	0.9945
Ac-228(Ra-228)	911.2	0.000713	40.5	0.00100	102.57	0.014097	5	0.266
	969	0.000667	42.4	0.00054	163.07	0.013378	5	0.1617
Pb-212	238.6	0.006775	8.8	0.00068	293.61	0.045685	5	0.4365
	300.1	0.00065	67.8	-0.00111	58.49	0.03731	5	0.03344
Co-60	1332.5	0.000283	78.7	0.00032	184.45	0.01011	5	0.999
	1173.3	0.000642	35.9	0.00015	538.16	0.011335	5	0.999
Cs-137	661.7	0.000483	63.7	0.00081	138.45	0.018483	5	0.8521
Eu-155	105.3	0.000494	113.6	-0.00174	46.79	0.068697	5	0.218
Eu-152	1408.1	0.000417	41.8	0.00037	145.41	0.009607	5	0.212
	344.3	-0.00018	247.8	-0.00009	1118.03	0.032933	5	0.27
Eu-154	723.3	-0.00084	33.9	0.00059	119.90	0.017137	5	0.197
	1004.8	-0.00031	78.5	-0.00123	51.60	0.012969	5	0.176
	1274.5	1.39E-05	1363.8	0.00006	905.71	0.010528	5	0.355

041

Client	BECHTEL
Client ID	BOFBK3
Filename	232115.CHN
LAL parent ID	L4467-2
Batch	6323211
Live Time	10800
Detector	2
Geometry	N
Aliquot (gms/L)	0.475
Count date	5/30/95 18:36
Collection Date	5/6/95
delta T to midpoint of count	25.4
Efficiency data file	N294
Background, Library files	WBKG2149

Nuclide	keV	Bq	pCi/L	MDA pCi/L	Decay factor	Corrected pCi/L	error 1 sigma	Corrected MDA pCi/L
Ra-226	186.1	0.104891	5.962239	201.78	1.00003	5.96	68.96	201.78
U-235	185.7	0.006375	0.362368	12.26	1	0.362	4.19	12.26
	143.8	-0.168731	-9.591034	44.75	1	-9.591	16.83	44.75
	163.3	-0.526603	-29.9332	97.05	1	-29.933	15.81	97.05
Pb-214(Ra-226)	351.9	0.120647	6.857857	19.44	1.00003	6.858	7.80	19.44
	295.1	0.26584	15.11093	34.40	1.00003	15.111	14.10	34.40
Fe-59	1099.2	0.068272	3.880732	15.00	1.47754	5.734	6.59	22.16
	1291.6	0.123632	7.027517	10.00	1.47754	10.383	7.76	14.77
Co-58	810.8	0.053851	3.061025	6.75	1.282413	3.925	2.66	8.66
Ac-228(Ra-228)	911.2	0.266807	15.16586	39.67	1.008419	15.294	15.70	40.00
	969	0.248254	14.11128	58.68	1.008419	14.230	23.22	59.18
Pb-212	238.6	0.034035	1.934608	15.58	1	1.935	5.68	15.58
	300.1	-0.892057	-50.7064	185.81	1	-50.706	29.77	185.81
Co-60	1332.5	0.031535	1.792537	8.07	1.009193	1.8090	3.34	8.15
	1173.3	0.012838	0.729719	11.03	1.009193	0.7364	3.96	11.13
Cs-137	661.7	0.051619	2.934117	10.39	1.001609	2.9388	4.07	10.40
Eu-155	105.3	-0.116483	-6.621127	19.06	1.009775	-6.686	3.146	19.251
Eu-152	1408.1	0.181844	10.3364	40.99	1.003802	10.38	15.10	41.15
	344.3	-0.010413	-0.591909	23.11	1.003802	-0.59	6.64	23.20
Eu-154	723.3	0.1737	9.873466	33.77	1.005686	9.93	11.92	33.96
	1004.8	-0.540854	-30.74327	61.93	1.005686	-30.92	16.03	62.28
	1274.5	0.016929	0.962277	22.70	1.005686	0.97	8.77	22.83

043

Client	BECHTEL
Client ID	BOFBK3
Filename	232115.CHN
LAL parent ID	L4467-2
Batch	6323211
Live Time	10800
Detector	2
Geometry	N
Aliquot (gms/L)	0.475
Count date	5/30/95 18:36
Collection Date	5/6/95
delta T to midpoint of count	25.4
Efficiency data file	N294
Background, Library files	WBKG2149

Nuclide	keV	Counting Error pCi/L	FINAL RESULT pCi/L	Total Error 2 sigma	MDA pCi/L
Ra-226	186.1	137.91	5.96	137.91	201.78
U-235	185.7	8.38	0.36	8.38	12.26
	143.8	20.55	-20.40	23.04	44.75
	163.3				97.05
Pb-214(Ra-226)	351.9	12.67	8.79	13.65	19.44
	295.1				34.40
Fe-59	1099.2	9.61	7.68	10.05	22.16
	1291.6				14.77
Co-58	810.8	5.31	3.93	5.32	8.66
Ac-228(Ra-228)	911.2	25.98	14.96	26.02	40.00
	969				59.18
Pb-212	238.6	2.22	1.93	11.36	15.58
	300.1		-50.71	59.54	185.81
Co-60	1332.5	4.76	1.36	5.11	8.15
	1173.3				11.13
Cs-137	661.7	8.14	2.94	8.14	10.40
Eu-155	105.3	6.26	-6.69	6.29	19.25
Eu-152	1408.1	3.42	1.19	12.16	41.15
	344.3				23.20
Eu-154	723.3	1.49	-1.58	12.92	33.96
	1004.8				62.28
	1274.5				22.83

6/1/95

044

Client	BECHTEL	
Client ID	BOFKH6	
Filename	232116.CHN	
LAL parent ID	L4482-8	
Batch	6323211	
Live Time	10800	
Detector	2	LAS Detector 2, GMX-30200-P, Ser. No. 30-TN10348
Geometry	N	
Aliquot (gms/L)	0.5	
Count date	5/31/95 10:50	
Collection Date	5/9/95	
delta T to midpoint of count	23.1	days
Efficiency data file	N294	
Background, Library files	WBKG2149	whc

V94093

Nuclide	keV	halflife (days)	chnl	GROSS	BKG	NET	Hand Calc NET	Sample cnts/sec	1 sig % err
Ra-226	186.1	5.84E+05	372	229	86	143		0.0132562	12.4
U-235	185.7	2.57E+11	372	229	86	143		0.0132562	12.4
	143.8	2.57E+11	288	139	123	16		0.0014815	101.2
	163.3	2.57E+11	327	137	105	32		0.002963	48.6
Pb-214(Ra-226)	351.9	5.84E+05	704	103	55	48		0.0044444	26.2
	295.1	5.84E+05	591	99	82	17		0.0016049	77.5
Fe-59	1099.2	4.51E+01	2198	16	12	4		0.0004012	121.4
	1291.6	4.51E+01	2583	9	11	-2		-0.000139	294.4
Co-58	810.8	7.08E+01	1622	23	16	7		0.0006173	94.1
Ac-228(Ra-228)	911.2	2.10E+03	1822	37	28	9		0.0008218	90.9
	969	2.10E+03	1938	37	18	19		0.0017593	39.0
Pb-212	238.6	5.11E+12	478	189	96	93		0.0086111	18.2
	300.1	5.11E+12	600	58	68	-10		-0.000926	112.2
Co-60	1332.5	1924	2665	67	8	60		0.0055093	14.5
	1173.3	1924	2347	72	18	54		0.005	17.6
Cs-137	661.7	10950	1324	36	53	-17		-0.001605	54.5
Eu-155	105.3	1810	211	121	123	-2		-0.000216	669.9
Eu-152	1408.1	4.64E+03	2816	10	9	1		6.173E-05	659.5
	344.3	4.64E+03	689	61	85	-24		-0.002238	50.0
Eu-154	723.3	3.11E+03	1447	25	28	-3		-0.000278	242.7
	1004.8	3.11E+03	2009	16	25	-9		-0.000787	74.9
	1274.5	3.11E+03	2549	16	12	4		0.0004012	121.4

