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Bechtel

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JAN 11 1995

Commanding Officer
Southern Division
Naval Facilities Engineering Command
Attention: B. K. Moring 1855BM
2155 Eagle Drive
North Charleston, SC 29406

SUBJECT: Bechtel Job No. 22567
Department of the Navy Contract No. N62467-93-D-0936
RADIOLOGICAL BACKGROUND DETERMINATION FOR THE NAS JACKSONVILLE SITE

Dear Mr. Moring:

The radiological background for the NAS Jacksonville site was determined by direct in situ measurement and soil sample analysis at 20 locations in and around the site. A summary of those findings, including the variability of the background quantities, is as follows:

	High	Low	Average
Dose Rate	7.8 μR/hr	5.7 μR/hr	6.4 μR/hr
Uranium - 238 decay chain	0.99 pCi/gm	0.37 pCi/gm	0.59 pCi/gm
Thorium - 232 decay chain	1.08 pCi/gm	0.47 pCi/gm	0.72 pCi/gm
Potassium - 40	5.22 pCi/gm	0.82 pCi/gm	2.52 pCi/gm
Cesium - 137	0.49 pCi/gm	0.01 pCi/gm	0.17 pCi/gm

For conservatism, the cleanup criteria for both the radium-226 and the thorium-232, including background, will be set at 5.4 pCi/gm.

The report of the measurements and associated data evaluations is attached. If you have any questions regarding these results, contact me at (904) 779-8900 or Edward Walker at (615) 220-2202.

Sincerely,

for V. Hermann Bauer

EW:tmm:T0334

NAS JACKSONVILLE

RADIOLOGICAL BACKGROUND

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NAS JACKSONVILLE - RADIOLOGICAL BACKGROUND

1.0 INTRODUCTION

The operating history of the NAS Jacksonville site has included handling and disposal of materials containing low levels of radioactive materials. Specific activities involving such materials included:

- Aircraft instrument maintenance and repair: radium-226
- Sandblasting and cleaning: thorium-232

Standards for both radium-226 and thorium-232 in soil are provided in regulation from the Environmental Protection Agency (EPA), in 40 CFR 192, "Health and Environmental Protection Standards for Uranium and Thorium Mill Tailings." For concentrations in soil, this value is:

$Sv \leq 5.0$ pCi/gram above background

Past cleanup and disposal activities involving these materials were based on regulatory standards that have been superceded by standards that are more directly applicable to the radioisotopes of interest, and in many cases are more restrictive than the previously applied standards. The NAS Jacksonville site is being resurveyed to evaluate the existing levels of residual activity for determining the needs and planning the actions for further remediation.

To support remediation, it is necessary to determine the background activity against which the release criteria will be applied. The background levels for this site have been determined at 20 different locations on the base and around the periphery of the base. The 20 locations are shown on the attached site map (Figure 1-1) and are described in Table 1-1.

The background characterization consisted of a series of in situ measurements and soil samples at each location. The in situ measurements consisted of the following:

• Pressurized Ion Chamber (PIC)	μR/hr
• Microroentgen Meter	μR/hr
• Gamma Flux using 2" by 2" NaI detector	cpm
• Beta activity	cpm
• Alpha activity	cpm

The soil samples were analyzed at an offsite radiochemistry laboratory for the following activities:

• Total Uranium	
• Uranium-238 & daughters	(naturally occurring)
• Radium-226 & daughters	(naturally occurring)
• Thorium-232 & daughters	(naturally occurring)
• Potassium-40	(naturally occurring)
• Cesium-137	(fallout)

Table 1-1
Background Measurement Locations: NAS/JAX

Number	Location	Description
1	Saratoga & Ranger	Across from Naval Legal Office, between sidewalk and parking lot
2	Highway 17	West side of road, south of main gate
3	Off Ortega Drive	Between apartments and railroad track
4.	Collins & Malaga	NE corner of street intersection
5.	Mustin Road	Edge of restricted area, adjacent to riverfront access road
6.	Child Road	West edge of Naval Hospital parking lot
7.	Mustin Road	Open area across from fire station, adjacent to BOQ
8.	Adams & Knight	On corner of open field
9.	Jason & Saratoga	Near parking lot to Yesterday Cafe
10.	Mustin Road	West side of road, across from Navy Lodge
11.	120th	At North Florida Anchor Gate
12.	Child Road	NW of Building 371, near ball fields
13.	Highway 17 & Collins	West side of H-17, south of U-Haul
14.	Tatum & Saphier	Wooded area along road, near Building 203
15.	Off Highway 17	At end of road in mobile home park
16.	Perimeter Road	NW corner of bend, south of Wastewater Treatment Area
17.	Mustin Road	West of street, near park
18.	Highway 17	West side of road, near cement plant
19.	Birmingham	Entrance to NAS-JAX RV park
20.	Perimeter Road	North side of road at first bend after gate

Since radium-226, and thorium-232 were the radioisotopes associated with past site activities, accurate determination of the background contribution was important. During remediation and final gamma clearance surveys, reliance will be placed on the in situ measurements using the micro R meter and the 2" by 2" NaI detector. The PIC, used in this background study, will be employed as a secondary measurement standard for background level measurements, in addition to being the primary background dose rate measurement. The performance of the other instruments will be corrected for future application onsite, using the PIC as the secondary standard.

2.0 RESULTS - IN SITU MEASUREMENTS

The results of the in situ measurements are summarized in Table 2-1. The record of the complete field log for each location are provided in Appendix A. The measurements using the PIC were recorded by two different methods. The instrument was operated at each location for 30 minutes with data points plotted on a strip chart approximately 2 seconds apart. At 10 minute intervals, an estimate of the average of a digital readout was recorded in the field log. It was noted from the strip charts that this instrument required 10-15 minutes to stabilize. The value taken from the chart was the average of the final 10 minutes. The sigma (σ) value recorded for the chart reading is the half-thickness of the plotted data band. The values obtained from the chart are the background dose rates assigned to each location for all subsequent comparative evaluations.

The 2" by 2" NaI gamma, the beta, and the alpha readings, summarized in Table 2-1, are a numerical average of three separate readings taken at each location. The sigma (σ) values shown for each is the variance of the three readings, <u>not</u> the statistics of the counting system. The beta and alpha readings were repeated at each location with the meter face toward the ground and away from the ground to assess whether a difference exists; e.g., is the activity directional or uniform. This is discussed in more detail in Section 4.0.

3.0 RESULTS - LABORATORY ANALYSIS

Two soil samples were obtained at each background measurement location and were submitted to the General Engineering Laboratory in Charleston, South Carolina, for isotopic analysis. One sample was analyzed for total uranium content using microwave digestion and kinetic phosphorescence analysis (KPA). The second sample was analyzed using gamma spectroscopy to identify the content of uranium-238, radium-226, thorium-232, potassium-40, and cesium-137. These results have been summarized in Table 3-1 with reference to the PIC in situ measured dose rate. The locations have been ordered from lowest to highest measured dose rate. The tables have been organized to present the decay chain activity together for easier comparison. This also facilitates the use of a single dose rate conversion for the entire chain for correlating with the in situ dose rate measurement.

Before attempting the dose rate conversion, inspection of the lab analysis results reveals a number of inconsistencies.

(1) The total uranium analysis does not correlate with the U-238 value obtained from the gamma spectrum.

Table 2-1
Background Summary: NAS Jacksonville
In Situ Measurements - Gamma

Location:	Pressurized Ion Chamber			Micro Roentgen Meter			2" by 2" NaI Detector			
	Chart		Meter	#109899		#95487	#157		#165	
	11/7-8/94			11/7-8/94	11/1-2/94	11/1-2/94				
	μR/Hr	σ	μR/Hr	-- μR/Hr --			CPM	σ	CPM	σ
1	6.2	1.0	6.5	3.5	6.0	--	--	--	3783	101
2	5.7	0.6	6.5	2.5	--	4.0	5087	43	--	--
3	5.8	0.7	6.0	3.0	4.0	--	--	--	2339	132
4	6.8	0.7	7.0	4.5	--	5.0	6691	163	--	--
5	6.6	1.0	6.2	4.5	--	5.0	4964	2338	--	--
6	5.8	0.6	6.0	4.0	--	4.0	--	--	2647	78
7	7.0	1.0	7.0	4.0	--	5.0	--	--	3213	66
8	6.4	0.7	6.5	3.5	5.0	--	5864	151	--	--
9	6.0	0.7	6.0	2.5	4.0	--	4507	176	--	--
10	6.9	1.0	6.3	3.0	5.0	--	6212	62	--	--
11	6.0	1.0	6.0	3.0	5.0	--	4839	198	--	--
12	7.8	1.2	8.2	5.0	--	6.5	--	--	4030	121
13	6.2	0.8	6.6	3.0	--	5.0	5463	109	--	--
14	7.3	0.6	7.0	3.0	--	5.0	--	--	3456	18
15	5.8	0.6	6.0	3.0	4.0	--	--	--	2276	95
16	6.3	1.0	7.0	3.0	5.0	--	--	--	3144	33
17	7.2	0.7	7.0	4.0	--	5.0	--	--	3285	35
18	5.7	0.7	5.8	2.8	--	4.0	4821	94	--	--
19	6.0	1.0	6.2	3.0	5.0	--	--	--	2686	351
20	5.9	0.7	6.5	3.0	4.0	--	--	--	2503	28

Table 2-1 (continued)
Background Summary: NAS Jacksonville
In Situ Measurements - Beta and Alpha

Location	Beta Measurements - CPM								Alpha Measurements - CPM	
	#116872		#116876		#116881		#116878		#095044	
	Face down	Face up	Face down	Face up	Face down	Face up	Face down	Face up	Face down	Face up
1	--	--	--	--	--	--	48±9	40±8	1.3±2.3	0.3±0.6
2	--	--	--	--	35±2	34±2	--	--	1.7±2.3	1.0±1.7
3	--	--	--	--	--	--	31±4	35±7	0.7±0.6	0.7±0.6
4	--	--	--	--	46±5	36±5	--	--	2.7±2.1	1.0±1.0
5	--	--	--	--	39±3	33±6	--	--	2.7±2.1	2.0±2.0
6	--	--	37±4	27±2	--	--	--	--	1.3±1.5	1.0±1.0
7	--	--	34±3	35±4	--	--	--	--	2.3±2.3	2.0±2.0
8	33±4	28±4	--	--	--	--	--	--	3.0±3.0	1.0±1.0
9	34±3	29±4	--	--	--	--	--	--	2.0±2.0	0.7±0.6
10	40±4	36±8	--	--	--	--	--	--	2.7±0.6	0.7±1.2
11	40±7	33±4	--	--	--	--	--	--	33±1.2	23±2.5
12	--	--	50±7	33±6	--	--	--	--	2.0±1.0	0±0
13	--	--	--	--	--	--	33±6	37±11	1.7±1.2	0.3±0.6
14	--	--	31±5	41±6	--	--	--	--	1.7±1.2	0.7±0.6
15	--	--	--	--	--	--	30±7	37±8	3.7±0.6	1.7±1.5
16	--	--	--	--	--	--	31±7	41±8	1.7±0.6	0.7±1.2
17	--	--	39±5	35±3	--	--	--	--	1.0±1.0	0.7±1.7
18	--	--	--	--	36±1	37±5	--	--	1.7±0.6	1.0±1.0
19	--	--	--	--	--	--	36±4	37±12	1.7±1.5	1.0±1.0
20	--	--	--	--	--	--	30±1	40±4	2.3±1.5	0.7±0.6

Table 3-1
Background Summary: NAS Jacksonville, Isotopic Composition - Picocuries per Gram

Location[1]	PIC	Total		Uranium-238		Thorium-234		Thorium-230		Radium-226		Uranium-235	
	(μR/Hr)	Uranium[2]	σ	Sv[3]	σ	Sv[4]	σ	Sv[5]	σ	Sv[6]	σ	Sv[7]	σ
18	5.7±0.7	0.358	0.007	1.55	1.26	1.55		0.511		0.511	0.097	0.128(U)	0.159
2	5.7±0.7	0.238(U)	0.007	1.14	0.896	1.14		0.462		0.462	0.075	0.213	0.215
3	5.8±0.7	0.192(U)	0.003	1.47	1.11	1.47		0.467		0.467	0.120	0.091(U)	0.145
6	5.8±0.6	0.215(U)	0.003	0.933(U)	1.42	0.93		0.681		0.681	0.103	0.042(U)	0.127
15	5.8±0.6	0.136(U)	0.003	1.56	0.849	1.56		0.385		0.395	0.119	0.093(U)	0.137
20	5.9±0.7	0.281(U)	0.003	2.18	0.861	2.18		0.484		0.484	0.067	0.054(U)	0.137
9	6.0±0.7	0.129(U)	0.003	1.11	0.387	1.11		0.367		0.367	0.088	0.124	0.093
11	6.0±1.0	0.215(U)	0.003	1.19	0.489	1.19		0.536		0.536	0.106	0.052(U)	0.089
19	6.0±1.0	0.199(U)	0.003	2.23	0.753	2.23		0.449		0.449	0.059	0.190	0.143
1	6.2±1.0	0.222(U)	0.003	1.51	1.43	1.51		0.708		0.708	0.093	0.051(U)	0.133
13	6.2±0.8	0.417	0.010	1.31	1.30	1.31		0.532		0.532	0.098	0.0003(U)	0.106
16	6.3±1.0	0.391	0.007	1.06	0.486	1.06		0.690		0.690	0.142	0.223	0.162
8	604±0.7	0.202(U)	0.003	1.89	0.065	1.89		0.502		0.502	0.063	0.108(U)	0.026
5	6.6±1.0	0.662	0.010	2.09	0.895	2.09		0.994		0.994	0.088	0.091(U)	0.173
4	6.8±0.7	0.295(U)	0.007	1.73	1.43	1.73		0.773		0.773	0.182	0.329	0.174
10	6.9±1.0	0.268(U)	0.003	1.71	0.734	1.71		0.583		0.583	0.084	0.132(U)	0.173
7	7.0±1.0	0.437	0.007	1.41	1.12	1.41		0.529		0.529	0.108	0.009(U)	0.121
17	7.2±0.7	0.225(U)	0.003	1.42	0.547	1.42		0.578		0.578	0.118	0.045(U)	0.098
14	7.3±0.6	0.268(U)	0.003	1.40	1.14	1.40		0.614		0.614	0.111	0.103(U)	0.127
12	7.8±1.2	0.536	0.010	1.69	1.38	1.69		0.830		0.830	0.125	0.160(U)	0.125
High	7.8	0.662		2.23						0.994			
Low	5.7	0.129		0.93						0.367			
Average	6.4	0.294		1.53						0.589			

Note: Values assompanied by a (U) designator are reported at values less than the detection limit.

Table 3-1 (continued)
Background Summary: NAS Jacksonville, Isotopic Composition - Picocuries per Gram

[1]Locations are arranged in sequence from lowest to highest background reading.
[2]Microwave digestion (dissolution) followed by KPA (kinetic phosphorescence analysis); dissolution and uranium recovery should be > 80%.
[3]Analysis of 60 KeV peak of thorium-234.
[4]Uranium-238 and thorium-234 assumed to be in equilibrium. Identical values reported.
[5]Thorium-230 and radium-226 assumed to be in equilibrium. Identical values reported.
[6]Analysis of 60 KeV peak of bismuth-214 (equilibrium daughter).
[7]Analysis of 60 KeV and 185 KeV peaks after correcting for presence of 186 KeV peak of radium-226.