045

Client	BECHTEL
Client ID	BOFKH6
Filename	232116.CHN
LAL parent ID	L4482-8
Batch	6323211
Live Time	10800
Detector	2
Geometry	N
Aliquot (gms/L)	0.5
Count date	5/31/95 10:50
Collection Date	5/9/95
delta T to midpoint of count	23.1
Efficiency data file	N294
Background, Library files	WBKG2149

Nuclide	keV	WBKG cnts/sec	1 sig % err	NET Sample cnts/sec	NET 1 sig % err	Efficiency	1 sigma % Eff err	Branch
Ra-226	186.1	0.013392	5.0	-0.00370	62.33	0.055571	5	0.035
U-235	185.7	0.013392	5.0	-0.00014	1702.80	0.055656	5	0.575
	143.8	0.003317	18.4	-0.00184	114.87	0.064542	5	0.109
	163.3	0.0015	37.2	0.00146	136.58	0.060486	5	0.05
Pb-214(Ra-226)	351.9	0.001383	33.1	0.00306	52.98	0.032285	5	0.358
	295.1	0.000822	58.8	0.00078	220.82	0.03788	5	0.185
Fe-59	1099.2	-0.00011	200.0	0.00040	121.38	0.012002	5	0.565
	1291.6	-0.0005	39.2	-0.00014	294.39	0.010402	5	0.432
Co-58	810.8	-3.9E-05	720.1	0.00062	94.07	0.01556	5	0.9945
Ac-228(Ra-228)	911.2	0.000713	40.5	0.00011	947.78	0.014097	5	0.266
	969	0.000667	42.4	0.00109	88.74	0.013378	5	0.1617
Pb-212	238.6	0.006775	8.8	0.00184	117.60	0.045685	5	0.4365
	300.1	0.00065	67.8	-0.00158	37.99	0.03731	5	0.03344
Co-60	1332.5	0.000283	78.7	0.00523	19.56	0.01011	5	0.999
	1173.3	0.000642	35.9	0.00436	25.45	0.011335	5	0.999
Cs-137	661.7	0.000483	63.7	-0.00209	27.17	0.018483	5	0.8521
Eu-155	105.3	0.000494	113.6	-0.00071	124.63	0.068697	5	0.218
Eu-152	1408.1	0.000417	41.8	-0.00035	163.73	0.009607	5	0.212
	344.3	-0.00018	247.8	-0.00224	50.03	0.032933	5	0.27
Eu-154	723.3	-0.00084	33.9	-0.00028	242.67	0.017137	5	0.197
	1004.8	-0.00031	78.5	-0.00079	74.87	0.012969	5	0.176
	1274.5	1.39E-05	1363.8	0.00039	174.64	0.010528	5	0.355

046

Client	BECHTEL
Client ID	BOFKH6
Filename	232116.CHN
LAL parent ID	L4482-8
Batch	6323211
Live Time	10800
Detector	2
Geometry	N
Aliquot (gms/L)	0.5
Count date	5/31/95 10:50
Collection Date	5/9/95
delta T to midpoint of count	23.1
Efficiency data file	N294
Background, Library files	WBKG2149

Nuclide	keV	Bq	pCi/L	MDA pCi/L	Decay factor	Corrected pCi/L	error 1 sigma	Corrected MDA pCi/L
Ra-226	186.1	-1.903227	-102.7742	188.44	1.000027	-102.78	64.26	188.44
U-235	185.7	-0.004234	-0.228632	11.45	1	-0.229	3.89	11.45
	143.8	-0.260862	-14.08655	43.58	1	-14.087	16.20	43.58
	163.3	0.48374	26.12194	89.12	1	26.122	35.70	89.12
Pb-214(Ra-226)	351.9	0.264848	14.30177	18.00	1.000027	14.302	7.61	18.00
	295.1	0.111692	6.031355	33.50	1.000027	6.032	13.32	33.50
Fe-59	1099.2	0.059169	3.195136	13.07	1.42571	4.555	5.53	18.64
	1291.6	-0.030908	-1.669035	14.67	1.42571	-2.380	7.01	20.91
Co-58	810.8	0.03989	2.154054	6.87	1.253564	2.700	2.54	8.61
Ac-228(Ra-228)	911.2	0.029138	1.573431	40.72	1.007646	1.585	15.03	41.03
	969	0.505069	27.2737	60.22	1.007646	27.482	24.43	60.68
Pb-212	238.6	0.092075	4.972047	15.84	1	4.972	5.85	15.84
	300.1	-1.263129	-68.20897	172.27	1	-68.209	26.14	172.27
Co-60	1332.5	0.5174	27.93961	8.82	1.008348	28.1729	5.69	8.90
	1173.3	0.384884	20.78375	11.45	1.008348	20.9573	5.43	11.54
Cs-137	661.7	-0.132594	-7.160069	12.16	1.001462	-7.1705	1.98	12.17
Eu-155	105.3	-0.047442	-2.56188	18.52	1.008877	-2.585	3.224	18.680
Eu-152	1408.1	-0.174267	-9.410427	49.11	1.003454	-9.44	15.47	49.28
	344.3	-0.251653	-13.58924	25.38	1.003454	-13.64	6.86	25.47
Eu-154	723.3	-0.082279	-4.44306	33.98	1.005165	-4.47	10.84	34.16
	1004.8	-0.344794	-18.61889	52.77	1.005165	-18.72	14.04	53.04
	1274.5	0.103638	5.596461	25.01	1.005165	5.63	9.83	25.14

047

Client	BECHTEL
Client ID	BOFKH6
Filename	232116.CHN
LAL parent ID	L4482-8
Batch	6323211
Live Time	10800
Detector	2
Geometry	N
Aliquot (gms/L)	0.5
Count date	5/31/95 10:50
Collection Date	5/9/95
delta T to midpoint of count	23.1
Efficiency data file	N294
Background, Library files	WBKG2149

Nuclide	keV	Counting Error pCi/L	FINAL RESULT pCi/L	Total Error 2 sigma	MDA pCi/L
Ra-226	186.1	128.12	-102.78	128.53	188.44
U-235	185.7	7.79	-0.23	7.79	11.45
	143.8	12.70	-7.22	29.50	43.58
	163.3				89.12
Pb-214(Ra-226)	351.9	12.64	12.27	13.22	18.00
	295.1				33.50
Fe-59	1099.2	4.24	1.89	8.69	18.64
	1291.6				20.91
Co-58	810.8	5.08	2.70	5.09	8.61
Ac-228(Ra-228)	911.2	15.37	8.70	25.60	41.03
	969				60.68
Pb-212	238.6	3.59	4.97	11.71	15.84
	300.1		-68.21	52.27	172.27
Co-60	1332.5	7.57	24.40	7.86	8.90
	1173.3				11.54
Cs-137	661.7	3.90	-7.17	3.96	12.17
Eu-155	105.3	6.44	-2.58	6.45	18.68
Eu-152	1408.1	12.39	-12.95	12.54	49.28
	344.3				25.47
Eu-154	723.3	4.13	-3.12	12.93	34.16
	1004.8				53.04
	1274.5				25.14