Table 3-1 (continued)
Background Summary: NAS Jacksonville, Isotopic Composition - Picocuries per Gram

Location[1]	PIC	Thorium-232		Radium-228		Thorium-228		Potassium-40		Cesium-137	
	(μR/Hr)	Sv[8]	σ	Sv[9]	σ	Sv[10]	σ	Sv[11]	σ	Sv[12]	σ
18	5.7±0.7	0.678	0.060	0.782	0.142	0.693	0.061	1.42	0.38	0.010	0.021
2	5.7±0.7	0.478	0.058	0.427	0.145	0.492	0.058	1.51	0.41	0.032	0.039
3	5.8±0.7	0.525	0.095	0.580	0.172	0.529	0.096	1.15	0.45	0.283	0.080
6	5.8±0.6	0.901	0.071	0.828	0.189	0.910	0.072	1.68	0.54	0.145	0.041
15	5.8±0.6	0.469	0.050	0.480	0.142	0.472	0.050	2.20	0.55	0.362	0.053
20	5.9±0.7	0.796	0.056	0.736	0.110	0.803	0.056	2.28	0.39	0.161	0.027
9	6.0±0.7	0.366	0.059	0.350	0.104	0.369	0.060	0.824	0.350	0.084	0.030
11	6.0±1.0	0.574	0.086	0.568	0.137	0.579	0.087	1.87	0.38	0.262	0.057
19	6.0±1.0	0.553	0.048	0.519	0.097	0.557	0.049	1.56	0.41	0.205	0.027
1	6.2±1.0	0.776	0.077	0.772	0.180	0.782	0.078	2.99	0.70	0.065	0.031
13	6.2±0.8	0.746	0.060	0.703	0.167	0.752	0.060	2.11	0.57	0.167	0.044
16	6.3±1.0	0.948	0.132	0.956	0.203	0.956	0.133	2.03	0.42	0.085	0.028
8	604±0.7	0.605	0.050	0.532	0.095	0.610	0.050	2.08	0.35	0.107	0.027
5	6.6±1.0	0.789	0.066	0.879	0.156	0.796	0.066	5.12	0.60	0.109	0.035
4	6.8±0.7	0.774	0.125	0.786	0.194	0.780	0.126	5.22	1.02	0.486	0.126
10	6.9±1.0	0.920	0.060	0.836	0.129	0.927	0.060	3.77	0.56	0.268	0.044
7	7.0±1.0	0.853	0.070	0.914	0.165	0.861	0.070	2.00	0.43	0.376	0.053
17	7.2±0.7	0.734	0.109	0.791	0.191	0.740	0.110	2.75	0.51	0.111	0.036
14	7.3±0.6	0.873	0.088	0.856	0.167	0.881	0.089	3.97	0.55	0.054	0.023
12	7.8±1.2	1.08	0.073	1.14	0.193	1.090	0.074	3.81	0.60	0.101	0.039
High		1.08						5.22		0.49	
Low		0.37						0.82		0.01	
Average		0.72						2.52		0.17	

Note: Values assompanied by a (U) designator are reported at values less than the detection limit.

Table 3 (continued)
Background Summary: NAS Jacksonville
Isotopic Composition - Picocuries per Gram

[1]Locations are arranged in sequence from lowest to highest background reading.
[8]Analysis of 239 keV peak of lead-212, averaged with 3 other peaks.
[9]Analysis of 911 keV peak of actinium-228, averaged with 11 other peaks.
[10]Analysis of 239 keV peak of lead-212, averaged with 2 other peaks.
[11]Analysis of 1,400 keV peak of argon-40.
[12]Analysis of 662 keV peak of barium-137m.

(2) The uranium-235 values are not consistent with the isotopic ratios anticipated.

(3) The uranium-238 and radium-226 values from the gamma spectrum analysis are not consistent with isotopic ratios anticipated.

With respect to the uranium-235 values, this data may be disregarded from further consideration. It may be noted that all but five of the analyses resulted in values less than the detection limit. Additionally, evaluation of uranium-235 from the 185 keV photopeak is confounded by the presence of a 186 keV photopeak from radium-226.

The primary issue to resolve for defining the background is the inconsistency between the uranium and radium-226 results. Barring prior geological anomalies that could chemically/physically separate the radium from the uranium decay chain, these elements should be in essential equilibrium. The gamma spectrometry analysis indicates uranium-238 concentrations that are 2-4 times greater than the radium. Conversely, the total uranium from KPA is lower than the radium-226, although generally within a factor of two. Discussion with the lab provided the following observations:

(1) The radium is evaluated using the 609 keV photopeak which will be much more accurate than the uranium 60 keV photopeak, due to much greater compton interference from higher energy photopeaks into the 60 keV photopeak.

(2) The total uranium analysis ((KPA) could be biased low if complete dissolution of the uranium from the sample matrix does not occur. For soil samples, dissolution should be at least 70-80%.

Table 3-2 shows a comparison of "corrected" total uranium concentration and radium-226 concentration, assuming 70% uranium recovery in the microwave digestion process. Using this correction only on the total uranium values reported above the detection limit, a reasonable comparison with the corresponding radium-226 concentrations results.

Finally, an analysis was performed to correlate the isotopic composition, determined from the lab analysis, with the in situ dose rate measurement obtained with the PIC. The PIC response is assumed to be comprised of two source components:

(1) cosmic radiation
(2) terrestrial radiation

Cosmic radiation may be assumed to be a constant at sea level. This value is taken as 28 mRem/yr (NCRP-94) which equates to 3.19 μR/hr. The remainder of the PIC response will be assumed to be from radioisotopes in the soil.

$$D(PIC) = D_S + D_C = D_T$$

D_S = Dose rate from soil
D_C = Dose rate from cosmic
D_T = Total estimated dose rate

Table 3-2
NAS-JAX Background - Uranium vs Radium Content

Location	Total Uranium Uncorrected (pCi/gm)	Total Uranium Corrected[a] (pCi/gm)	Radium-226 (pCi/gm)
18	0.358	0.511 ± 0.010	0.511 ± 0.097
2	0.238 (U)		0.462
3	0.192 (U)		0.467
6	0.215 (U)		0.681
15	0.136 (U)		0.395
20	0.281 (U)		0.484
9	0.129 (U)		0.367
11	0.215 (U)		0.536
19	0.199 (U)		0.449
1	0.222 (U)		0.708
13	0.417	0.596 ± 0.014	0.532 ± 0.098
16	0.391	0.559 ± 0.010	0.690 ± 0.142
8	0.202 (U)		0.502
5	0.662	0.946 ± 0.014	0.994 ± 0.088
4	0.295 (U)		0.773
10	0.268 (U)		0.583
7	0.437	0.624 ± 0.010	0.529 ± 0.108
17	0.225 (U)		0.578
14	0.268 (U)		0.614
12	0.536	0.766 ± 0.014	0.830 ± 0.125

[a]Assumes a 70 percent recovery from the microwave digestion process.

(U) - indicates presence of analyte less than detection limit.

The soil dose rate is estimated from the laboratory analysis radioisotope concentrations for:

(1) Uranium-238 + daughters
(2) Thorium-232 + daughters
(3) Potassium-40
(4) Cesium-137

Dose rate conversion factors were obtained from three reference sources: Federal Guidance Report No. 12 (EPA), RESRAD (DOE), and NUREG-5512 (NRC). Each set of conversion factors were applied to the lab results for each of two assumptions:

(1) The U-238 gamma photopeak analysis correctly represents the U-238 decay chain.

(2) The Ra-226 gamma photopeak analysis correctly represents the U-238 decay chain.

A summary of this evaluation is presented in Table 3-3. This evaluation indicates a very good correlation for the EPA and DOE conversion factors, assuming Ra-226 lab analysis correctly represents the uranium decay chain and a poor correlation assuming the U-238 analysis is correct. The use of the NRC conversion factors results in an opposite conclusion.

Based on the various factors previously discussed, namely better correlation between total "corrected" uranium analysis from KPA and radium-226, and the difficulty in assessing the U-238 60 keV photopeak in the presence of numerous higher energy photopeaks, it is concluded that the gamma spectrometry analysis for radium-226 correctly predicts the concentration of the uranium decay chain in the background. The radium-226 that represents background at the NAS Jacksonville site is given by:

High =	0.99 pCi/gm
Low =	0.37 pCi/gm
Average =	0.58 pCi/gm

For conservatism, use the low value above which the release criteria is added. This implies that remediation has satisfied the criteria for unrestricted release when the residual activity for radium or thorium is:

$S_R \leq 5.4$ pCi/gm

Table 3

Background Summary Comparison: NAS Jacksonville

Dose Rate vs Isotopic Composition

Location[1]	PIC	FRG # 12 -Γ_γ				RESRAD - Γ_γ				NUREG 5512 - Γ_γ			
	(μR/Hr)	Based on U-238		Based on Ra-226		Based on U-238		Based on Ra-226		Based on U-238		Based on Ra-226	
		D_T	D_T/PIC	D_T	D_T/PIC	D_T	/PIC	D_T	D_T/PIC	D_T	D_T/PIC	D_T	D_T/PIC
18	5.7±0.7	7.30	1.281	5.94	1.042	7.79	367	5.94	1.042	6.13	1.075	4.98	0.874
2	5.7±0.7	6.22	1.091	5.35	0.939	6.60	158	5.39	0.946	5.37	0.942	4.61	0.809
3	5.8±0.7	6.85	1.181	5.56	0.959	7.40	276	5.63	0.988	5.88	1.104	4.77	0.822
6	5.8±0.6	7.21	1.243	6.88	1.186	7.34	266	6.89	1.188	5.87	1.012	5.58	0.962
15	5.8±0.6	6.95	1.198	5.45	0.939	7.60	310	5.54	0.955	6.01	1.036	4.73	0.816
20	5.9±0.7	8.62	1.461	6.41	1.086	9.40	593	6.38	1.081	7.16	1.214	5.27	0.893
9	6.0±0.7	5.81	0.968	4.84	0.807	6.22	307	4.90	0.817	5.11	0.852	4.28	0.713
11	6.0±1.0	6.68	1.113	5.83	0.972	7.09	182	5.93	0.988	5.69	0.948	4.97	0.798
19	6.0±1.0	7.90	1.317	5.61	0.935	8.81	468	5.65	0.942	6.76	1.127	4.79	0.798
1	6.2±1.0	7.74	1.248	6.71	1.082	8.20	323	6.77	1.092	6.42	1.035	5.53	0.892
13	6.2±0.8	7.33	1.182	6.32	1.019	7.72	245	6.33	1.021	6.10	0.984	5.23	0.844
16	6.3±1.0	7.54	1.197	7.05	1.119	7.71	224	7.04	1.117	6.11	0.970	5.69	0.903
8	6.4±0.7	7.38	1.153	5.58	0.872	8.13	270	5.66	0.884	6.34	0.991	4.80	0.750
5	6.6±1.0	8.82	1.336	7.39	1.120	9.59	453	7.63	1.156	7.32	1.109	6.09	0.923
4	6.8±0.7	8.44	1.241	7.19	1.057	9.11	340	7.39	1.087	7.03	1.034	5.96	0.877
10	6.9±1.0	8.57	1.242	7.11	1.030	9.12	322	7.11	1.030	7.02	1.017	5.76	0.835
7	7.0±1.0	7.82	1.117	6.69	0.956	8.24	177	6.67	0.953	6.44	0.920	5.46	0.780
17	7.2±0.7	7.47	1.038	6.39	0.888	7.92	100	6.42	0.892	6.23	0.865	5.29	0.735
14	7.3±0.6	7.96	1.090	6.93	0.949	8.35	144	6.94	0.951	6.53	0.895	5.66	0.775
12	7.8±1.2	8.90	1.141	7.81	1.001	9.39	204	7.86	1.008	7.19	0.922	6.22	0.797
		1.192±.112		0.998±.094			6±.120	1.007±.095		1.003±.093		0.831±.065	

U-238: γ - spec using 60 keV peak (Th-234)

Ra-226: γ - spec using 609 keV peak (Bi-214)

4.0 IN SITU SURVEY METER CORRELATIONS

The background evaluation at each of the 20 locations included gamma, beta, and alpha measurements using the meters described in Table 4-1. These background measurements are summarized in Table 2-1. It may be noted from Table 2-1 that measurements were taken at the same location, but at different times, using different meters. During the course of the background measurements, the following survey instruments were used:

1.	PIC	Serial No. E-9691
2.	MicroR Meter	Serial No. 109899 Serial No. 95487
3.	2" by 2" NaI Detector	Serial No. 157 Serial No. 165
4.	Pancake GM Detector	Serial No. 116872 Serial No. 116876 Serial No. 116878 Serial No. 116881
5.	Alpha Scintillator Probe	Serial No. 95044

The daily source check response for each of these instruments (except the PIC) is provided in Appendix C. These checks are used as the basis for the "acceptability" for use prior to initiating daily characterization activities. During the period of time the background measurements were made, the daily source checks indicated that all instruments used were "acceptable," based upon the response remaining within a $\pm$ 20 percent tolerance band. As previously discussed, the PIC is used as a secondary standard for the evaluation of all other background data.

4.1 MICRO R METER RESPONSE

During the time period that the background surveys were made, two different micro R meters were used, as summarized in Table 2-1. Inspection of that data indicates that both instruments under responded in comparison to the PIC. The characteristics of this under response were evaluated by assuming a linear relationship between the two detectors (i.e., both detectors are responding to the same source: background).

$$R\ (\mu R) = A + B\ (PIC)$$

Correlations were evaluated for three sets of conditions:

1. The response follows a standard linear relationship.
2. The response of the microR meter is different by a constant value: $B = 1.0$
3. The response is a constant percent of "true": $A = 0$

Table 4-1
Portable Survey Instruments

Activity	Detector Type	Model	Readout
Dose Rate	Pressurized ion chamber	Reuter-Stokes	μR/hr
Dose Rate	1" by 1" NaI detector	Ludlum 19	μR/hr
Gamma Flux	2" by 2" NaI detector	Ludlum 44-10	cpm
Beta Flux	Thin window pancake GM detector	Ludlum 44-9	cpm
Alpha Flux	ZnS(Ag) alpha scintillator	Ludlum 43-65	cpm

Correlation coefficients were determined for each condition, with the best fit for each of the two micro R meters being:

Detector No. 95487 : R (μR) = -340 + 54.9 (PIC)
with a correlation coefficient of 0.608

Detector No. 109899 : R (μR) = -230 + 36.8 (PIC)
with a correlation coefficient of 0.503

Both of these relationships imply a severe non-linearity in resonse to a "true" background of zero. This is reflected in the large negative value of "A." If the detector and associated electronics were truly responding to a radiation source only, this constant should be equal to or very near zero. The response of a detector to varying radiation fields is more likely to be one of the following:

1. The variation in detector response is a percentage of the "true" source (the constant "A" is zero in the linear relationship).

2. The variation in detector response is a constant offset from the "true" source (the constant "B" is zero in the linear relationship).

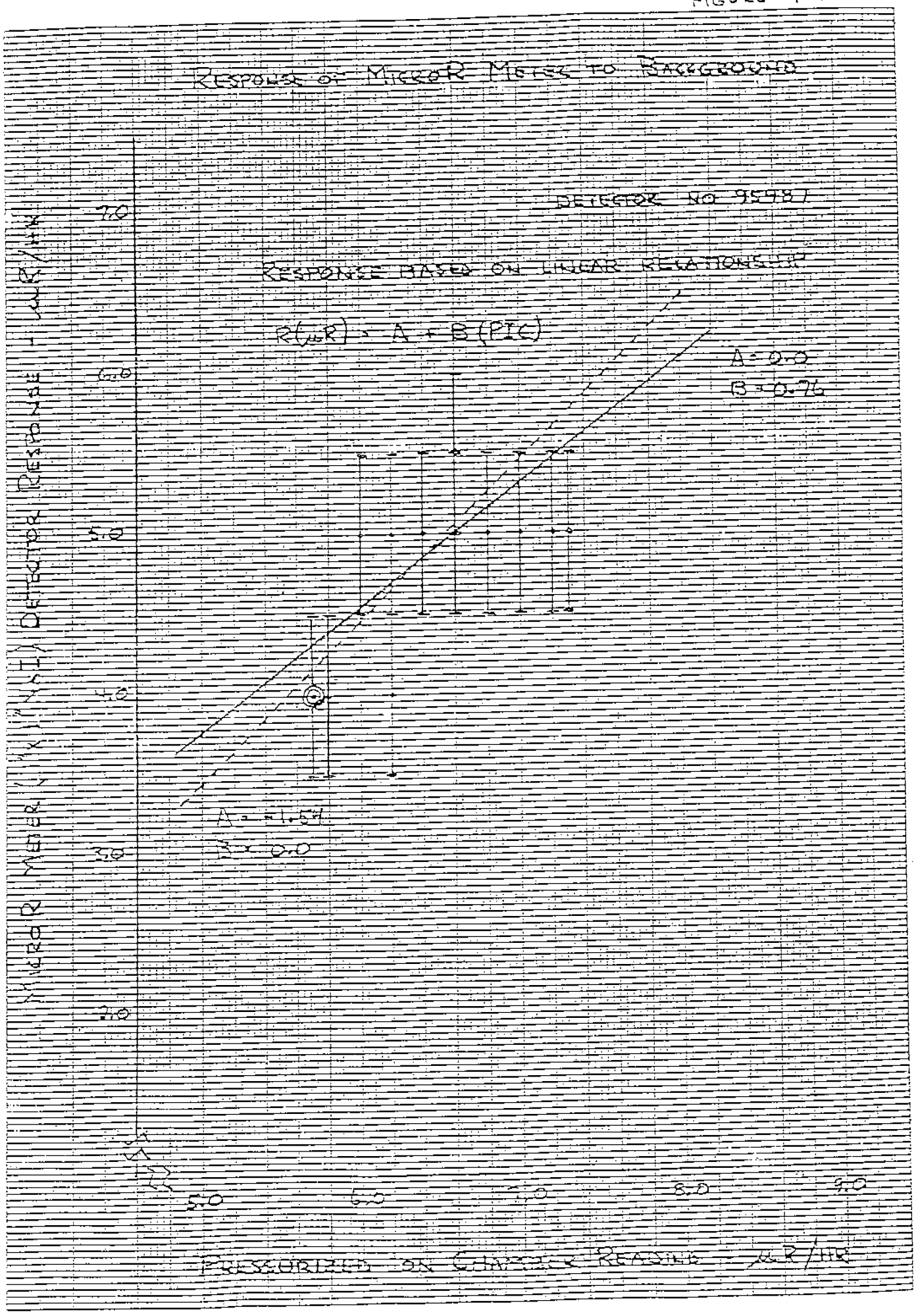
The percentage theory implies that meter no. 95487 is responding approximately 75 percent of "true," and meter no. 109899 is responding approximately 50 percent of "true." The constant offset theory indicates that meter no. 95487 is under responding by approximately 1.5 μR/hr from "true" background, and meter no. 109889 is under responding by approximately 3.0 μR/hr from "true" background.

The response functions for each of these evaluations are shown on Figures 4-1 and 4-2.

The observed differences in response between the two micro R meters and the response of each to the "true" background source would normally not be anticipated for a properly calibrated and properly operating instrument. From the daily source check responses, each instrument was determined to be operating properly. Further discussion with the facility that performed the calibration revealed that no source check is performed on the two lowest scales. The electronics are pulse checked for proper operating response but the detector itself is not part of that check. There is an "acceptable" range for the voltage plateau for the detector, and the exact setting within that range could account for the response variations observed.

It is not possible to determine the appropriate response relationship for these instruments from the data obtained here. The range of the "true" background measurements (5.7 - 7.8 μR/hr) introduce error bands that mask a true response correlation. In order to properly define the response functions, a greater range of radiation field strengths must be provided using sources that would produce fields up to approximately 100 μR/hr. The responses observed in this study result from "calibration" protocols that exclude the quantity being measured.

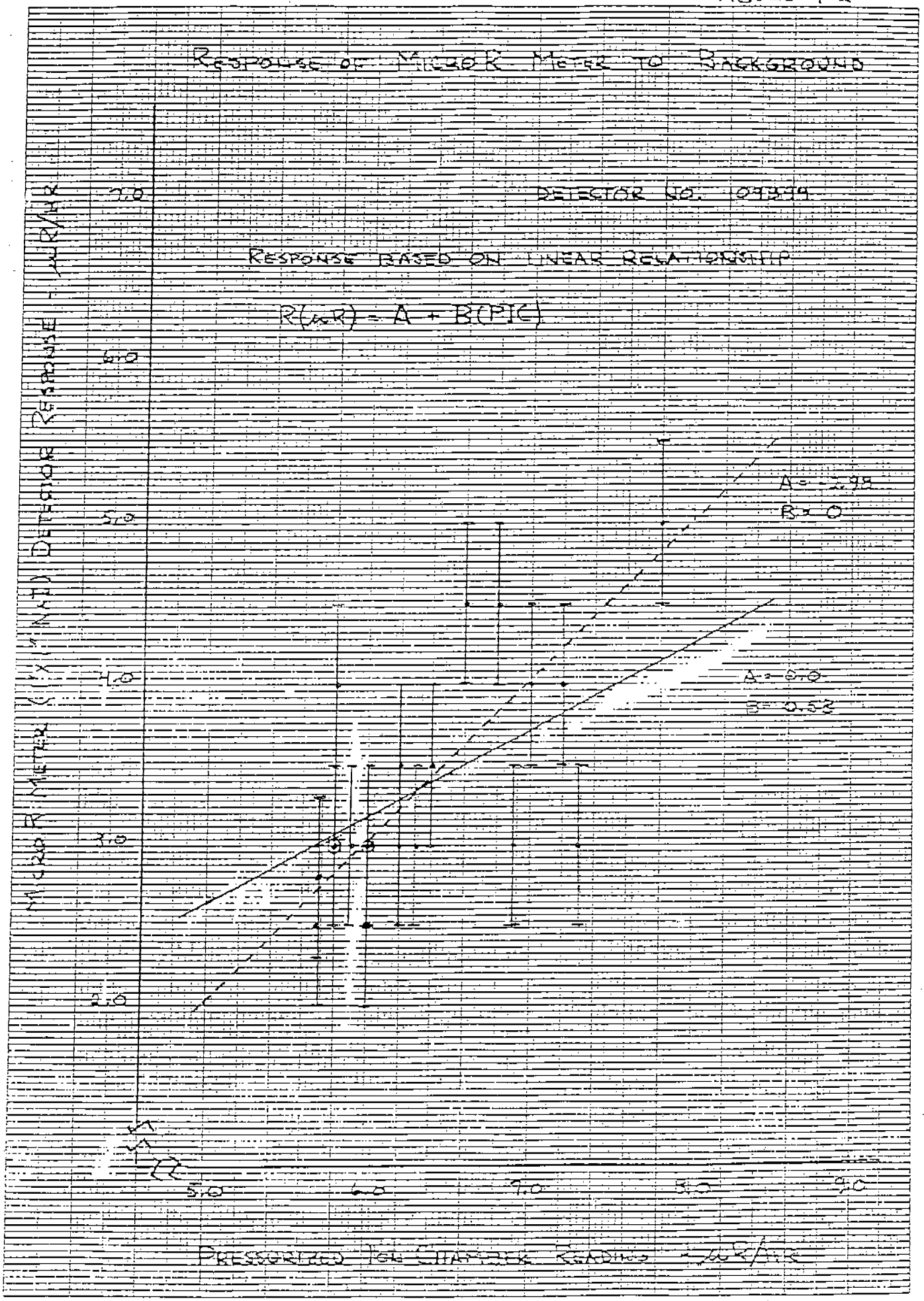
FIGURE 4-1



46 1323

K+E 10 X 10 TO 1/2 INCH 7 X 10 INCHES KEUFFEL & ESSER CO. MADE IN U.S.A.

FIGURE 4-2



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4.2 2" by 2" NaI DETECTOR RESPONSE

The background surveys, measuring the equivalent gamma flux, were made using two different 2" by 2" NaI detectors. These results are summarized in Table 2-1. As with the micro R meters, a different response for each detector was observed. In this case the difference was approximately a factor of two. Each detector was evaluated to determine a count rate versus dose rate relationship. A linear response to dose rate was assumed for each detector by the relationship

$$R\ (NaI) = A + B\ (PIC)$$

where the PIC readings are taken as "true" background.

The response function for each detector is as follows:

Detector No. 157: R (NaI) = -2446 + 1252 (PIC)
with a correlation coefficient r = 0.776

Detector No. 165: R (NaI) + -1291 + 672 (PIC)
with a correlation coefficient r = 0.809

These response functions are shown on Figure 4-3.

As with the micro R meters, the variation in response between the two meters may be attributed to the same calibration protocol, wherein the setting of the voltage plateau could account for the observed differences. The problem appears to arise from a lack of any requirement that low range instruments be calibrated to a standard radiological source.

4.3 BETA DETECTOR RESPONSE

Beta measurements were made at the 20 background locations using a thin window pancake GM probe. Paired measurements were taken at each location:

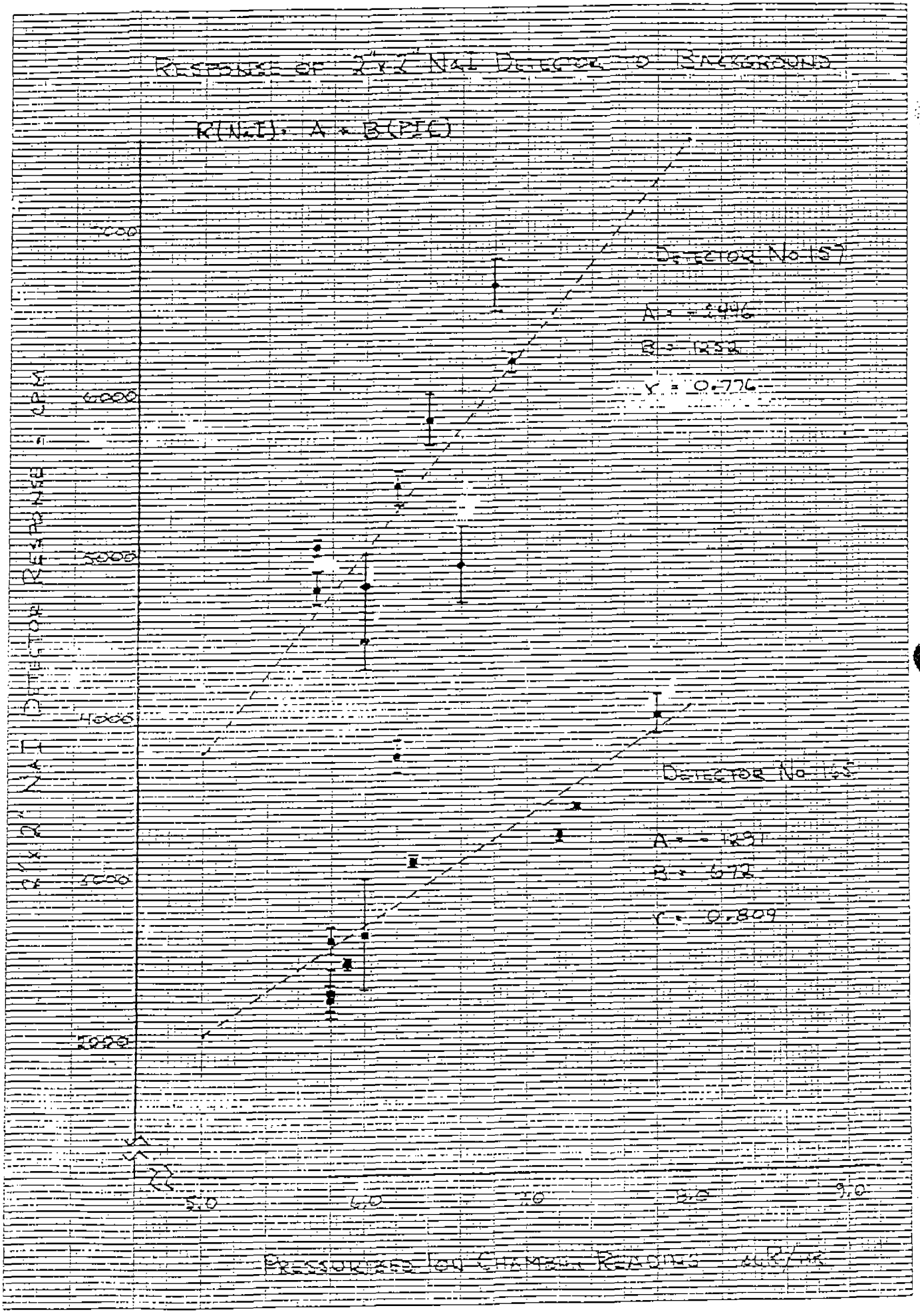
- probe window facing the surface
- probe window facing downward

This was done to determine if there would be a directional response to background or if the background is essentially uniform.

During the performance of these measurements, four different detector probes were used. The summary of these measurements is shown in Table 2-1 and Table 4-2. These data were evaluated to address two questions:

1. Is the instrument response to background directional or uniform (face down vs. face up)?
2. Is there a variation in instrument response as was observed with the NaI detectors?