6/1/95

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National Institute of Standards & Technology

Certificate

Standard Reference Material 4275C
Radioactivity Standard

MIXED-RADIONUCLIDE POINT-SOURCE STANDARD
for the
EFFICIENCY CALIBRATION OF GERMANIUM-SPECTROMETER SYSTEMS

Antimony-125-Tellurium-125m
Europium-154
Europium-155

Source identification	SRM 4275C-62
Source description	Point source on polyester tape [(1)*]
Reference time	1200 EST September 1, 1988

This standard is intended for use in measuring the full-energy-peak efficiencies of spectrometry systems for x and gamma rays from 27 to 1596 keV, provided that the responses to radiations approximately 5 keV apart can be resolved. Emission rates are specified at 18 energies for photon radiations from a mixture of antimony-125-tellurium-125m, europium-154, and europium-155. Uncertainties are estimated and combined at a level corresponding to a standard deviation of the mean, with the intent that the user can propagate this uncertainty along with the other uncertainties in the spectrometer calibration. For a more conservative overall uncertainty corresponding to that given on other NIST radioactivity certificates, multiply the combined uncertainty by three.

Table 1 gives the energies, emission rates, and uncertainties for selected radiations. A footnote indicates how emission rates will change with time. If there are any changes in measured emission rates that would correspond to an emission rate 0.5 percent different from that calculated from Table 1, or in measured half lives that would cause a corresponding difference after five years, notification will be sent to purchasers of the standard.

Table 2 lists the estimates of component uncertainties which have been added in quadrature to give the combined uncertainty in each emission rate.

Notes on the use of this standard are appended. One of the tables in the supplemental notes gives relative emission rates for radiations close in energy to the certified radiations; for spectrometry systems of poorer resolution, it may be necessary to use a combined emission rate for some multiple peaks.

This Standard Reference Material was prepared in the Center for Radiation Research, Ionizing Radiation Division, Radioactivity Group, Dale D. Hoppes, Group Leader.

Gaithersburg, MD 20899
September, 1988

Stanley D. Rasberry, Chief
Office of Standard Reference Materials

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*Notes on page 4

TABLE 1

X-Ray and Gamma-Ray Energies, Emission Rates [2,3], and Uncertainties for Standard Reference Material 4275C-62

Radionuclide	Photon Energy (keV)	Emission Rate ($\times s^{-1}$) or (γs^{-1}) 1200 EST September 1, 1988	Total Estimated Uncertainty (%)*
^{125}Sb-^{125m}Te	Kα, 27.4	3.246×10^4	1.3
^{154}Eu-^{155}Eu	Kα, 42.8	1.915×10^4	1.3
^{155}Eu	86.5	7.330×10^3	0.9
^{155}Eu	105.3	5.104×10^3	1.3
^{154}Eu	123.1	2.982×10^4	0.8
^{125}Sb	176.3	3.562×10^3	0.6
^{154}Eu	247.7	5.055×10^3	0.6
^{125}Sb	427.9	1.548×10^4	0.8
^{125}Sb	463.4	5.444×10^3	0.7
^{154}Eu	591.8	3.618×10^3	0.6
^{125}Sb	600.6	9.199×10^3	0.7
^{125}Sb	635.9	5.878×10^3	0.6
^{154}Eu	723.3	1.468×10^4	0.6
^{154}Eu	873.2	8.910×10^3	0.7
^{154}Eu	996.3	7.629×10^3	0.9
^{154}Eu	1004.7	1.323×10^4	0.7
^{154}Eu	1274.5	2.549×10^4	0.5
^{154}Eu	1596.4	1.296×10^3	0.7

* Estimated total uncertainties have the significance of one standard deviation of the mean. Components of these estimates are given in Table 2.

TABLE 2

Estimates of the Component Uncertainties for Photon-Emission-Rate Values for SRM 4275C

TYPICAL UNCERTAINTY COMPONENTS (%)

Photon Energy (keV)	Number of Determi-nations	Std. Dev. of the Mean	Effici-ency	Peak Analysis	Pile-up Compen-sation	Geometry	Other*	Combined Uncer-tainty**
27.4	6	0.3	1.0	0.7	0.3	0.1	0.3	1.3
42.8	12	0.05	1.0	0.7	0.1	0.1	0.3	1.3
86.5	12	0.06	0.70	0.5	0.1	0.1	0.3	0.9
105.3	12	0.06	1.2	0.5	0.1	0.1	0.4	1.3
123.1	6	0.08	0.6	0.4	0.1	0.08	0.4	0.8
176.3	6	0.09	0.5	0.2	0.2	0.1	0.4	0.6
247.7	6	0.04	0.5	0.3	0.1	0.08	0.4	0.6
427.9	6	0.23	0.7	0.2	0.2	0.08	0.4	0.8
463.4	7	0.22	0.58	0.2	0.2	0.08	0.4	0.7
591.8	6	0.12	0.45	0.3	0.1	0.08	0.4	0.6
600.6	7	0.20	0.42	0.4	0.2	0.08	0.4	0.7
635.9	6	0.19	0.42	0.2	0.2	0.08	0.4	0.6
723.3	6	0.05	0.54	0.2	0.1	0.08	0.4	0.6
873.2	5	0.12	0.63	0.3	0.1	0.08	0.4	0.7
996.3	5	0.11	0.54	0.75	0.1	0.08	0.4	0.9
1004.7	5	0.06	0.54	0.4	0.1	0.08	0.4	0.7
1274.5	5	0.06	0.45	0.1	0.1	0.08	0.4	0.5
1596.4	6	0.43	0.40	0.1	0.2	0.15	0.4	0.7

* Includes contributions for the half lives for the Te x ray, for the decay schemes for the Gd x ray, and for gravimetric factors in the source preparation.

**Components of the uncertainty have been added in quadrature. This is the uncertainty for a typical detector, and some of the values are slightly greater than those given in the last column in Table 1.

NOTES

1) Sample consists of a dried deposit of the radionuclides between two layers of polyester type 0.006-cm thick which are mounted on an aluminum annulus (3.8-cm inside diameter and 5.4-cm outside diameter).

2) These values are based on gamma-ray spectrometry measurements made at the National Institute of Standards and Technology, which are described in the reference: B.M. Coursey, D.D. Hoppes, and F.J. Schima, "Determination of the Photon Emission Rates of the NBS Long-Lived Mixed-Radionuclide Standard", Nuclear Instruments and Methods 193, 1 (1982).

3) Emission rates at later times can be calculated using the following evaluated half-life values and decay constants:

	Half Life	Decay Constant
^{125}Sb	1008 ± 2 days	6.876×10^{-4} days^{-1}
^{154}Eu	3141 ± 12 days	2.207×10^{-4} days^{-1}
^{155}Eu	1738 ± 4 days	3.986×10^{-4} days^{-1}

4) For the 42.8-keV Gd K_α x rays, the emission rate N_t is given by

$$N_t = N_o \times (0.6724\ e^{-2.207 \times 10^{-4}\ t} + 0.3276\ e^{-3.986 \times 10^{-4}\ t}),$$

where N_o is the emission rate given in Table 1, and t is the time in days from 1200 EST September 1, 1988.