FIGURE 4-3



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KEUFFEL & ESSER CO. 10 X 10 TO 1/2 INCH 7 X 10 INCHES

Table 4-2
Alpha and Beta Background Determination

	Beta				Alpha		
Location	PIC	Probe down	Probe up	Δ	Probe down	Probe up	Δ
18	5.7 ± 0.7	36 ± 1^3	37 ± 5	<1> ±	1.7 ± 0.6	1.0 ± 1.0	0.7
2	5.7 ± 0.6	35 ± 2^3	34 ± 2	1 ±	1.7 ± 2.1	1.0 ± 1.7	0.7
3	5.8 ± 0.7	31 ± 4^4	35 ± 7	<4> ±	0.7 ± 0.6	0.7 ± 0.6	0.0
6	5.8 ± 0.6	37 ± 4^2	27 ± 2	10 ±	1.3 ± 1.5	1.0 ± 1.0	0.3
15	5.8 ± 0.6	30 ± 7^4	37 ± 8	<7> ±	3.7 ± 0.6	1.7 ± 1.5	2.0
20	5.9 ± 0.7	30 ± 1^4	40 ± 4	<10> ±	2.3 ± 1.5	0.7 ± 0.6	1.6
9	6.0 ± 0.7	34 ± 3^1	29 ± 4	5 ±	2.0 ± 2.0	0.7 ± 0.6	1.3
11	6.0 ± 1.0	40 ± 7^1	33 ± 4	7 ±	3.3 ± 1.2	2.3 ± 2.5	1.0
19	6.0 ± 1.0	36 ± 4^4	34 ± 12	2 ±	1.7 ± 1.5	1.0 ± 1.0	0.7
1	6.2 ± 1.0	48 ± 9^4	40 ± 8	8 ±	1.3 ± 2.3	0.3 ± 0.6	1.0
13	6.2 ± 0.8	33 ± 6^4	37 ± 11	<4> ±	1.7 ± 1.2	0.3 ± 0.6	1.4
16	6.3 ± 1.0	31 ± 7^4	41 ± 8	<10> ±	1.7 ± 0.6	0.7 ± 1.2	1.0
8	6.4 ± 0.7	33 ± 4^1	28 ± 4	5 ±	3.0 ± 1.0	1.0 ± 1.0	2.0
5	6.6 ± 1.0	39 ± 3^3	33 ± 6	6 ±	2.7 ± 2.1	2.0 ± 2.0	0.7
4	6.8 ± 0.7	46 ± 5^3	36 ± 5	10 ±	2.7 ± 2.1	1.0 ± 1.0	1.7
10	6.9 ± 1.0	40 ± 4^1	36 ± 8	4 ±	2.7 ± 0.6	0.7 ± 1.2	2.0
7	7.0 ± 1.0	34 ± 3^2	35 ± 4	<1> ±	2.3 ± 2.3	2.0 ± 2.0	0.3
17	7.2 ± 0.7	39 ± 5^2	34 ± 3	5 ±	1.0 ± 1.0	2.0 ± 1.7	<1.0>
14	7.3 ± 0.6	31 ± 5^2	41 ± 6	<10> ±			
12	7.8 ± 1.2	50 ± 7^2	33 ± 6	17 ±	2.0 ± 1.0	0 ± 0	2.0
Σ				33			19.4
n = 20							20
Σ/n				1.7			1.0

4.3.1 Directional Response

Each paired set of readings was compared by taking the difference:

Difference = Probe down - probe up

Of the paired sets, the difference was positive for 12 sets and negative for eight sets. The average of the differences is within the statistical variation of each reading. These two observations tend to support a conclusion that the detector response is uniform to the background encountered.

4.3.2 Instrument Variation

A review of the response of each instrument to the corresponding PIC readings in Table 4-2 results in two observations:

1. There is no discernable trend of increasing beta activity as the gamma background increases.

2. There is no discernable difference between the various detectors used and variations in the background source (as defined by the PIC readings).

It may be concluded that the pancake GM detectors are not as sensitive to electronic calibration variations (as expected, based on GM performance characteristics), and that the measurements observed result primarily from the response of the detector to the background gamma activity. Higher directional beta response would require a source of beta activity that was essentially on the surface of the ground.

4.4 ALPHA DETECTOR RESPONSE

The alpha measurements at each of the 20 background locations were made using one ZnS alpha scintillator detector. Paired measurements were taken at each location, using the same protocol as was used for the beta measurements. The summary of these measurements is shown in Table 2-1 and Table 4-2.

Each paired set of readings was compared by taking the difference

Difference = Probe down - probe up

All but one of the paired readings of sets in Table 4-2 had a higher probe down versus probe up reading. This could indicate activity at the surface of the ground (e.g., uniform distribution of isotopes in the soil). However, the average magnitude of this difference (including the negative difference) is within the statistical variation of each of the readings. Also, there is no observable increase trend in the probe down readings with increasing gamma background in Table 4-2. Finally, there is no corresponding increase between alpha and beta measurements indicated in Table 4-2. The field measured alpha "background" at each location is typically greater than the background determined at the beginning of each day (note data in Appendix A) which would indicate the presence of some surface activity in the soil. However, the magnitude of this activity is not sufficient to be noted in the field measured beta "background."

5.0 REFERENCES

DOE - C. Yu, et al, "Manual for Implementing Residual Radioactive Material Guidelines Using RESRAD, Version 5.0," ANL/EAD/LD-2 Argonne National Laboratory, Argonne, IL, September 1993.

EPA - Federal Guidance Report No. 12, "External Exposure to Radionuclides in Air, Water, and Soil," EPA 401-R-93-081, United States Environmental Protection Agency, Wshington, DC, September 1993.

NCRP-94 - NCRP Report No. 94, "Exposure of the Population in the United States and Canade from Natural Background Radiation," National Council on Radiation Protection and Measurements, Bethesda, MD, December 30, 1097.

NRC - "Residual Radioactive Contamination from Decommissioning," NUREG/CR-5512, Vol. 1, US Nuclear Regulatory Commission, Washington, DC, October 1992.

FIGURE 2-19
BACKGROUND RADIOLOGICAL SURVEY LOCATIONS

REMEDIAL INVESTIGATION REPORT FOR OU 1

NAS JACKSONVILLE
JACKSONVILLE, FLORIDA

JAX200/DRM/04-07-95

APPENDIX A

FIELD DATA ACQUISITION FORMS: BACKGROUND DATA

FIELD DATA ACQUISITION FORMS

BACKGROUND DATA

Site: NAS-JACKSONVILLE WBS No: 201 Date: 02 NOV 94

Technicians: STEVE HAESE / W. CARL MAY Bkg Loc. No.: 03

Descriptions of Location: ORTEGA HILLS DRIVE ; WEST OF ATLANTIC COAST LINE RAILROAD AND SOUTH OF WEDGEWOOD APARTMENT SIGN

INSTRUMENTS

					EFFICIENCY
(1) Meter LUDLUM 19	S/N 109899	Detector	S/N		
(2) Meter LUDLUM 2221	S/N 99136	Detector 44-10	S/N 165		.069
(3) Meter LUDLUM 2221	S/N 117366	Detector 44-9	S/N 116878		.259
(4) Meter LUDLUM 2221	S/N 117366	Detector 44-9	S/N 116878		.259
** (5) Meter LUDLUM 2221	S/N 102049	Detector 43-65	S/N 095044		
** (6) Meter LUDLUM 2221	S/N 102049	Detector 43-65	S/N 095044		
** (7) PIC Model # RSS-111	S/N 009994 (IT)	Cal. Due 11-2-95			

MEASUREMENTS * C/G

#	cpm (1)	cpm (2)	cpm (3)	cpm (4)	cpm (5)**	cpm (6)**	uR/hr (7)**
0301	* 5uR/hr 4uR/hr	2405	29	33	1	1	6.1
0302	5uR/hr 4uR/hr	2187	36	29	1	0	5.6
0303	5uR/hr 4uR/hr	2424	29	43	0	1	6.0
	4.0 ± 0	2339 ± 132	31.3 ± 4.0	35 ± 7.2	0.7 ± 0.6	0.7 ± 0.6	5.9 ± .3

REMARKS

* NOTE: MEASUREMENT @ WAIST LEVEL WITH LUDLUM 19 — 4uR/HR

** READINGS TAKEN 11/08/94 & LUDLUM 19 (#109899) 2.5-30 uR/HR (AVG 30)

DATA RECORDED BY R. PARRISH & W.C. MAY

BACKGROUND DATA

Site: NAS- JACKSONVILLE WBS No: 201 Date: 02 NOV 94

Technicians: ROBERT PARRISH / GEUSA SHOWERS Bkg Loc. No.: 04

Descriptions of Location: OFF SITE 17 SOUTH TO COLLINS ROAD EAST TO MALAGA ROAD NORTHEAST CORNER LOCATION IN FRONT OF DEAD END SIGN.

INSTRUMENTS

						EFFICIENCY
	(1) Meter LUDLUM 19	S/N 95487	Detector	S/N		
	(2) Meter LUDLUM 2221	S/N 97830	Detector 44-10	S/N 157		.125
	(3) Meter LUDLUM 2221	S/N 108881	Detector 44-9	S/N 116881		.256
	(4) Meter LUDLUM 2221	S/N 108881	Detector 44-9	S/N 116881		.256
**	(5) Meter LUDLUM 2221	S/N 102049	Detector 43-65	S/N 095044		
**	(6) Meter LUDLUM 2221	S/N 102049	Detector 43-65	S/N 095044		
**	(7) PIC Model # RSS-111	S/N 009994 (IT)	Cal. Due 11-2-95			

MEASUREMENTS* 0/6"

	#	cpm (1)		cpm (2)	cpm (3) DOWN	cpm (4) UP	cpm (5)** DOWN	cpm (6)** UP	uR/hr (7)**
	0401 ~~0501~~	* 6uR/hr	5uR/hr	6508	41	32	5	2	7.9
	0402 ~~0502~~	6uR/hr	6uR/hr	6822	50	36	2	0	7.1
	0403 ~~0503~~	6uR/hr	5uR/hr	6742	47	41	1	1	7.0
		5.3±.6		6691±163	46±4.6	36.3±4.5	2.7±2.1	1.0±1.0	7.3±.5

REMARKS

NOTE: MEASUREMENT @ WAIST LEVEL WITH LUDLUM 19 - 5uR/HR

** READINGS TAKEN 11/2/94 : LUDLUM 19 (#109899) 41-5 μR/HR (AVE = 4.5)

DATA RECORDED BY R PARRISH E. WALKER S/W

BACKGROUND DATA

Site: NAS JACKSONVILLE WBS No: 201 Date: 02 NOV 94

Technicians: ROBERT PARRISH/ GEUSA SHOWERS Bkg Loc. No.: 05

Descriptions of Location: MUSTIN ROAD SOUTH - TO RESTRICTED AREA AT GATE ACCESS ON SOUTH SIDE ROAD

INSTRUMENTS

						EFFICIENCY
	(1) Meter LUDLUM 19	S/N 95487	Detector	S/N		
	(2) Meter LUDLUM 2221	S/N 97830	Detector 44-10	S/N 157		.125
	(3) Meter LUDLUM 2221	S/N 108681	Detector 44-9	S/N 116881		.256
	(4) Meter LUDLUM 2221	S/N 108881	Detector 44-9	S/N 116881		.256
**	(5) Meter LUDLUM 2221	S/N 102049	Detector 43-65	S/N 095044		
**	(6) Meter LUDLUM 2221	S/N 102049	Detector 43-65	S/N 095044		
**	(7) PIC Model # ~~[illegible]~~ RSS-111	S/N 009994	Cal. Due 11-2-95			

MEASUREMENTS * C/6"

#	cpm (1)		cpm (2)	cpm (3) DOWN	cpm (4) UP	cpm (5) DOWN **	cpm (6) UP **	uR/hr (7) **
0501	* 5uR/hr	4uR/hr	4952	41	32	5	2	7.5
0502	5uR/hr	4uR/hr	4733	35	29	1	4	6.8
0503	5uR/HR	5uR/hr	5208	41	39	2	0	6.2
	4.3±.6		4964±235	39±3.5	33.0±5.6	2.7±2.1	2.0±2.0	6.8±0.7

REMARKS

* NOTE: MEASUREMENT @ WAIST LEVEL WITH LUDLUM 19 - 5uR/HR

ROAD ADJACENT TO SURVEY LOCATION - 6.5uR/HR - 7357 CPM

** READINGS TAKEN 11/7/94 ; LUDLUM 19 (#109899) : 3.5-5 uR/HR (AVG = 4.

DATA RECORDED BY J. SHOWERS, R. PARRISH, E. WALKER S/W

AVERAGE ON GRAVEL ROAD = 6.5 uR/HR

BACKGROUND DATA

Site: NAS - JACKSONVILLE WBS No: 201 Date: 01 NOV 94

Technicians: STEVE HAESE / W. CARLMAY Bkg Loc. No.: 06

Descriptions of Location: CHILD STREET WEST OF NAVAL HOSPITAL EDGE OF TREE LINE

INSTRUMENTS

						EFFICIENCY
	(1) Meter LUDLUM 19	S/N 95487	Detector	S/N		
	(2) Meter LUDLUM 2221	S/N 99136	Detector 44-10	S/N 165		.070
	(3) Meter LUDLUM 2221	S/N 115123	Detector 44-9	S/N 116876		.225
	(4) Meter LUDLUM 2221	S/N 115123	Detector 44-9	S/N 116876		.225
**	(5) Meter LUDLUM 2221	S/N 102049	Detector 43-65	S/N 095044		
**	(6) Meter LUDLUM 2221	S/N 102049	Detector 43-65	S/N 095044		
**	(7) PIC Model # RSS-111	S/N 009994 (IT)	Cal. Due 11-2-95			

MEASUREMENTS * c/6"

#	cpm (1)	cpm (2)	DOWN cpm (3)	UP cpm (4)	DOWN cpm (5)**	UP cpm (6)**	uR/hr (7)
C601	5uR/HR / 4uR/HR	2557	33	25	1	0	6.3
C602	5uR/HR / 4uR/HR	2686	38	27	3	2	6.1
C603	4uR/HR / 4uR/HR	2697	41	28	0	1	6.0
	4.0 ± 0	2647 ± 78	37.3 ± 4.6	26.7 ± 1.5	1.3 ± 1.5	1.0 ± 1.0	6.1 ± .2

REMARKS

NOTE: MEASUREMENT @ WAIST LEVEL WITH LUDLUM 19 — 4uR/HR

** READINGS TAKEN 11/3/94: LUDLUM 19 (#109899) 3-5 uR/HR (AVG=

DATA TAKEN BY J. SHOWERS, R PARRISH, E. WALKER E/W

BACKGROUND DATA

Site: NAS JACKSONVILLE WBS No: 201 Date: 01 NOV 94

Technicians: ROBERT PARRISH / GEUSA SHOWERS Bkg Loc. No.: 07

Descriptions of Location: MUSTIN ROAD NORTH ACROSS FROM FIRE STATION #2

INSTRUMENTS

						EFFICIENCY
(1) Meter LUDLUM 19	S/N 95487	Detector		S/N		
(2) Meter LUDLUM 2221	S/N ~~99186~~ 99136	Detector 4410		S/N 165		.070
(3) Meter LUDLUM 2221	S/N 115123	Detector 44-9		S/N 116876		.225
(4) Meter LUDLUM 2221	S/N 115123	Detector 44-9		S/N 116876		.225
** (5) Meter LUDLUM 2221	S/N 102049	Detector 43-65		S/N 095044		
(6) Meter LUDLUM 2221	S/N 102049	Detector 43-65		S/N 095044		

MEASUREMENTS @ 6"

#	cpm (1)		cpm (2)	cpm (3) DOWN	cpm (4) UP	cpm (5)** DOWN	cpm (6)** UP	uR/hr (7)**
0701	5uR/HR	5uR/HR	3281	33	39	1	4	7.4
0702	6uR/HR	5uR/HR	3149	32	34	5	0	7.3
0703	6uR/HR	5uR/HR	3209	38	33	1	2	7.0
	5.0 ± 0		3213 ± 66	34.3 ± 3.2	34.7 ± 3.8	2.3 ± 2.3	2.0 ± 2.0	7.2 ± .2