For further information contact Dr. F.J. Schima (301) 975-5537 or Dr. D.D. Hoppes (301) 975-5532.

U. S. Department of Commerce
Malcolm Baldrige
Secretary
National Bureau of Standards
Ernest Ambler, Director

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Standard Reference Material 4288

Radioactivity Standard

Radionuclide	Technetium-99
Source identification	4288-83
Source description	Liquid in NBS borosilicate-glass ampoule
Solution composition	59.31 μg of Tc(VII) as potassium pertechnetate per gram of approximately 0.001 molar KOH (1)*
Mass	4.910 grams
Radioactivity concentration	3.759×10^4 Bq g^{-1}
Reference time	November, 1982
Measuring instrument	Liquid-scintillation counter (2)
Random uncertainty	0.27 percent (3)
Systematic uncertainty	1.35 percent (4)
Total uncertainty (Random plus systematic)	1.62 percent
Photon-emitting impurities	None observed (5)
Half life	$(2.111 \pm 0.036) \times 10^5$ years (6)

This Standard Reference Material was prepared in the Center for Radiation Research, Nuclear Radiation Division, Radioactivity Group, Dale D. Hoppes, Group Leader.

Washington, D.C. 20234
November, 1982

George A. Uriano, Chief
Office of Standard Reference Materials

*Notes on back

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FOOTNOTES

(1) The $KTcO_4$ was prepared by M.W. Heitzmann of the U.S. Food and Drug Administration from NH_4TcO_4 obtained from Oak Ridge National Laboratory. The solution density is 0.998 g cm^{-3} at 21.8°C, and the $KTcO_4$ concentration is 0.00060 molar. The UV spectrum of this material exhibited only the characteristic doublets at 243 and 287 nm [A].≠

(2) Two liquid-scintillation counters were calibrated using the method of J.A.B. Gibson [B,C,D]. Three different radionuclides were used as the standard: ^3H, ^{14}C, and ^{60}Co. The results obtained using the three radionuclides agreed to within 0.32 percent. The ^{14}C result was used for confirmation only. The value given here is the unweighted mean of the ^3H and ^{60}Co results.

(3) Half the 99-percent confidence interval for the average of the ^3H result and the ^{60}Co result. The standard deviation of the mean of the ^3H result is 0.15 percent based on 6 degrees of freedom, and the standard deviation of the mean of the ^{60}Co result is 0.09 percent based on 9 degrees of freedom.

(4) The systematic uncertainty is the average of that for the ^3H result, 1.20 percent, and that for the ^{60}Co result, 1.49 percent. These values are linear sums of estimated upper limits of uncertainties due to the following:

	^3H	^{60}Co
a) reference material for standard radionuclide	0.63	0.68
b) source preparation	0.07	0.17
c) theoretical model	0.30	0.20
d) gamma-ray contribution to beta-particle detector		0.24
e) quenching	0.10	0.10
f) interpolation from calibration curve	0.10	0.10
	1.20	1.49

(5) The master solution from which these standards were prepared was examined with germanium gamma-ray spectrometers and no impurity was found. Limits of detection as a ratio of gamma-ray-emission rate to technetium-99 activity are

1×10^{-6} between 90 and 300 keV
1×10^{-7} between 300 and 1900 keV.

(6) NBS-measured half life based on the formula $T_{1/2} = N \ln(2)/A$, where N is the number of atoms, computed using an atomic mass for technetium-99 of 98.906254 ± 0.000002 grams and the gravimetrically determined mass of technetium-99, and A is the activity determined by liquid-scintillation counting. The value recommended by the Oak Ridge Nuclear Data Project is $(2.13 \pm 0.05) \times 10^5$ years. [E]

≠ References on last page

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The following individuals and organizations contributed to the characterization of this Standard Reference Material.

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B. Gale, H.J. and Gibson, J.A.B., Atomic Energy Research Establishment Report AERE-R5067 (1965), Harwell, United Kingdom.

C. Gibson, J.A.B. and Marshall, M., Int. J. Appl. Radiat. Isotopes, 23, 321 (1972).

D. Gibson, J.A.B., Computed counting efficiencies as a function of merit figure for 14 beta-particle-emitting radionuclides (July, 1980). Unpublished data.

E. Kocher, D.C., Radioactive Decay Data Tables DOC/TIC-11026, p. 108 (1981). Available from NTIS, Springfield, VA.

ISOTOPE WEIGHT DILUTION RECORD

Isotope: Tc-99 Vendor: NIST

Total Received Activity: 1.85 E 5 Bq Vendor ID: SRM 4288.

Wt. Received: 4.91 g (in 0.001 m KOH) - NIST Traceable Y / N Source ~~Cert.~~ # 4288-83

Activity in Units/g: 3.759 X 10^4 Bq/g Reference Date: NOV 1982

x 60/2.22 = 1.016 E 6 pci/g

Activity converted (dpm/g): 4.988 x 10^6 pci ~~dpm/g~~ Total Receive Date: ~~3-29-92~~ 3-30-1992 AW 7-23-93

Halflife (Yrs or days) t½ = 2.111 E 5 yrs * Receiver's Name: J. Morales

PRIMARY DILUTION: Balance wt. check done (✓)

a: Source activity: 1.016 E 6 pci/g ~~dpm/g~~ rgs * (if t½ = <100yr decay to prep. date)

b: Wt. of Source transfered: 4.8698 g

AA0128 Diluted

Diluent used: 0.1 m NH_4OH

c: Total diluted weight: 146.81 g

d: Activity of dilution (a*b/c): 3.37 E 4 pci/g ~~dpm/g~~ rgs

100 mL = 99.56 g

e: Calculated density of solution: .9956 g/mL ~~(4M HNO_3~~

f: Activity by volume = (d*e): 3.355 E 4 pci/mL ~~dpm/mL~~ rgs

Dilution Log Book ID: LAL 92-353-100-1

Preparation Date: 6/16/93 Preparer's Name: [signature]

U.S. Department of Commerce
National Institute of Standards and Technology AA0128
^{99}Tc Radioactivity Standard
Amount 3.759 x 10^4 Bq g^{-1}
Date November 1, 1982
SRM 4288
CAUTION
RADIOACTIVE

SECONDARY OR WORKING LEVEL DILUTION Balance wt. check done (✓)

Log Book ID of source being diluted: LAL 92-353-100-1

a: Source activity: 3.355 E 4 pci/mL ~~dpm/g~~ rgs * (if t½ = <100yr decay to prep. date)

b: Wt. of Source transfered: 2.3211 g

Diluent used: 0.1 m NH_4OH

c: Total diluted weight: 71.89 g

d: Activity of dilution (a*b/c): N/A dpm/g

e: Calculated density of solution: N/A g/mL (4M HNO_3 = 1.1294 ± .0007 g/mL)

f: Activity by volume = (d*e): 1083 pci/mL ~~dpm/mL~~ rgs

Dilution Log Book ID: LAL 92-353-100-2

Preparer's Name: [signature] Preparation Date: 6/16/93

Reviewed By: [signature] Review Date: 6/16/93

082

AA00128

SECONDARY/WORKING LEVEL STANDARD DILUTION RECORD

Dilution Source Information	
Isotope:	Tc-99
Parent Barcode Number	AA0128
Vendor or Certificate I.D. # of Parent Standard:	SRM 4288
Diluted Source Logbook I.D. #:	92-353-100-1
Balance Verification?:	yes
Diluent Used:	0.1 M NH4OH

Dilution		
*Diluent:	0.1 M NH4OH	
*Density of diluent (g/ml):	0.9956	g/ml
a: Parent Specific Activity:	3.355 E4	~~pCi/g~~ BW 11-16-94 pCi/mL
b: Amount of Source Transferred:	36.0938	g
c: Total amount of Dilution:	123.36	g
d: Total Volume of Dilution:	N/A	ml
e: Activity of Dilution (a * b / c):	N/A	pCi/g
f: Activity of Dilution (a * b / d):	9816.37	pCi/ml
Dilution Logbook I.D. #:	94-677-17-1	

Prepared By: Agnes Wong Preparation Date: 11-16-94

Reviewed By: Joe Hutchison Review Date: 11/17/94

*If the diluent remains unchanged from the diluent used for the dilution source, then a weight dilution of a volume unit source can be performed without a density conversion. If the diluent changes, a weighted proportion density conversion is necessary.

CERTIFICATE OF CALIBRATION
BETA STANDARD SOLUTION

Radionuclide	Tc-99	Customer:	LOCKHEED ENGINEERING & SCIENCES Co.
Half Life:	(2.13 ± 0.05) x 10^5 years	P.O.No.:	06LAB1036
Catalog No.:	7099	Reference Date:	September 1 1991 12:00 PST.
Source No.:	389-22-1	Contained Radioactivity:	1.003 µCi.

Description of Solution

a. Mass of solution: 4.9929 grams.

b. Chemical form: NH_4TcO_4 in 0.1M NH_4OH

c. Carrier content: None added

d. Density: 0.9974 gram/ml @ 20°C.

Radioimpurities

None detected

Radioactive Daughters

None

Radionuclide Concentration

0.201 µCi/gram.

Method of Calibration

Weighed aliquots of the solution were assayed using a liquid scintillation counter.

Uncertainty of Measurement

a. Systematic uncertainty in instrument calibration: ±2.1%

b. Random uncertainty in assay: ±1.0%

c. Random uncertainty in weighing(s): ±0.0%

d. Total uncertainty at the 99% confidence level: ±3.1%

NIST Traceability

This calibration is implicitly traceable to the National Institute of Standards and Technology.

Notes

1. Nuclear data were taken from "Table of Isotopes", Seventh Edition, edited by Virginia S. Shirley.
2. IPL participates in an NIST measurement assurance program to establish and maintain implicit traceability for a number of nuclides, based on the blind assay(and later NIST certification) of Standard Reference Materials. (As in NRC Regulatory Guide 4.15)

QUALITY CONTROL

ISOTOPE PRODUCTS LABORATORIES
1800 No. Keystone Street.,
Burbank, California 91504
(818) 843 - 7000

AA0041

AA0047

ISOTOPE WEIGHT DILUTION RECORD

Isotope: Tc - 99 Vendor: IPL

Total Received Activity: ~1µci Vendor ID: 389-22-1

Wt. Received: ~5 g NIST Traceable (Y) N Cert. # implicitly

Activity in Units/g: ~~0.20~~ 0.201µCi/g Reference Date: 9-1-91

Activity converted (dpm/g): _____ dpm/g Receive Date: ~~N/A~~ 10-30-199

Halflife (Yrs or days) t½ = 2.13 X 10^5 years Receiver's Name: ~~N/A~~ Jimmy Morel

PRIMARY DILUTION: Balance wt. check done (✓)

a: Source activity: 2.01 X 10^5 pCi/g ~~dpm/g~~ (if t½ = <100yr decay to prep. date)

b: Wt. of Source transfered: 4.9320 g g

Diluent used: 0.1 M NH4OH

c: Total diluted ~~weight~~ volume 100 ml ~~g~~

d: Activity of dilution (a*b/c): N/A dpm/g

e: Calculated density of solution: N/A g/mL (4M HNO_3 = 1.1294 ± .0007 g/mL)

f: Activity by volume = (d*e): 9910 pCi/ml ~~dpm/mL~~

Dilution Log Book ID: 91-225-41-1

Preparation Date: 1-23-92 Preparer's Name: Joe Hutchinson

SECONDARY OR WORKING LEVEL DILUTION Balance wt. check done ( )

Log Book ID of source being diluted: 91-225-42-1

a: Source activity: 9910 pCi/mL dpm/g * (if t½ = <100yr decay to prep. date)

b: Wt. of Source transfered: 1.0051 g g

Diluent used: 0.1m NH4OH

c: Total diluted weight: 50.621 g

d: Activity of dilution (a*b/c): N/A dpm/g

e: Calculated density of solution: .997 g/mL g/mL (4M HNO_3 = 1.1294 ± .0007 g/mL)

f: Activity by volume = ~~(d*e)~~ axb/c 196.8 ~~dpm/mL~~ pCi/mL

Dilution Log Book ID: 91-225-42-1

Preparer's Name: Joe Hutchinson Preparation Date: 1-27-92

Reviewed By : [signature] Review Date: 6/8/93

AA0041

SECONDARY / WORKING LEVEL STANDARD DILUTION RECORD

Dilution Source Information

Isotope:	Tc-99
From NIST traceable standard?:	Implicitly
Vendor or Certificate I.D. # of parent standard:	AA0047
Diluted source logbook I.D. #:	91-225-41-1
Balance verification?:	yes
Diluent used:	0.1M NH4OH

Dilution

*Diluent:	0.1 M NH4OH
*Density of diluent (g/ml):	N/A
a. Parent standard activity:	9910 pCi/ml
b. Amount of standard transferred:	2.8759 g
c. Total amount of dilution:	254.69 g
d. Activity of dilution [a * b / c]:	111.90 pCi/ml as of 9-1
Dilution logbook I.D. #:	93-474-96-1

Prepared by: Agnes Wong Preparation date: 8-17-94

Reviewed by: Joe Hutchison Review date: 8/25/94

*If the diluent remains unchanged from the diluent used for the dilution source, then a weight dilution of a volume unit source can be performed without a density conversion. If the diluent changes, a weighted proportion density conversion is necessary.

LAL-91-SOP-0174

SECONDARY / WORKING LEVEL STANDARD DILUTION RECORD

Dilution Source Information

Isotope:	Tc-99
From NIST traceable standard?:	Implicitly
Vendor or Certificate I.D. # of parent standard:	AA0047
Diluted source logbook I.D. #:	91-225-41-1
Balance verification?:	yes
Diluent used:	0.1 M NH4OH

Dilution

*Diluent:	0.1 M NH4OH
*Density of diluent (g/ml):	N/A
a. Parent standard activity:	9910 pCi/ml
b. Amount of standard transferred:	1.9605 g
c. Total amount of dilution:	166.25 g
d. Activity of dilution [a * b / c]:	116.86 pCi/ml as of 9-1-1991
Dilution logbook I.D. #:	93-474-97-1

Prepared by: Byron Wong Preparation date: 8-17-94

Reviewed by: Joe Hutchison Review date: 8/25/94

*If the diluent remains unchanged from the diluent used for the dilution source, then a weight dilution of a volume unit source can be performed without a density conversion. If the diluent changes, a weighted proportion density conversion is necessary.

LAL-91-SOP-0174

Los Alamos Technical Associates, Inc.