REMARKS

* NOTE: MEASUREMENT @ WAIST LEVEL WITH LUDLUM 19 - 5uR/HR

** READINGS TAKEN 11/7/94 : LUDLUM 19 (#109899) 3-5 uR/HR (AVG=4)

DATA TAKEN BY J. SHOWERS, R PARRISH, E. WALKER S/W

BACKGROUND DATA

Site: NAS JACKSONVILLE WBS No: 201 Date: 01 Nov 94

Technicians: STEVE HAESE / W. CARL MAY Bkg Loc. No.: 08

Descriptions of Location: MUSTIN ROAD SOUTH TO ADAMS AVENUE / KNIGHT LANE INTERSECTION IN FIELD AT NORTHWEST CORNER ADJACENT TO PARKING LOT ON WEST SIDE

INSTRUMENTS *EFFICIENCY*

	(1) Meter LUDLUM 19	S/N 109899	Detector	S/N		
	(2) Meter LUDLUM 2221	S/N 97830	Detector 44-40	S/N 157		.125
	(3) Meter LUDLUM 2221	S/N 117363	Detector 44-9	S/N 116872		.247
	(4) Meter LUDLUM 2221	S/N 117363	Detector 44-9	S/N 116872		.247
**	(5) Meter LUDLUM 2221	S/N 102049	Detector 43-65	S/N 095044		
**	(6) Meter LUDLUM 2221	S/N 102049	Detector 43-65	S/N 095044		
**	(7) PIC Model # RSS-111	S/N 009994 (IT)	Cal. Due 11-2-95			

MEASUREMENTS * C/6"

#	cpm (1)	cpm (2)	cpm (3) DOWN	cpm (4) UP	cpm (5) ** DOWN	cpm (6) ** UP	uR/hr (7)
0801	6uR/HR 5uR/HR	5871	37	33	4	1	6.8
0802	6uR/HR 5uR/HR	6011	31	26	3	0	6.3
0803	6uR/HR 5uR/HR	5709	30	26	2	2	6.5
		5864 ± 151	32.7 ± 3.8	28.3 ± 4.0	3.0 ± 1.0	1.0 ± 1.0	6.5 ± 0.2

REMARKS

NOTE: MEASUREMENT @ WAIST LEVEL WITH LUDLUM 19 – 5uR/HR

** READINGS TAKEN 11/7/94: LUDLUM 19 (#109899) 3-4 uR/HR (AVG = 3.5)

DATA TAKEN BY J. SHOWERS, R. PARRISH, E. WALKER S/W

BACKGROUND DATA

Site: NAS JACKSONVILLE WBS No: 201 Date: 01 NOV 94

Technicians: STEVE HAESE / W. CARL MAY Bkg Loc. No.: 09

Descriptions of Location: INTERSECTION OF SARATOGA AVENUE AND JASON STREET AT YESTERDAY'S CAFE PARKING LOT - NORTHWEST CORNER

INSTRUMENTS

					EFFICIENCY
(1) Meter LUDLUM 19	S/N 109899	Detector	S/N		
(2) Meter LUDLUM 2221	S/N 97830	Detector 44-10	S/N 157		.125
(3) Meter LUDLUM 2221	S/N 117363	Detector 44-9	S/N 116872		.247
(4) Meter LUDLUM 2221	S/N 117363	Detector 44-9	S/N 116872		.247
** (5) Meter LUDLUM 2221	S/N 102049	Detector 43-65	S/N 095044		
** (6) Meter LUDLUM 2221	S/N 102049	Detector 43-65	S/N 095044		
** (7) PIC Model # RSS-111	S/N 009994 (IT)	Cal. Due 11-2-95			

MEASUREMENTS * C/6'

#	cpm (1)	cpm (2)	cpm (3) DOWN	cpm (4) UP	cpm (5) DOWN **	cpm (6) UP **	uR/hr (7) **
0901	* 5uR/HR / 4uR/HR	4707	37	31	4	0	6.5
0902	4uR/HR / 4uR/HR	4439	35	25	0	1	6.2
0903	4uR/HR / 4uR/HR	4375	31	31	2	1	6.0
	4±0	4507±176	34.3±3.1	29.0±3.5	2.0±2.0	0.7±0.6	6.2±0.3

REMARKS

* NOTE: MEASUREMENT @ WAIST LEVEL WITH LUDLUM 19 - 4uR/HR

** READINGS TAKEN 11/8/94: LUDLUM 19 (#109899) 2-3 μR/HR

DATA RECORDED BY R. PARRISH, E. WALKER

BACKGROUND DATA

Site: NAS JACKSONVILLE WBS No: 201 Date: 01 NOV 94

Technicians: STEVE HAESE / W. CARL MAY Bkg Loc. No.: 10

Descriptions of Location: MUSTIN ROAD NORTH – ACROSS FROM NAVY LODGE (SW)
EAST OF GOLF COURSE / PIPELINE

INSTRUMENTS

						EFFICIENCY
	(1) Meter LUDLUM 19	S/N 109899	Detector	S/N		
	(2) Meter LUDLUM 2221	S/N 97830	Detector 44-10	S/N 165 157		.125
	(3) Meter LUDLUM 2221	S/N 117363	Detector 44-9	S/N 116872		.247
	(4) Meter LUDLUM 2221	S/N 117363	Detector 44-9	S/N 116872		.247
**	(5) Meter LUDLUM 2221	S/N 102049	Detector 43-65	S/N 095044		
**	(6) Meter LUDLUM 2221	S/N 102049	Detector 43-65	S/N 095044		
**	(7) PIC Model # RSS-111	S/N 009994 (IT)	Cal. Due 11-2-95			

MEASUREMENTS * c/6"

#	cpm (1)	cpm (2)	cpm (3) DOWN	cpm (4) UP	cpm (5) DOWN **	cpm (6) UP **	uR/hr (7) **
1001	* 5uR/HR / 5uR/HR	6150	36	29	3	0	7.2
1002	5uR/HR / 5uR/HR	6211	39	44	3	2	7.1
1003	6uR/HR / 6uR/HR	6274	44	34	2	0	6.3
	5.3 ± .6	6212 ± 62	39.7 ± 4.0	35.7 ± 7.6	2.7 ± 0.6	0.7 ± 1.2	6.9 ± .5

REMARKS

* NOTE: MEASUREMENT @ WAIST LEVEL WITH LUDLUM 19 – 5uR/HR

** READINGS TAKEN 11/8/94 : LUDLUM 19 (#109899) 2.5-3.5 μR/HR

DATA RECORDED BY R. PARRISH, E. WALKER 2/W

BACKGROUND DATA

Site: NAS JACKSONVILLE WBS No: 201 Date: 01 NOV 94

Technicians: STEVE HAESE / W. CARL MAY Bkg Loc. No.: 11

Descriptions of Location: OFF SITE - 120TH STREET WEST TO NORTH FLORIDA ARCH GATE (IN FRONT)

INSTRUMENTS

						EFFICIENCY
	(1) Meter LUDLUM 19	S/N 109899	Detector		S/N	
	(2) Meter LUDLUM 2221	S/N 97830	Detector 44-10		S/N 165 157	.125
	(3) Meter LUDLUM 2221	S/N 117363	Detector 44-9		S/N 116872	.247
	(4) Meter LUDLUM 2221	S/N 117363	Detector 44-9		S/N 116872	.247
**	(5) Meter LUDLUM 2221	S/N 102049	Detector 43-65		S/N 095044	
**	(6) Meter LUDLUM 2221	S/N 102049	Detector 43-65		S/N 095044	
**	(7) PIC Model #RSS-111	S/N009994(FT)	Cal. Due 11-2-95			

MEASUREMENTS @ C/6"

#	cpm (1)		cpm (2)	cpm (3)	cpm (4)	cpm (5) **	cpm (6) **	uR/hr (7) **
				DOWN	UP	DOWN	UP	
1101	5uR/HR*	4uR/HR	5019	42	35	2	0	7.0
1102	5uR/HR	5uR/HR	4627	32	36	4	5	6.2
1103	5uR/HR	5uR/HR	4871	45	28	4	2	6.0
	4.7 ± .6		4839 ± 198	39.7 ± 6.8	33 ± 4.4	3.3 ± 1.2	2.3 ± 2.5	6.4 ± .5

REMARKS

NOTE: MEASUREMENT @ WAIST LEVEL WITH LUDLUM 19 - 5uR/HR

** READINGS TAKEN 11/8/94 & LUDLUM 19 (#109899) 2.5 - 3.5 uR/HR

DATA TAKEN BY R. PARRISH & W. C. MAY

BACKGROUND DATA

Site: NAS-JACKSONVILLE WBS No: 201 Date: 01 NOV 94

Technicians: ROBERT PARRISH/GEORGA SHOWERS Bkg Loc. No.: 12

Descriptions of Location: CHILD ROAD NORTH TO BUILDING 371 @ PARKING AREA (NORTH) NEXT TO BASEBALL COMPLEX

INSTRUMENTS

						EFFICIENCY
	(1) Meter LUDLUM 19	S/N 95487	Detector	S/N		
	(2) Meter LUDLUM 2221	S/N ~~99186~~ 99136	Detector 44-10	S/N 165		.070
	(3) Meter LUDLUM 2221	S/N 115123	Detector 44-9	S/N 116876		.225
	(4) Meter LUDLUM 2221	S/N 115123	Detector 44-9	S/N 116876		.225
**	(5) Meter LUDLUM 2221	S/N 102049	Detector 43-65	S/N 095044		
**	(6) Meter LUDLUM 2221	S/N 102049	Detector 43-65	S/N 095044		
**	(7) PIC Model # RSS-111	S/N 009994 (IT)	Cal. Due 11-2-95			

MEASUREMENTS * C/6"

#	cpm (1)	cpm (2)	cpm (3) DOWN	cpm (4) UP	cpm (5) DOWN **	cpm (6) UP **	uR/hr (7) **
1201	* 7uR/HR / 6uR/HR	3993	50	28	1	0	8.3
1202	7uR/HR / 6uR/HR	4165	56	33	2	0	8.5
1203	7uR/HR / 6uR/HR	3932	43	39	3	0	8.2
	6 ± 0	4030 ± 121	49.7 ± 6.5	33.3 ± 5.5	2 ± 1	0 ± 0	8.3 ± .2

REMARKS

* NOTE - MEASUREMENTS @ WAIST LEVEL WITH LUDLUM 19 - 6.5 uR/HR

** READINGS TAKEN 11/7/94 : LUDLUM 19 (#109899) 4.5-5.5 uR/HR (AVG=5)

DATA TAKEN BY R. PARRISH, E. WALKER S/W

BACKGROUND DATA

Site: NAS JACKSONVILLE WBS No: 201 Date: 02 NOV 94

Technicians: ROBERT PARRISH / GEUSA SHOWERS Bkg Loc. No.: 13

Descriptions of Location: OFF SITE HWY. 17 SOUTH TO COLLINS ROAD SOUTH OF U-HAUL BUSINESS

INSTRUMENTS

						EFFICIENCY
	(1) Meter LUDLUM 19	S/N 95487	Detector	S/N		
	(2) Meter LUDLUM 2221	S/N 97830	Detector 44-10	S/N 157		.125
	(3) Meter LUDLUM 2221	S/N 108881	Detector 44-9	S/N 116881		.256
	(4) Meter LUDLUM 2221	S/N 108881	Detector 44-9	S/N 116881		.256
**	(5) Meter LUDLUM 2221	S/N 102049	Detector 43-65	S/N 095044		
**	(6) Meter LUDLUM 2221	S/N 102049	Detector 43-65	S/N 095044		
**	(7) PIC Model # RSS-111	S/N 009994 (IT)	Cal. Due 11-2-95			

MEASUREMENTS ¥ c/6"

#	cpm (1)		cpm (2)	DOWN cpm (3)	UP cpm (4)	DOWN cpm (5) **	UP cpm (6) **	uR/hr (7) **
1301	* SUR/HR	SUR/HR	5496	29	43	1	0	7.0
1302	SUR/HR	SUR/HR	5552	40	39	1	0	6.5
1303	SUR/HR	SUR/HR	5341	31	28	3	1	6.2
	5.0±0		5463±109	33.3±5.9	36.7±11.0	1.7±1.2	0.3±0.6	6.6±.4

REMARKS

NOTE! MEASUREMENT @ WAIST LEVEL WITH LUDLUM 19 - SUR/HR

** DATA TAKEN 11/8/94 : LUDLUM 19 (#109899) 2:5-3:5

DATA RECORDED BY R. PARRISH E. WALKER S/W

BACKGROUND DATA

Site: NAS JACKSONVILLE WBS No: 201 Date: 01 NOV 94

Technicians: ROBERT PARRISH/GEUSA SHOWERS Bkg Loc. No.: 014

Descriptions of Location: INTERSECTION OF TATUM / SAPHIER, WEST OF BUILDING 204 PARKING LOT (MANHOLE COVER)

INSTRUMENTS

					EFFICIENCY
(1) Meter LUDLUM 19	S/N 95487	Detector		S/N	
(2) Meter LUDLUM 2221	S/N 98136	Detector 44-10		S/N 166	.070
(3) Meter LUDLUM 2221	S/N 115123	Detector 44-9		S/N 116876	.225
(4) Meter LUDLUM 2221	S/N 115123	Detector 44-9		S/N 116876	.225
(5) Meter Ludlum 2221	S/N 102049	Detector 43-65		S/N 095044	.192
(6) Meter Ludlum 2221	S/N 102049	Detector 43-65		S/N 095044	.192
(7) PIC Model # 111	S/N 0099 (27)	Cal. Due 11-2-95			

MEASUREMENTS *C/6"

#	cpm (1)	cpm (2)	cpm (3) Down	cpm (4) UP	cpm (5)** Down	cpm (5) UP	uR/hr (7)***
1401	6uR/hr / 6uR/hr	3465	29	44	1	1	8
1402	6uR/hr / 5uR/hr	3468	37	34	1	0	7.5
1403	6uR/hr / 5uR/hr	3435	27	46	3	1	7.0
	5.3 ± .6	3456 ± 18	31.0 ± 5.3	41.3 ± 6.4	1.7 ± 1.2	0.7 ± 0.6	7.5 ± 0.5

Post-it® Fax Note 7671 Date 11-21-94 # of pages ▸ 1
To ED WALKER From Bell
Co./Dept. Location #14 Co.
Phone # As you requested Phone #
Fax # Fax #

REMARKS
NOTE: MEASUREMENT @ WAIST LEVEL WITH LUDLUM 19 – 5uR/HR
Readings taken on 11-01-94 (Location #14 (014)): 2.5 To 3.5 uR/hr Bkg
Data Taken by R. Parrish J. Showers

BACKGROUND DATA

Site: NAS JACKSONVILLE WBS No: 201 Date: 02 NOV 94

Technicians: STEVE HAESE / W. CARL MAY Bkg Loc. No.: 15

Descriptions of Location: 120TH STREET (NORTH FLORIDA ARCHER GATE) WEST TO YUKON ROAD IN MOBILE HOME PARK ON NORTH END

INSTRUMENTS *EFFICIENCY*

	(1) Meter LUDLUM 19	S/N 109899	Detector	S/N		
	(2) Meter LUDLUM 2221	S/N 99136	Detector 44-10	S/N 165		.069
	(3) Meter LUDLUM 2221	S/N 117366	Detector 44-9	S/N 116878		.259
**	(4) Meter LUDLUM 2221	S/N 117366	Detector 44-9	S/N 116878		.259
**	(5) Meter LUDLUM 2221	S/N 102049	Detector 43-65	S/N 095044		
**	(6) Meter LUDLUM 2221	S/N 102049	Detector 43-65	S/N 095044		
	(7) PIC Model # RSS-111	S/N 009994 (IT)	Cal. Due 11-2-95			

MEASUREMENTS # C/6"

#	cpm (1)	cpm (2)	DOWN cpm (3)	UP cpm (4)	DOWN cpm (5)**	UP cpm (6)**	uR/hr (7)**
1501	* Hue/He / Hue/He	2386	36	38	3	2	6.5
1502	Hue/He / Hue/He	2227	33	44	4	3	6.0
1503	Hue/He / Hue/He	2215	22	29	4	0	6.0
	4 ± 0	2276 ± 95	30.3 ± 7.4	37.0 ± 7.6	3.7 ± 0.6	1.7 ± 1.5	6.2 ± .3

REMARKS

* NOTE: MEASUREMENT @ WAIST LEVEL WITH LUDLUM 19 – Hue/He

** Readings taken 11/08/94 : Ludlum 19 (#109899) = 2-4 uR/hr (Aug 3)

Data taken by R. Parrish & W.C. May

BACKGROUND DATA

Site: NAS JACKSONVILLE WBS No: 201 Date: 02 NOV 94

Technicians: STEVE HAESE / W. CARL MAY Bkg Loc. No.: 16

Descriptions of Location: NORTH END OF STATION BOUNDARY LINE ON WEST SIDE OF PATROL ROAD ALONG FENCE LINE (ACROSS FROM WOODED AREA SOUTH OF SEWAGE TREATMENT PLANT)

INSTRUMENTS

						EFFICIENCY
	(1) Meter LUDLUM 19	S/N 109899	Detector	S/N		
	(2) Meter LUDLUM 2221	S/N 99136	Detector 44-10	S/N 165		.069
	(3) Meter LUDLUM 2221	S/N 117366	Detector 44-9	S/N 116878		.259
**	(4) Meter LUDLUM 2221	S/N 117366	Detector 44-9	S/N 116878		.259
**	(5) Meter LUDLUM 2221	S/N 102849	Detector 43-65	S/N 095044		
**	(6) Meter LUDLUM 2221	S/N 102049	Detector 43-65	S/N 095044		
	(7) PIC Model # RDS-111	S/N 009994 (~~FT~~)	Cal. Due 11-2-95			

MEASUREMENTS ** C/6"

#	cpm (1)	cpm (2)	cpm (3) DOWN	cpm (4) UP	cpm (5)** DOWN	cpm (6)** UP	uR/hr (7)**
1601	6uR/HR 5uR/HR	3181	28	45	1	0	7.0
1602	6uR/HR 5uR/HR	3136	28	32	2	2	7.0
1603	6uR/HR 5uR/HR	3116	36	47	2	0	7.0
	5±0	3144±33	30.7±4.6	41.3±8.1	1.7±0.6	0.7±1.2	7.2±.4

REMARKS

NOTE: MEASUREMENT @ WAIST LEVEL WITH LUDLUM 19 - 5uR/HR

** Readings taken 11/08/94: Ludlum 19 (#109899): 2.5-4 uR/HR (Aug 3)

Data taken by R. Parrish + W.C. May

BACKGROUND DATA

Site: NAS JACKSONVILLE WBS No: 201 Date: 01 NOV 94

Technicians: ROBERT PARRISH/GEUSA SHOWERS Bkg Loc. No.: 17

Descriptions of Location: MUSTIN ROAD EAST SIDE ACROSS FROM OFFICER HOUSING OUTSIDE FENCED PARK AREA

INSTRUMENTS

						EFFICIENCY
	(1) Meter LUDLUM 19	S/N 95487	Detector		S/N	
	(2) Meter LUDLUM 2221	S/N ~~99186~~ 99136	Detector 44-10		S/N 165	.070
	(3) Meter LUDLUM 2221	S/N 115123	Detector 44-9		S/N 116876	.225
**	(4) Meter LUDLUM 2221	S/N 115123	Detector 44-9		S/N 116876	.225
**	(5) Meter LUDLUM 2221	S/N 102049	Detector 43-65		S/N 095044	
**	(6) Meter LUDLUM 2221	S/N 102049	Detector 43-65		S/N 095044	
	(7) PIC Model # RSS-111	S/N 009994 (IT)	Cal. Due 11-2-95			

MEASUREMENTS @ C/6"

#	cpm (1)		cpm (2)	cpm (3) DOWN	cpm (4) UP	cpm (5) DOWN **	cpm (6) UP **	uR/hr (7) **
1701	6uR/HR	5uR/HR	3314	33	37	0	1	7.2
1702	6uR/HR	5uR/HR	3247	42	31	2	4	7.0
1703	6uR/HR	5uR/HR	3295	42	35	1	1	7.0
	5±0		3235 ± 35	39.0 ± 5.2	34.3 ± 3.1	1.0 ± 1.0	2.0 ± 1.7	7.1 ± 0.1

REMARKS

NOTE: MEASUREMENT @ WAIST LEVEL WITH LUDLUM 19 - 5uR/HR

** READINGS TAKEN 11/1/94 : LUDLUM 19 (# 109899) : 3-5 uR/HR (AVG = 4)

DATA TAKEN BY J. SHOWERS, R. PARRISH, E. WRIKER S/W

BACKGROUND DATA

Site: NAS JACKSONVILLE WBS No: 201 Date: 02 NOV 94

Technicians: ROBERT PARRISH / GEUSA SHOWERS Bkg Loc. No.: 18

Descriptions of Location: HWY. 17 WEST SIDE OF ROAD NEAR CONCRETE FACTORY

INSTRUMENTS

						EFFICIENCY
	(1) Meter LUDLUM 19	S/N 95487	Detector	S/N		
	(2) Meter LUDLUM 2221	S/N 97830	Detector 44-10	S/N 157		.125
	(3) Meter LUDLUM 2221	S/N 108881	Detector 44-9	S/N 116881		.256
	(4) Meter LUDLUM 2221	S/N 108881	Detector 44-9	S/N 116881		.256
**	(5) Meter LUDLUM 2221	S/N 102049	Detector 43-65	S/N 095044		
**	(6) Meter LUDLUM 2221	S/N 102049	Detector 43-65	S/N 095044		
**	(7) PIC Model # RSS-111	S/N 009994 (IT)	Cal. Due 11-2-95			

MEASUREMENTS #C/6"

#	cpm (1)	cpm (2)	cpm (3) DOWN	cpm (4) UP	cpm (5)** DOWN	cpm (6)** UP	uR/hr (7)**
1801	*4uR/HR / 4uR/HR	4774	36	31	1	1	6.1
1802	4uR/HR / 4uR/HR	4760	35	39	2	0	5.6
1803	4uR/HR / 4uR/HR	4930	37	40	2	2	5.8
	4±0	4821 ± 94	36.0 ± 1.0	36.7 ± 4.9	1.7 ± 0.6	1.0 ± 1.0	5.8 ± .3

REMARKS

NOTE: MEASUREMENT @ WAIST LEVEL WITH LUDLUM 19 - 4uR/HR

** DATA TAKEN 11/8/94 : LUDLUM 19 (#109899) 2.5-3 uR/HR

DATA RECORDED BY R. PARRISH, E. WALKER E/W

BACKGROUND DATA

Site: NAS JACKSONVILLE WBS No: 201 Date: 02 NOV 94

Technicians: STEVE HAESE / W. CARL MAY Bkg Loc. No.: 19

Descriptions of Location: ON BIRMINGHAM AVENUE EAST OF MUSTIN ROAD – NORTH SIDE OF NAS JACKSONVILLE R.V. PARK ALONG TREE LINE

INSTRUMENTS

						EFFICIENCY
	(1) Meter LUDLUM 19	S/N 109899	Detector	S/N		
	(2) Meter LUDLUM 2221	S/N 99136	Detector 44-10	S/N 165		.069
	(3) Meter LUDLUM 2221	S/N 117366	Detector 44-9	S/N 116878		.259
	(4) Meter LUDLUM 2221	S/N 117366	Detector 44-9	S/N 116878		.259
**	(5) Meter LUDLUM 2221	S/N 102049	Detector 43-65	S/N 095044		
**	(6) Meter LUDLUM 2221	S/N 102049	Detector 43-65	S/N 095044		
**	(7) PIC Model # RSS-111	S/N 009994 (IT)	Cal. Due 11-2-95			

MEASUREMENTS 4/6"

#	cpm (1)		cpm (2)	cpm (3) DOWN	cpm (4) UP	cpm (5)** DOWN	cpm (6)** UP	uR/hr (7)**
1901	* 5uR/HR	5uR/HR	2910	31	27	0	1	6.2
1902	6uR/HR	5uR/HR	2868	38	28	2	2	6.5
1903	5uR/HR	5uR/HR	2781	38	48	3	0	6.2
	5 ± 0		2856 ± 351	35.7 ± 4.0	34.3 ± 11.9	1.7 ± 1.5	1.0 ± 1.0	6.3 ± .2

REMARKS

NOTE: MEASUREMENT @ WAIST LEVEL WITH LUDLUM 19 – 5uR/HR

** DATA TAKEN 11/8/94 : LUDLUM 19 (#109899) 2.5-3.5 uR/HR

DATA RECORDED BY R. PARRISH, E. WALKER S/W

BACKGROUND DATA

Site: NAS JACKSONVILLE WBS No: 201 Date: 02 NOV 94

Technicians: STEVE HAESE / W.CARL MAY Bkg Loc. No.: 20

Descriptions of Location: FARTHEST POINT NORTHWEST ON STATION BOUNDARY LINE ON NORTH SIDE OF PATROL ROAD ALONG TREE LINE.

INSTRUMENTS

					EFFICIENCY
(1) Meter LUDLUM 19	S/N 109899	Detector		S/N	
(2) Meter LUDLUM 2221	S/N 99136	Detector 44-10		S/N 165	.069
(3) Meter LUDLUM 2221	S/N 117366	Detector 44-9		S/N 116878	.259
(4) Meter LUDLUM 2221	S/N 117366	Detector 44-9		S/N 116878	.259
** (5) Meter LUDLUM 2221	S/N 102049	Detector 43-65		S/N ~~099~~ 095044	
** (6) Meter LUDLUM 2221	S/N 102049	Detector 43-65		S/N 095044	
** (7) PIC Model # RSS-111	S/N 009994(IT)	Cal. Due 11-2-95			

MEASUREMENTS * C/6"

#	cpm (1)	cpm (2)	cpm (3) DOWN	cpm (4) UP	cpm (5) DOWN *	cpm (6) UP **	uR/hr (7) **
2001	SUR/HR / SUR/HR	2526	30	39	1	0	7.0
2002	SUR/HR / SUR/HR	2511	29	45	2	1	6.5
2003	SUR/HR / SUR/HR	2471	30	37	4	1	6.5
	5 ± 0	2503 ± 28	29.7 ± 0.6	40.3 ± 4.2	2.3 ± 1.5	0.7 ± 0.6	6.7 ± .3

REMARKS

NOTE: MEASUREMENT @ WAIST LEVEL WITH LUDLUM 19 - 4uR/HR

**DATA TAKEN 11/8/94: LUDLUM 19 (# 109899) 2.5-3.5 uR/HR

DATA RECORDED BY R. PANISH + W.C. MAY

APPENDIX B

GENERAL ENGINEERING LABORATORIES: ANALYSIS RESULTS

GENERAL ENGINEERING LABORATORIES

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Laboratory Certifications

STATE	GEL	EPI
FL	E87156/87294	E87472/87458
NC	233	
SC	10120	10582
TN	02934	
VA	00151	
WI	999558779	

CERTIFICATE OF ANALYSIS

Client: Bechtel
PO Box 350
Oak Ridge, Tennessee 37831-0350

Contact: Ms. Lori Keller

Project Description: Cecil Field/JX

cc: BECH00394 Report Date: December 01, 1994

Sample ID	: JX00601 SFS
Lab ID	: 9411095-07
Matrix	: Soil
Date Collected	: 11/02/94
Date Received	: 11/04/94
Priority	: Rush
Collector	: Client

Parameter	Qualifier	Result		DL	RL	Units	DF	Analyst	Date	Time	Batch	M	C
Radiological													
Total Uranium	U	0.670	+/- 0.0100	1.00	1.00	ug/g	1.0	DGS	11/09/94	1054	56721	1	N
Gamma PHA - 10 items													
Cesium-137	J	0.0645	+/- 0.0309	0.0405	0.100	pCi/g	1.0	MDS	11/10/94	0737	57403	2	N
Potassium-40		2.99	+/- 0.703	0.326	1.00	pCi/g	1.0						
Radium-226	J	0.708	+/- 0.0931	0.0694	1.00	pCi/g	1.0						
Radium-228	J	0.772	+/- 0.180	0.136	1.00	pCi/g	1.0						
Thorium-228	J	0.782	+/- 0.0779	0.0803	5.00	pCi/g	1.0						
Thorium-230	J	0.708	+/- 0.0931	0.0694	1.00	pCi/g	1.0						
Thorium-232	J	0.776	+/- 0.0773	0.0797	2.00	pCi/g	1.0						
Thorium-234	J	1.51	+/- 1.43	1.23	5.00	pCi/g	1.0						
Uranium-235	U	0.0506	+/- 0.133	0.231	1.00	pCi/g	1.0						
Uranium-238	J	1.51	+/- 1.43	1.23	5.00	pCi/g	1.0						

M = Method	Method-Description
M 1	EPI-A-023
M 2	HASL 300

Notes:
The qualifiers in this report are defined as follows:
J indicates presence of analyte < RL (Report Limit)
U indicates presence of analyte < DL (Detect Limit)

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SC	10120	10582
TN	02934	
VA	00151	
WI	99985779	

CERTIFICATE OF ANALYSIS

Client: Bechtel
PO Box 350
Oak Ridge, Tennessee 37831-0350

Contact: Ms. Lori Keller

Project Description: Cecil Field/JX

cc: BECH00394 Report Date: December 01, 1994

Sample ID : JX00001 SFS

M = Method Method-Description

This data report has been prepared and reviewed in accordance with General Engineering Laboratories standard operating procedures. Please direct any questions to your Project Manager, Winter Seibert at (803) 769-7388.