8633 Gage Blvd. / Kennewick, WA 99336 / Telephone (509) 783-4369 / FAX (509) 783-9661

JUL 1995
RECEIVED
Log In

July 14, 1995
LATA95-142

Ms. Joan Kessner
CH2M Hill
345 Hills
Richland, WA 99352

Subject: VB403.65, SDG LK4467-LAS

Dear Ms. Kessner:

Attached is the data validation report for analytical results for 200-BP-5 Groundwater Round 3 (SDG LK4467-LAS). The package was received by Los Alamos Technical Associates on June 26, 1995.

If you have any questions, please let me know.

Sincerely,

Marsha C. Webb

Marsha C. Webb
Deputy Project Manager

Attachment

cc: Jeanette Duncan, CH2M Hill
DJ Smith, LATA
VB403.65
MCW/lb

ln

JUL 1995
RECEIVED
Validation
Log In

DATA VALIDATION REPORT
for
200-BP-5 Groundwater Round 3
Radiochemistry Analysis
SDG LK4467-LAS
LATA VB403.65

Bechtel Hanford Inc.
P.O. Box 969
Richland, Washington

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200-BP-5 Groundwater Round 3
Data Validation Narrative

INTRODUCTION

All samples in Sample Delivery Group (SDG) LK4467-LAS (VB403.65) were validated at level "C" as defined in the Data Validation Procedures for Radiochemical Analyses (WHC-SD-EN-SPP-001, Rev. 1).

The analyses were performed by Lockheed Analytical Services.

ANALYSES REQUESTED

See Table 1.

DATA QUALITY OBJECTIVES

Precision:	Goals for precision were met.
Accuracy:	Goals for accuracy were met.
Sample Result Verification:	Not applicable to summary data packages that contain no raw data.
Detection Limits:	Detection limit goals were met for all sample results as specified in the *Quality Assurance Program Plan for 200-BP-5 Groundwater Operable Unit,* DOE/RL 88-32, Rev. 1.
Completeness:	The data package was 100% complete for all requested analyses.

MAJOR DEFICIENCIES

No major deficiencies were identified during data validation which required qualification of data as unusable.

MINOR DEFICIENCIES

No minor deficiencies were identified during data validation which required qualification of data as unusable.

Table 1
Chain-of-Custody
Analysis Request

LATA ID #: VB403.65 SDG: LK4467-LAS

Sample Information							Analyses Requested		
SAMPLE NO.	DATE COLLECTED	MATRIX	SAF	SAMPLING LOCATION	FIELD QC INFO	TEMP °C	1	2	3
B0FBK3	6-May-95	WATER	B95-050	299-E33-30	Split w/ B0FBJ5	2	X	X	X

Method References:

	Analysis	Method
1.	Gamma Spec (Co-60)	LAL-91-SOP-0063
2.	Technetium-99	LAL-91-SOP-0169
3.	Activity Scan	Lab Specific

NOTES:

1. The Rad Screen before shipment was deemed unnecessary.
2. The field QC split will be evaluated in SDG W0553-QES.

REFERENCES

WHC 1993, *Data Validation Procedures for Radiochemical Analyses*, WHC-SD-EN-SPP-001, Rev. 1, Westinghouse Hanford Company, Richland, Washington.

DOE 1994, *Quality Assurance Program Plan for 200-BP-5 Operable Unit*, DOE/RL 88-32, Rev. 1, Department of Energy-Hanford, Richland, Washington.

GLOSSARY OF VALIDATION APPLIED QUALIFIERS (RADIOCHEMISTRY)

Qualifiers which may be applied by data validators in compliance with the procedures herein are as follows.

U- Indicates the constituent was analyzed for, but was not detected at a concentration above the Minimum Detectable Activity (MDA). The concentration reported is the sample result corrected for sample aliquot size, dilutino factors, and percent solids (in the case of solid matrices) by the laboratory. The associated data should be considered usable for decision making puposes.

UJ- Indicates the constituent was analyzed for and was not detected at a concentration above the Minimum Detectable Activity (MDA). Due to a quality control deficiency identified during data validation, the result reported may not accurately reflect the sample concentration. The associated data should be considered usable for decision making purposes.

J- Indicates a constituent was analyzed for and detected. The associated value is estimated due to a quality control deficiency identified during validation. The data should be considered usable for decision making purposes.

R- Indicates the constituent was analyzed for and detected; however, due to an identified quality control deficiency the data should be considered unusable for decision making purposes.

UR- Indicates the constituent was analyzed for and not detected; however, due to an identified quality control deficiency the data should be considered unusable for decision making purposes.

GLOSSARY OF LABORATORY APPLIED QUALIFIERS

Qualifiers which may be applied by the laboratory in compliance with applicable requirements are as follows.
Commonly used laboratory radiochemistry qualifiers:

U- Indicates the analyte was analyzed for but not detected in the sample.

J- Indicates the value reported is estimated due to the presence of interference.

Qualification Summary Table

Qualification Summary Table

Radiochemistry

ANALYTE	TYPE	QUALIFIER	SAMPLES AFFECTED	DQO	REASON
No qualifiers were added by the validator.					

Comments:

1. The "U" qualifers added to the Data Summary Tables and Form Is are laboratory concentration qualifiers to indicate that the results are <MDA and have not been applied by the validator.
2. The RPD problem discussed in the laboratory case narrative applies to a sample that is not part of this work order.

Data Summary Table

RADIOCHEMISTRY
DATA SUMMARY TABLE

LATA ID#: VB403.65		HEIS #:	B0FBK3	
		Date:	6-May-95	
		Matrix:	WATER	
Constituent	CAS #	Units	Results	Q
Technetium-99	14133-76-7	pCi/L	45.4	
GAMMA-SCAN				
Actinium-228 (Ra-228)	15262-20-1	pCi/L	15	U
Cesium-137	10045-97-3	pCi/L	2.9	U
Cobalt-58	13981-38-9	pCi/L	3.9	U
Cobalt-60	10198-40-0	pCi/L	1.4	U
Europium-152	14683-23-9	pCi/L	1	U
Europium-154	15585-10-1	pCi/L	-2	U
Europium-155	14391-16-3	pCi/L	-6.7	U
Iron-59	14596-12-4	pCi/L	8	U
Lead-212	PB-212	pCi/L	2	U
Lead-214 (Ra-226)	PB-214	pCi/L	9	U
Radium-226 (gamma)	13982-63-3	pCi/L	10	U
Uranium-235 (gamma)	15117-96-1	pCi/L	-20	U

Sample Results (Form I's)

LOCKHEED ANALYTICAL SERVICES

RAD DATA REPORT (ra01)

Bechtel Hanford, Inc. * Richland, WA

Bechtel Hanford Project (Project BECHTEL-HANFORD)

Client Sample ID: B0FBK3 | LAL Sample ID: L4467-2

Date Collected: 06-MAY-95 | Date Received: 09-MAY-95

Matrix: Water | Login Number: L4467

SDG: LK4467

Constituent	Analyzed	Batch	Activity	Error	MDA	DataQual	Units
Ac-228(Ra-228)	30-MAY-95	GAMMA SPEC LAL-0063_23211	15.	26.	40.	U	pCi/L
Co-58	30-MAY-95	GAMMA SPEC LAL-0063_23211	3.9	5.3	8.7	U	pCi/L
Co-60	30-MAY-95	GAMMA SPEC LAL-0063_23211	1.4	5.1	8.1	U	pCi/L
Cs-137	30-MAY-95	GAMMA SPEC LAL-0063_23211	2.9	8.1	10.	U	pCi/L
Eu-152	30-MAY-95	GAMMA SPEC LAL-0063_23211	1.	12.	41.	U	pCi/L
Eu-154	30-MAY-95	GAMMA SPEC LAL-0063_23211	-2.	13.	34.	U	pCi/L
Eu-155	30-MAY-95	GAMMA SPEC LAL-0063_23211	-6.7	6.3	19.	U	pCi/L
Fe-59	30-MAY-95	GAMMA SPEC LAL-0063_23211	8.	10.	22.	U	pCi/L
Pb-212	30-MAY-95	GAMMA SPEC LAL-0063_23211	2.	11.	16.	U	pCi/L
Pb-214(Ra-226)	30-MAY-95	GAMMA SPEC LAL-0063_23211	9.	14.	19.	U	pCi/L
Ra-226(GAMMA)	30-MAY-95	GAMMA SPEC LAL-0063_23211	10	140	200	U	pCi/L
U-235(GAMMA)	30-MAY-95	GAMMA SPEC LAL-0063_23211	-20.	23.	45.	U	pCi/L

7-11-95

~~015~~

000012

LOCKHEED ANALYTICAL SERVICES

RAD DATA REPORT (ra01)

Bechtel Hanford, Inc.* Richland, WA

Bechtel Hanford Project (Project BECHTEL-HANFORD)

Client Sample ID: BOFBK3 | LAL Sample ID: L4467-6

Date Collected: 06-MAY-95 | Date Received: 09-MAY-95

Matrix: Water | Login Number: L4467

SDG: LK4467

Constituent	Analyzed	Batch	Activity	Error	MDA	Dataqual	Units
Tc-99	31-MAY-95	TC-99 LAL-0169_23139	45.4	8.8	6.0		pCi/L

7-11-95

~~016~~

Checklist

LATA RADIOCHEMISTRY
DATA VALIDATION CHECKLIST

VALIDATION LEVEL:	A	B	C	D	E

VALIDATION PROCEDURE:	☐ WHC-CM-5-3, Rev. 0		☒ WHC-SD-EN-SPP-001, Rev. 1		
PROJECT:	200-BP-5 ROUND 3		SDG:	LK4467-LAS	
VALIDATOR:	MC WEBB 7-12-95	LATA NO:	VB403.65	DATE:	11-Jul-95
REVIEWER:	BJ MORRIS 7-12-95	LAB:	LAS	CASE:	N/A
SAF NO:	B95-050	QAPP NO:	N/A	SAP NO:	DOE/RL 88-32 R1

ANALYSES REQUESTED

☒ Gamma Spec LAL-91-SOP-0063	☒ Technetium-99 LAS-91-SOP-0169				

SAMPLE NO.	MATRIX
B0FBK3	WATER

COMMENTS:

1. DATA PACKAGE COMPLETENESS AND CASE NARRATIVE	YES	NO	N/A
Is technical verification documentation present?	☒	☐	☐
Is a case narrative present?	☒	☐	☐

2. HOLDING TIMES	YES	NO	N/A
Are sample holding times acceptable?	☒	☐	☐
Are samples preserved correctly?	☒	☐	☐

See HOLDING TIME SUMMARY form

3. INSTRUMENT PERFORMANCE AND CALIBRATIONS	YES	NO	N/A
Were instruments/detectors calibrated within one year of sample analysis?	☐	☐	☒
Are initial calibrations acceptable?	☐	☐	☒
Are standards NIST traceable?	☐	☐	☒
Are standards acceptable?	☐	☐	☒

Comments:

4. CONTINUING CALIBRATION

	YES	NO	N/A
Background checked at proper frequency?			X
Background check acceptable?			X
Efficiency checked at proper frequency?			X
Efficiency check acceptable?			X
Calibration check standards NIST traceable?			X
Calibration check standards acceptable?			X

If NO(s) are checked, see CALIBRATION DATA SUMMARY form

5. BLANKS

	YES	NO	N/A
Were method blanks analyzed?	X		
Are the method blanks free of analytes?	X		
Were method blank results acceptable?	X		
Validation calculation/transcription checks were performed and are acceptable.			X

If NO(s) are checked, see BLANK DATA SUMMARY form

6. ACCURACY

	YES	NO	N/A
Were spike samples analyzed at the proper frequency?			X
Are all spike sample recoveries acceptable?			X
Were laboratory control standards (LCS) analyzed at the proper frequency?	X		
Are all LCS recoveries acceptable?	X		
Was a tracer/chemical carrier added?			X
Was the tracer/chemical carrier recovery acceptable?			X
Are standard sources traceable?			X
Are standards acceptable?			X
Validation calculation checks were performed and are acceptable.			X

If NO(s) are checked, see ACCURACY DATA SUMMARY form

7. PRECISION

	YES	NO	N/A
Were laboratory duplicates analyzed at the proper frequency?	X		
Are all duplicate RPD values acceptable?	X		
Validation calculation checks were performed and are acceptable.			X

If NO(s) are checked, see PRECISION DATA SUMMARY form

8. FIELD QC SAMPLES

	YES	NO	N/A
Were field QC samples (field/trip blanks, duplicates, splits, performance audit) identified?	X		
Are field/trip blank results acceptable? (see Blank Data Summary form)			X
Are field duplicate RPD values acceptable? (see Field QC calculations)			X
Are field split RPD values acceptable? (see Field QC calculations)			X
Are performance audit sample results acceptable?			X

Comments: B0FBK3 is a split with B0FBJ5. B0FBJ5 is in SDG W0553-QES. The split will be evaluated in SDG W0553-QES.

9. REPORTED RESULTS AND DETECTION LIMITS

	YES	NO	N/A
Are results reported for all requested analyses?	X		
Are all results supported in the raw data?			X
Are results calculated properly?			X
Do MDAs meet the RDLs?	X		
Validation calculation checks were performed and are acceptable.			X

Comments:

VALIDATION SUMMARY

For deficiencies (major and minor) and comments, please refer to the Qualification Summary Table.

LATA RADIOCHEMISTRY
DATA VALIDATION CHECKLIST

HOLDING TIME SUMMARY

SDG:	LK4467-LAS		VALIDATOR: MC WEBB					DATE: 11-Jul-95		
PROJECT:	200-BP-5 ROUND 3		REVIEWER: BJ MORRIS					LATA NO.: VB403.65		
HEIS-SN	MATRIX CODE	ANALYSIS	DATE COLLECTED	PREP DATE	ANALYSIS DATE	PREP HT (days)	***Required HT (days)***	ANALYSIS HT (days)	***Required HT (days)***	VAL Q
B0FBK3	WATER	Gamma Scan	6-May-95	N/A	30-May-95	N/A	N/A	24	***180***	NONE
B0FBK3	WATER	Tc-99	6-May-95	N/A	31-May-95	N/A	N/A	25	***180***	NONE

LATA RADIOCHEMISTRY
DATA VALIDATION CHECKLIST

PRECISION DATA SUMMARY

SDG: LK4467-LAS						VALIDATOR: MC WEBB				DATE: 11-Jul-95	
PROJEC 200-BP-5 ROUND 3						REVIEWER: BJ MORRIS				LATA NO.: VB403.65	
HEIS-SN	ANALYTE	ORIG RESULTS	LAB Q	DUPE RESULTS	LAB Q	UNITS	RDL	DUPE RPD %	DUPE CRDL dif	SAMPLES AFFECTED	VAL Q
B0FBK3	Tc-99	45.4		50.6		pCi/L	15	N/A	5.2	NONE	NONE
B0FBK3	Cs-137	2.94	U	1.9	U	pCi/L	15	N/A	N/A	NONE	NONE