Barbara A. Seymour
Analytical Report Specialist

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NC	233	
SC	10120	10582
TN	02934	
VA	00151	
WI	99988779	

CERTIFICATE OF ANALYSIS

Client: Bechtel
PO Box 350
Oak Ridge, Tennessee 37831-0350

Contact: Ms. Lori Keller

Project Description: Cecil Field/JX

cc: BECH00394

Report Date: December 01, 1994

Sample ID	: JX00002 SFS
Lab ID	: 9411095-21
Matrix	: Soil
Date Collected	: 11/02/94
Date Received	: 11/04/94
Priority	: Rush
Collector	: Client

Parameter	Qualifier	Result		DL	RL	Units	DF	Analyst	Date	Time	Batch	M	C
Radiological													
Total Uranium	U	0.720	+/- 0.0200	1.00	1.00	ug/g	1.0	DGS	11/09/94	1404	56798	1	N
Gamma PHA - 10 items													
Cesium-137	U	0.0319	+/- 0.0385	0.0363	0.100	pCi/g	1.0	MDS	11/10/94	1911	57404	2	N
Potassium-40		1.51	+/- 0.406	0.273	1.00	pCi/g	1.0						
Radium-226	J	0.462	+/- 0.0745	0.0599	1.00	pCi/g	1.0						
Radium-228	J	0.427	+/- 0.145	0.104	1.00	pCi/g	1.0						
Thorium-228	J	0.482	+/- 0.0582	0.0530	5.00	pCi/g	1.0						
Thorium-230	J	0.462	+/- 0.0745	0.0599	1.00	pCi/g	1.0						
Thorium-232	J	0.478	+/- 0.0577	0.0526	2.00	pCi/g	1.0						
Thorium-234	U	1.14	+/- 0.896	1.22	5.00	pCi/g	1.0						
Uranium-235	J	0.213	+/- 0.215	0.192	1.00	pCi/g	1.0						
Uranium-238	U	1.14	+/- 0.896	1.22	5.00	pCi/g	1.0						

M = Method	Method-Description
M 1	EPI -A-023
M 2	HASL 300

Notes:
The qualifiers in this report are defined as follows:
J indicates presence of analyte < RL (Report Limit)
U indicates presence of analyte < DL (Detect Limit)

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NC	233	
SC	10120	10532
TN	02934	
VA	00151	
WI	99983779	

CERTIFICATE OF ANALYSIS

Client: Bechtel
PO Box 350
Oak Ridge, Tennessee 37831-0350

Contact: Ms. Lori Keller

Project Description: Cecil Field/JX

cc: BECH00394 Report Date: December 01, 1994

Sample ID : JX00003 SFS
Lab ID : 9411095-08
Matrix : Soil
Date Collected : 11/02/94
Date Received : 11/04/94
Priority : Rush
Collector : Client

Parameter	Qualifier	Result		DL	RL	Units	DF	Analyst	Date	Time	Batch	M	C
Radiological													
Total Uranium	U	0.580	+/- 0.0100	1.00	1.00	ug/g	1.0	DGS	11/09/94	1056	56721	1	N
Gamma PHA - 10 items													
Cesium-137		0.283	+/- 0.0802	0.0457	0.100	pCi/g	1.0	MDS	11/10/94	0738	57403	2	N
Potassium-40		1.15	+/- 0.453	0.330	1.00	pCi/g	1.0						
Radium-226	J	0.467	+/- 0.120	0.0909	1.00	pCi/g	1.0						
Radium-228	J	0.580	+/- 0.172	0.278	1.00	pCi/g	1.0						
Thorium-228	J	0.529	+/- 0.0956	0.0672	5.00	pCi/g	1.0						
Thorium-230	J	0.467	+/- 0.120	0.0909	1.00	pCi/g	1.0						
Thorium-232	J	0.525	+/- 0.0948	0.0666	2.00	pCi/g	1.0						
Thorium-234	J	1.47	+/- 1.11	1.35	5.00	pCi/g	1.0						
Uranium-235	U	0.0907	+/- 0.145	0.251	1.00	pCi/g	1.0						
Uranium-238	J	1.47	+/- 1.11	1.35	5.00	pCi/g	1.0						

M = Method	Method-Description
M 1	EPI -A-023
M 2	HASL 300

Notes:
The qualifiers in this report are defined as follows:
J indicates presence of analyte < RL (Report Limit)
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SC	10120	10582
TN	02934	
VA	00151	
WI	99988779	

CERTIFICATE OF ANALYSIS

Client: Bechtel
PO Box 350
Oak Ridge, Tennessee 37831-0350

Contact: Ms. Lori Keller

Project Description: Cecil Field/JX

cc: BECH00394

Report Date: December 01, 1994

Sample ID : JX00003 SFS

M = Method	Method-Description

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Barbara A. Sigman

Analytical Report Specialist

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VA	00151	
WI	99985779	

CERTIFICATE OF ANALYSIS

Client: Bechtel
PO Box 350
Oak Ridge, Tennessee 37831-0350

Contact: Ms. Lori Keller

Project Description: Cecil Field/JX

cc: BECH00394 Report Date: December 01, 1994

Sample ID : JX00004 SFS
Lab ID : 9411095-16
Matrix : Soil
Date Collected : 11/02/94
Date Received : 11/04/94
Priority : Rush
Collector : Client

Parameter	Qualifier	Result		DL	RL	Units	DF	Analyst	Date	Time	Batch	M	C
Radiological													
Total Uranium	U	0.890	+/- 0.0200	1.00	1.00	ug/g	1.0	DGS	11/09/94	1349	56798	1	N
Gamma PHA - 10 items													
Cesium-137		0.486	+/- 0.126	0.0450	0.100	pCi/g	1.0	MDS	11/10/94	1413	57404	2	N
Potassium-40		5.22	+/- 1.02	0.425	1.00	pCi/g	1.0						
Radium-226	J	0.773	+/- 0.182	0.0926	1.00	pCi/g	1.0						
Radium-228	J	0.786	+/- 0.194	0.145	1.00	pCi/g	1.0						
Thorium-228	J	0.780	+/- 0.126	0.0744	5.00	pCi/g	1.0						
Thorium-230	J	0.773	+/- 0.182	0.0926	1.00	pCi/g	1.0						
Thorium-232	J	0.774	+/- 0.125	0.0738	2.00	pCi/g	1.0						
Thorium-234	J	1.73	+/- 1.43	1.68	5.00	pCi/g	1.0						
Uranium-235	J	0.329	+/- 0.174	0.296	1.00	pCi/g	1.0						
Uranium-238	J	1.73	+/- 1.43	1.68	5.00	pCi/g	1.0						

M = Method	Method-Description
M 1	EPI-A-023
M 2	HASL 300

Notes:
The qualifiers in this report are defined as follows:
J indicates presence of analyte < RL (Report Limit)
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CERTIFICATE OF ANALYSIS

Client: Bechtel
PO Box 350
Oak Ridge, Tennessee 37831-0350

Contact: Ms. Lori Keller

Project Description: Cecil Field/JX

cc: BECH00394 Report Date: December 01, 1994

Sample ID : JX00004 SFS

M = Method Method-Description

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Barbara A. Sigan

Analytical Report Specialist

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SC	10120	10582
TN	02934	
VA	00151	
WI	99988779	

CERTIFICATE OF ANALYSIS

Client: Bechtel
PO Box 350
Oak Ridge, Tennessee 37831-0350

Contact: Ms. Lori Keller

Project Description: Cecil Field/JX

cc: BECH00394

Report Date: December 01, 1994

Sample ID	: JX00005 SFS
Lab ID	: 9411095-17
Matrix	: Soil
Date Collected	: 11/02/94
Date Received	: 11/04/94
Priority	: Rush
Collector	: Client

Parameter	Qualifier	Result		DL	RL	Units	DF	Analyst	Date	Time	Batch	M	C
Radiological													
Total Uranium		2.00	+/- 0.0300	1.00	1.00	ug/g	1.0	DGS	11/09/94	1354	56798	1	N
Gamma PHA - 10 items													
Cesium-137		0.109	+/- 0.0353	0.0315	0.100	pCi/g	1.0	MDS	11/10/94	1416	57404	2	N
Potassium-40		5.12	+/- 0.598	0.307	1.00	pCi/g	1.0						
Radium-226	J	0.994	+/- 0.0882	0.0623	1.00	pCi/g	1.0						
Radium-228	J	0.879	+/- 0.156	0.106	1.00	pCi/g	1.0						
Thorium-228	J	0.796	+/- 0.0662	0.0697	5.00	pCi/g	1.0						
Thorium-230	J	0.994	+/- 0.0882	0.0623	1.00	pCi/g	1.0						
Thorium-232	J	0.789	+/- 0.0657	0.0691	2.00	pCi/g	1.0						
Thorium-234	J	2.09	+/- 0.895	1.08	5.00	pCi/g	1.0						
Uranium-235	U	0.0913	+/- 0.173	0.294	1.00	pCi/g	1.0						
Uranium-238	J	2.09	+/- 0.895	1.08	5.00	pCi/g	1.0						

M = Method	Method-Description
M 1	EPI -A-023
M 2	HASL 300

Notes:
The qualifiers in this report are defined as follows:
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SC	10120	10582
TN	02934	
VA	00151	
WI	999888779	

CERTIFICATE OF ANALYSIS

Client: Bechtel
PO Box 350
Oak Ridge, Tennessee 37831-0350

Contact: Ms. Lori Keller

Project Description: Cecil Field/JX

cc: BECH00394

Report Date: December 01, 1994

Sample ID : JX00005 SFS

M = Method

Method-Description

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NC	233	
SC	10120	10582
TN	02934	
VA	00151	
WI	99988779	

CERTIFICATE OF ANALYSIS

Client: Bechtel
PO Box 350
Oak Ridge, Tennessee 37831-0350
Contact: Ms. Lori Keller

Project Description: Cecil Field/JX

cc: BECH00394 Report Date: December 01, 1994

Sample ID	: JX00006 SFS
Lab ID	: 9411095-13
Matrix	: Soil
Date Collected	: 11/01/94
Date Received	: 11/04/94
Priority	: Rush
Collector	: Client

Parameter	Qualifier	Result		DL	RL	Units	DF	Analyst	Date	Time	Batch	M	C
Radiological													
Total Uranium	U	0.650	+/- 0.0100	1.00	1.00	ug/g	1.0	DGS	11/09/94	1343	56798	1	N
Gamma PHA - 10 items													
Cesium-137		0.145	+/- 0.0408	0.0407	0.100	pCi/g	1.0	MDS	11/10/94	1050	57404	2	N
Potassium-40		1.68	+/- 0.541	0.458	1.00	pCi/g	1.0						
Radium-226	J	0.681	+/- 0.103	0.0818	1.00	pCi/g	1.0						
Radium-228	J	0.828	+/- 0.189	0.152	1.00	pCi/g	1.0						
Thorium-228	J	0.910	+/- 0.0721	0.0613	5.00	pCi/g	1.0						
Thorium-230	J	0.681	+/- 0.103	0.0818	1.00	pCi/g	1.0						
Thorium-232	J	0.901	+/- 0.0714	0.0608	2.00	pCi/g	1.0						
Thorium-234	U	0.933	+/- 1.42	1.39	5.00	pCi/g	1.0						
Uranium-235	U	0.0423	+/- 0.127	0.226	1.00	pCi/g	1.0						
Uranium-238	U	0.933	+/- 1.42	1.39	5.00	pCi/g	1.0						

M = Method	Method-Description
M 1	EPI-A-023
M 2	HASL 300

Notes:
The qualifiers in this report are defined as follows:
J indicates presence of analyte < RL (Report Limit)
U indicates presence of analyte < DL (Detect Limit)

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NC	233	
SC	10120	10582
TN	02934	
VA	00151	
WI	99988779	

CERTIFICATE OF ANALYSIS

Client: Bechtel
PO Box 350
Oak Ridge, Tennessee 37831-0350

Contact: Ms. Lori Keller

Project Description: Cecil Field/JX

cc: BECH00394 Report Date: December 01, 1994

Sample ID : JX00006 SFS

M = Method Method-Description

This data report has been prepared and reviewed in accordance with General Engineering Laboratories standard operating procedures. Please direct any questions to your Project Manager, Winter Seibert at (803) 769-7388.

Barbara A. Sigman

Analytical Report Specialist

22507-001-0000-001-01

GENERAL ENGINEERING LABORATORIES

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STATE	GEL	EPI
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NC	233	
SC	10120	10582
TN	02934	
VA	00151	
WI	99988779	

CERTIFICATE OF ANALYSIS

Client: Bechtel
PO Box 350
Oak Ridge, Tennessee 37831-0350

Contact: Ms. Lori Keller

Project Description: Cecil Field/JX

cc: BECH00394 Report Date: December 01, 1994

Sample ID : JX00007 SFS
Lab ID : 9411095-14
Matrix : Soil
Date Collected : 11/01/94
Date Received : 11/04/94
Priority : Rush
Collector : Client

Parameter	Qualifier	Result		DL	RL	Units	DF	Analyst	Date	Time	Batch	M	C
Radiological													
Total Uranium		1.32	+/- 0.0200	1.00	1.00	ug/g	1.0	DGS	11/09/94	1345	56798	1	N
Gamma PHA - 10 items													
Cesium-137		0.376	+/- 0.0534	0.0389	0.100	pCi/g	1.0	MDS	11/10/94	1133	57404	2	N
Potassium-40		2.00	+/- 0.427	0.314	1.00	pCi/g	1.0						
Radium-226	J	0.529	+/- 0.108	0.0722	1.00	pCi/g	1.0						
Radium-228	J	0.914	+/- 0.165	0.111	1.00	pCi/g	1.0						
Thorium-228	J	0.861	+/- 0.0703	0.0542	5.00	pCi/g	1.0						
Thorium-230	J	0.529	+/- 0.108	0.0722	1.00	pCi/g	1.0						
Thorium-232	J	0.853	+/- 0.0696	0.0537	2.00	pCi/g	1.0						
Thorium-234	J	1.41	+/- 1.12	1.25	5.00	pCi/g	1.0						
Uranium-235	U	-0.00856	+/- 0.121	0.210	1.00	pCi/g	1.0						
Uranium-238	J	1.41	+/- 1.12	1.25	5.00	pCi/g	1.0						

M = Method	Method-Description
M 1	EPI-A-023
M 2	HASL 300

Notes:
The qualifiers in this report are defined as follows:
J indicates presence of analyte < RL (Report Limit)
U indicates presence of analyte < DL (Detect Limit)

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TN	02934	
VA	00151	
WI	99988779	

CERTIFICATE OF ANALYSIS

Client: Bechtel
PO Box 350
Oak Ridge, Tennessee 37831-0350

Contact: Ms. Lori Keller

Project Description: Cecil Field/JX

cc: BECH00394

Report Date: December 01, 1994

Sample ID : JX00007 SFS

M = Method	Method-Description

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Analytical Report Specialist

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9411095-14*

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Laboratory Certifications

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NC	233	
SC	10120	10582
TN	02934	
VA	00151	
WI	99985779	

CERTIFICATE OF ANALYSIS

Client: Bechtel
PO Box 350
Oak Ridge, Tennessee 37831-0350
Contact: Ms. Lori Keller

Project Description: Cecil Field/JX

cc: BECH00394 Report Date: December 01, 1994

Sample ID	: JX00008 SFS
Lab ID	: 9411095-03
Matrix	: Soil
Date Collected	: 11/01/94
Date Received	: 11/04/94
Priority	: Rush
Collector	: Client