000019

LOCKHEED ANALYTICAL SERVICES

RADIOCHEMISTRY ANALYTES

QC Data Summary For Duplicate Sample Analysis

SDG: LK4467

Analyte	Batch ID	Client ID	LAL ID	Date Analyzed	Sample Result	Error 2 Sigma	Duplicate Result	Error 2 Sigma	RER	RPD	Q
Tc-99	23139	B0FBK3	L4467-6	05/31/95	45.4	8.78	50.6	9.29	1.57	10.8	
Tc-99	23139	B0FKH6	L4482-17	05/31/95	1560	128	2020	163	1.57	25.7	*
Cs-137	23211	B0FBK3	L4467-2	05/31/95	2.94	8.14	1.9	5.72	0.08	43	
Pb-214(Ra-2	23211	B0FBK3	L4467-2	05/31/95	8.79	13.7	7.97	13.8	0.03	9.79	
Cs-137	23211	B0FKH6	L4482-8	05/30/95	-7.17	3.96	4.79	7.31	1.06	1010	*
Pb-214(Ra-2	23211	B0FKH6	L4482-8	05/30/95	12.3	13.2	6.32	13.9	0.22	64.2	

MCW
7-12-95

~~020~~

Laboratory Case Narrative

CASE NARRATIVE
RADIOCHEMICAL ANALYSES

The routine calibration and quality control analyses performed for this batch include as applicable: instrument calibration, initial and continuing calibration verification, quench monitoring standards, instrument background analysis, method blanks, yield tracer, laboratory control samples, matrix spike samples, duplicate samples.

Holding Time Requirements

All holding time requirements were met.

Chemical Recoveries and MDAs, where applicable, can be found on the preparation and calculation sheets of the attached raw data for each method.

Analytical Method

Gamma Spectrum Analysis

The gamma spectrum analysis was performed using LAL-91-SOP-0063. The second sample duplicate analysis for Cs-137 was out of limits; however, since the first duplicate was within limits, the data is considered acceptable, and all other QC criteria were met.

Technetium-99

The technetium-99 analysis was performed using LAL-91-SOP-0169. The second sample duplicate analysis was out of limits; however, since the first duplicate was within limits, the data is considered accetpable, and all other QC criteria were met.

Yvonne M. Jacoby
Prepared By

June 12, 1995
Date

7-11-95

Chain-of-Custody Information

Bechtel Hanford, Inc. L4467 **CHAIN OF CUSTODY/SAMPLE ANALYSIS REQUEST**

Page 1 of 1

Data Turnaround: ☐ Priority ■ Normal

Collector: DAVE ST JOHN	Company Contact: G.L. Kasza	Telephone: (509) 372-9675
Project Designation: 200-BP-5 Groundwater Round 3	Sampling Location: 200 East	SAF No.: B95-050
Ice Chest No.: GWS-141	Field Logbook No.: EFL-1125	Method of Shipment: Federal Express
Shipped To: Lockheed	Offsite Property No.: W95-0-02061-056	Bill of Lading/Air Bill No.: 2904627686

Possible Sample Hazards/Remarks

Special Handling and/or Storage: Maintain samples between 2°C and 6°C.

Preservation	HNO3	HCl	Cool 4°									
Type of Container	~~P/G~~ 5-6-95 P	P	P									
No. of Container(s)	4	4	1									
Volume	1L	1L	20mL									
SAMPLE ANALYSIS	Gamma Spec to include Co-60	Tc-99	Activity Scan									

Sample No.	Matrix*	Date Sampled	Time Sampled										
B0FBK3	W	5-6-95	1050	X	X	X							

CHAIN OF POSSESSION — Sign/Print Names

Relinquished By	Date/Time	Received By	Date/Time
David St. John ERC	05-08-95 0830	ERC B. Whitten	0830 5-8-95
ERC B. Whitten	5-8-95 1000		

SPECIAL INSTRUCTIONS

Matrix*: S = Soil; SE = Sediment; SO = Solid; SL = Sludge; W = Water; O = Oil; A = Air; DS = Drum Solids; DL = Drum Liquids; T = Tissue; WI = Wipe; L = Liquid; V = Vegetation; X = Other

LABORATORY SECTION	Received By: M M Miller	Title: Sample Custodian	Date/Time: 5-9-95 0830
FINAL SAMPLE DISPOSITION	Disposal Method	Disposed By	Date/Time

000024

Lockheed Analytical Services
Sample Receiving Checklist

Client Name: Bechtel - Hanford Job No. L4467 Cooler ID: ~~UP-1~~ 5-2-95 GWS-141

COOLER CONDITION UPON RECEIPT

Temperature of cooler upon receipt: 2°C

temperature of temp. blank upon receipt:

	Yes	No	* Comments/Discrepancies
custody seals intact	X		
chain of custody present	X		
blue ice (or equiv.) present/frozen	X		
rad survey completed	X		

SAMPLE CONDITION UPON RECEIPT

	Yes	No	* Comments/Discrepancies
all bottles labeled	X		
samples intact	X		
proper container used for sample type	X		
sample volume sufficient for analysis	X		
proper pres. indicated on the COC	X		
VOA's contain headspace			N/A
are samples bi-phasic (if so, indicate sample ID'S):			N/A

MISCELLANEOUS ITEMS

	Yes	No	* Comments/Discrepancies
samples with short holding times		X	
samples to subcontract		X	

ADDITIONAL COMMENTS/DISCREPANCIES

Completed by / date: Mmiller 5-9-95

Sent to the client (date/initials): ** Client's signature upon receipt:

*Notes: * = contact the appropriate CSR of any discrepancies immediately upon receipt*

*** = please review this information and return via facsimile to the appropriate CSR (702) 361-8146*

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~~012~~

version 2.0 (11/11/94)

Supplemental Information

Environmental Restoration Contractor **ERC Team**

Interoffice Memorandum

Job No. 22192
Written Response Required: NO
CCN: N/A
OU: 200-BP-5
TSD: N/A
ERA: N/A
Subject Code: 1995 Round 3 Sampling

TO:	W. S. Thompson	N3-06	DATE:	April 21, 1995
COPIES:	D. B. Erb	H6-01	FROM:	S. K. De Mers Radiological Controls N3-06/376-2764

SUBJECT: **1995 Round 3 sampling for 200-BP-5**

There is no need to perform total activities prior to offsite shipment to NRC licensed labs of samples taken from the attached list of wells.

The wells listed in the attachment were reviewed for radiological content based on the previous 4 years of sampling data. No well listed has a β activity in excess of 100,000 pCi/l (<.1 uCi/sample based on a 1 liter sample size) nor any α activity in excess of 10,000 pCi/l (<.01 uCi/l based on a 1 liter sample). All wells show activities < 2,000 pCi/gm (< 2 nCi/gm D.O.T. limit). The highest activity in recent samples is 17,000 pCi/l β and 170 pCi/l α.

Radiological monitoring during sampling will only be required if the wells are located in radiological areas or if the wells themselves are labeled with radiological stickers. Monitoring requirements for down hole work such as pump removal will be determined based on the history of each well on a case by case basis.

skd

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7-11-95

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END OF PACKAGE