Parameter	Qualifier	Result		DL	RL	Units	DF	Analyst	Date	Time	Batch	M	C
Radiological													
Total Uranium	U	0.610	+/- 0.0100	1.00	1.00	ug/g	1.0	DGS	11/09/94	1044	56721	1	N
Gamma PHA - 10 items													
Cesium-137		0.107	+/- 0.0265	0.0272	0.100	pCi/g	1.0	MDS	11/09/94	1527	57403	2	N
Potassium-40		2.08	+/- 0.352	0.226	1.00	pCi/g	1.0						
Radium-226	J	0.502	+/- 0.0629	0.0508	1.00	pCi/g	1.0						
Radium-228	J	0.532	+/- 0.0951	0.0787	1.00	pCi/g	1.0						
Thorium-228	J	0.610	+/- 0.0499	0.0395	5.00	pCi/g	1.0						
Thorium-230	J	0.502	+/- 0.0629	0.0508	1.00	pCi/g	1.0						
Thorium-232	J	0.605	+/- 0.0495	0.0392	2.00	pCi/g	1.0						
Thorium-234	J	1.89	+/- 0.647	0.714	5.00	pCi/g	1.0						
Uranium-235	U	0.108	+/- 0.0257	0.153	1.00	pCi/g	1.0						
Uranium-238	J	1.89	+/- 0.647	0.714	5.00	pCi/g	1.0						

M = Method	Method-Description
M 1	EPI -A-023
M 2	HASL 300

Notes:
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U indicates presence of analyte < DL (Detect Limit)

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TN	02934	
VA	00151	
WI	99988779	

CERTIFICATE OF ANALYSIS

Client: Bechtel
PO Box 350
Oak Ridge, Tennessee 37831-0350

Contact: Ms. Lori Keller

Project Description: Cecil Field/JX

cc: BECH00394 Report Date: December 01, 1994

Sample ID : JX00008 SFS

M = Method	Method-Description

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NC	233	
SC	10120	10582
TN	02934	
VA	00151	
WI	99988779	

CERTIFICATE OF ANALYSIS

Client: Bechtel
PO Box 350
Oak Ridge, Tennessee 37831-0350

Contact: Ms. Lori Keller

Project Description: Cecil Field/JX

cc: BECH00394 Report Date: December 01, 1994

Sample ID : JX00009 SFS
Lab ID : 9411095-04
Matrix : Soil
Date Collected : 11/01/94
Date Received : 11/04/94
Priority : Rush
Collector : Client

Parameter	Qualifier	Result		DL	RL	Units	DF	Analyst	Date	Time	Batch	M	C
Radiological													
Total Uranium	U	0.390	+/- 0.0100	1.00	1.00	ug/g	1.0	DGS	11/09/94	1047	56721	1	N
Gamma PHA - 10 items													
Cesium-137	J	0.0841	+/- 0.0298	0.0249	0.100	pCi/g	1.0	MDS	11/09/94	1536	57403	2	N
Potassium-40	J	0.824	+/- 0.350	0.267	1.00	pCi/g	1.0						
Radium-226	J	0.367	+/- 0.0880	0.0489	1.00	pCi/g	1.0						
Radium-228	J	0.350	+/- 0.104	0.0933	1.00	pCi/g	1.0						
Thorium-228	J	0.369	+/- 0.0595	0.0353	5.00	pCi/g	1.0						
Thorium-230	J	0.367	+/- 0.0880	0.0489	1.00	pCi/g	1.0						
Thorium-232	J	0.366	+/- 0.0590	0.0350	2.00	pCi/g	1.0						
Thorium-234	J	1.11	+/- 0.387	0.327	5.00	pCi/g	1.0						
Uranium-235	J	0.124	+/- 0.0933	0.119	1.00	pCi/g	1.0						
Uranium-238	J	1.11	+/- 0.387	0.327	5.00	pCi/g	1.0						

M = Method	Method-Description
M 1	EPI -A-023
M 2	HASL 300

Notes:
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U indicates presence of analyte < DL (Detect Limit)

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SC	10120	10582
TN	02934	
VA	00151	
WI	99988779	

CERTIFICATE OF ANALYSIS

Client: Bechtel
PO Box 350
Oak Ridge, Tennessee 37831-0350

Contact: Ms. Lori Keller

Project Description: Cecil Field/JX

Report Date: December 01, 1994

cc: BECH00394

Sample ID : JX00019 SFS

M = Method

Method-Description

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Analytical Report Specialist

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NC	233	
SC	10120	10582
TN	02934	
VA	00151	
WI	99983779	

CERTIFICATE OF ANALYSIS

Client: Bechtel
PO Box 350
Oak Ridge, Tennessee 37831-0350

Contact: Ms. Lori Keller

Project Description: Cecil Field/JX

cc: BECH00394

Report Date: December 01, 1994

Sample ID	: JX00020 SFS
Lab ID	: 9411095-12
Matrix	: Soil
Date Collected	: 11/02/94
Date Received	: 11/04/94
Priority	: Rush
Collector	: Client

Parameter	Qualifier	Result		DL	RL	Units	DF	Analyst	Date	Time	Batch	M	C
Radiological													
Total Uranium	U	0.803	+/- 0.0160	1.00	1.00	ug/g	1.0	DGS	11/03/94	1321	56795	1	N
Gamma PHA - 10 items													
Cesium-137		0.161	+/- 0.0274	0.0245	0.100	pCi/g	1.0	MDS	11/10/94	1047	57404	2	N
Potassium-40		2.28	+/- 0.385	0.272	1.00	pCi/g	1.0						
Radium-226	J	0.484	+/- 0.0674	0.0543	1.00	pCi/g	1.0						
Radium-228	J	0.736	+/- 0.110	0.0877	1.00	pCi/g	1.0						
Thorium-228	J	0.803	+/- 0.0560	0.0452	5.00	pCi/g	1.0						
Thorium-230	J	0.484	+/- 0.0674	0.0543	1.00	pCi/g	1.0						
Thorium-232	J	0.796	+/- 0.0555	0.0449	2.00	pCi/g	1.0						
Thorium-234	J	2.18	+/- 0.861	0.799	5.00	pCi/g	1.0						
Uranium-235	U	0.0543	+/- 0.137	0.168	1.00	pCi/g	1.0						
Uranium-238	J	2.18	+/- 0.861	0.799	5.00	pCi/g	1.0						

M = Method	Method-Description
M 1	EPI -A-023
M 2	HASL 300

Notes:
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SC	10120	10582
TN	02934	
VA	00151	
WI	99988779	

CERTIFICATE OF ANALYSIS

Client: Bechtel
PO Box 350
Oak Ridge, Tennessee 37831-0350

Contact: Ms. Lori Keller

Project Description: Cecil Field/JX

cc: BECH00394 Report Date: December 01, 1994

Sample ID : JX00020 SFS

M = Method	Method-Description

This data report has been prepared and reviewed in accordance with General Engineering Laboratories standard operating procedures. Please direct any questions to your Project Manager, Winter Seibert at (803) 769-7388.

Barbara A. Sigmon

Analytical Report Specialist

APPENDIX C

SURVEY METER SOURCE CHECK LOG

Attachment 7.2

SOURCE CHECK LOG

Meter - Model 19 Serial No. 109899

Detector - Model NA (uR Meter) Serial No. MT

Calibrated 10-20-94 Due ~~4-20-94~~ WCM 4-20-95

Source Nuclide Cs 137 Serial No. 06-94 1388

Activity 1 uci RF = 140 Units 2.22 E6 dpm

Date/ Time	Background (cpm, mR/hr)	Source Check (cpm, mR/hr)	Response Factor (RF)	Comments	OK/By
11-1-94 0740	4 uR	150	146		OK BD
11-2-94 0730	4 uR	150	146		OK —
11-3-94 0730	4 uR	145	141		✓
11-4-94 0730	4 uR/hr	145 ur/h	145		✓ B
11-7-94 0730	4 ur/h	145 ur/h	144 ur/h		✓ P
11-8-94 0730	4 ur/h	135 ur/h	130 ur/hr		✓ P
11-9-94 0640	2 ur/hr	130 ur/h	128 ur/hr		✓ P
11-10-94 0630	2 ur/hr	135 ur/hr	133 ur/hr		✓ P
11-14-94 0630	2 ur/hr	140 ur/h	138 ur/hr		✓ P
11-15-94 0630	2 ur/hr	140 ur/hr	138 ur/h		✓ P
11-16-94 0630	2 ur/h	135	133		✓ P

Attachment 7.2

SOURCE CHECK LOG

Meter - Model ~~220~~ #19 Serial No. 109899

Detector - Model nn Serial No. nA

Calibrated 10-20-94 Due 4-20-94

Source Nuclide Cs137 Serial No. 06-94 #1388

Activity 1 uci Units 2.22 E6 dpm

Date/ Time	Background (cpm, mR/hr)	Source Check (cpm, mR/hr)	Response Factor (RF)	Comments	OK/By
11-17-94	ur/hr	ur/hr			✓
0630	2	140	138		P
11-21-94					✓
0630 ~~11-23-94~~	2	145	143		P
11-22-94					no
0630	2	120	119		P
11-23-94					no
0630	3	100	—		P
12-05-94				New Source Work-up 2 uci 12-94 #3609	✓
1300	4			4.44 E6 dpm	P

Attachment 7.2

SOURCE CHECK LOG

Meter - Model 19 Serial No. 109899

Detector - Model NA Serial No. NA

Calibrated 10-20-94 Due ~~4-20-94~~ WOM 4-20-95

Source Nuclide Cs/137 Serial No. P 12-94 # 1388

Activity 2 uci Units 4.44 E6 dpm

Date/ Time	Background (cpm, mR/hr)	Source Check (cpm, mR/hr)	Response Factor (RF)	Comments	OK/By
12-5-94	uR/Hr	uR/Hr	uR/Hr	New Source work up	—
1300	4	328	324	All uR/HR	P
12-6-94					✓
0630	4	330	326		P
12-7-94					—
0630	4	330	330		P
12-8-94					✓
0600	4	330	330		P
12-12-94					✓
0600	4	330	330		P
12-13-94					✓
0600	4	330	330		P
12-14-94					✓
0600	4	330	330		P
12-15-94					✓
0700	4	330	330		P
12-19-94					✓
0600	4	330	330		P
12-20-94	4	340	340		WOM
0600					✓
12-21-9	4	340 ~~400~~ WOM	340 ~~400~~ WOM		WOM
0600					✓

Attachment 7.2

SOURCE CHECK LOG

Meter - Model 19 Serial No. 109899

Detector - Model NA Serial No. NA

Calibrated 10-20-94 Due 4-20-95

Source Nuclide Cs 137 Serial No. 12-94 #1388

Activity 2 uci Units 4.44 E6 dpm

Date/ Time	Background (cpm, mR/hr)	Source Check (cpm, mR/hr)	Response Factor (RF)	Comments	OK/By
12-22-94	4uR/hr	320	320		[illegible]
0600					✓
12-27-94					P
0600	4	330	330		✓
12-28-94					✓
0600	4	340	340		P
1-3-95					✓
	4	340	340		P
L/E 12-29-94					✓
	4	340	340		P
1-4-95					✓
	4	340	340		P

Attachment 7.2

SOURCE CHECK LOG

Meter - Model 19 Serial No. 95487

Detector - Model NA (uR METER) Serial No. NA

Calibrated 10-20-94 Due ~~4-20-94~~ 4-20-95

Source Nuclide Cs 137 Serial No. 06-94 1388

Activity 1 uci RF = 235 Units 2.22 E6 dpm

Date/ Time	Background (cpm, mR/hr)	Source Check (cpm, mR/hr)	Response Factor (RF)	Comments	OK/By
11-1-94 0730	4 uR/hr	240 uR/hr	235 uR/hr		OK RP
11-2-94 0730	4 uR/hr	240 uR/hr	235 uR/hr		OK RP
11-3-94 1000	4 uR/hr	250 uR/hr	245 uR/hr		✓ RP
11-4-94 0730	4 ur/h	240 ur/h	240 ur/h		✓ P
11-7-94 0730	4 ur/h	250 ur/h	250 ur/h		✓ P
11-8-94 0730	4 ur/hr	230 urhr	230/ ur/hr		✓ P
11-9-94 0640	4 ur/hr	235 ur/hr	231		— P
11-10-94 0630	2 ur	235 ur/hr	233 ur/h		✓ P
11-14-94 0630	2 ur/hr	240 ur/hr	238 ur/hr		✓ P
11-15-94 0630	2 ur/hr	240 ur/hr	238 ur/hr		— P
11-16-94 0630	4 ur/hr	245	240		✓ P

Attachment 7.2

SOURCE CHECK LOG

Meter - Model 19 Serial No. 95487

Detector - Model Serial No.

Calibrated 10-20-94 Due ~~4-2-94~~ 4-20-95

Source Nuclide Cs137 Serial No. 06-94-1388

Activity 1uci Units 2.22 E6 DPM.

Date/ Time	Background (cpm, mR/hr)	Source Check (cpm, mR/hr)	Response Factor (RF)	Comments	OK/By
11-17-94	uR/HR	uR/HR			✓
0630	4	250	246		P
11-21-94					✓
0630 ~~11-22-94~~	4	240	236		P
11-22-94					✓
0630	4	260	255		P
11-23-94					✓
0630	8	260	252		P
11-28-94					✓
0620	4	260	254		P
11-29-94					✓
0630	4	260	254		P
11-30-94					✓
0630	4	250	245		P
12-1-94					✓
0630	4	250	245		P
12-5-94					✓
0630	4	260	255		P
12-6-94		260 / 500	257 / 597	old source / New Source	✓
0630	3				P
12-7-94					✓
0630	4	500	500	New Source	P

Attachment 7.2

SOURCE CHECK LOG

Meter - Model L-19 Serial No. 95487

Detector - Model nn Serial No. nn

Calibrated 10-20-94 Due ~~4-2-95~~ 4-20-95

Source Nuclide Cs137 Serial No. 012-94- #1388

Activity 2uci Units 4.44 E6 dpm

Date/ Time	Background (cpm, mR/hr)	Source Check (cpm, mR/hr)	Response Factor (RF)	Comments	OK/By
12-8-94					—
0600	4	500	500	MR/HR	P
12-12-94					✓
0600	4	500	500		P
12-13-94					✓
0600	4	500	500		P
12-14-94					✓
0600	4	500	500		P
12-15-94					✓
0700	4	500	500		P
12-19-94					✓
0600	4	500	500		P
12-20-94					WEM
0600	4	650	650		✓
12-21-94					WEM
0600	4	620	620		✓
12-22-94					[illegible]
0600	4	600	600		✓
12-27-94					✓
0600	4	600	600		P
12-28-94					✓
0600	4	600	600		P

Attachment 7.2

SOURCE CHECK LOG

Meter - Model Ludlum -19 | Serial No. 95487

Detector - Model NA | Serial No. NA

Calibrated 10-20-94 | Due 4-20-95

Source Nuclide Cs137 | Serial No. 012-94 #1388

Activity 2uci | Units 4.44E6 dpm

4/E

Date/ Time	Background (cpm, mR/hr)	Source Check (cpm, mR/hr)	Response Factor (RF)	Comments	OK/By
1-3-~~94~~95 0600	4	600	600		✓ P
12-29-94 0600	4	600	600		✓ P
1-4-95 0600	4	600	600		✓ P

Attachment 7.2

SOURCE CHECK LOG

Meter - Model 2221 Serial No. ~~97830~~ 97830

Detector - Model 44-10 (2"x2" NaI) Serial No. 157

Calibrated 10-20-94 Due 4-20-95

Source Nuclide Cs 137 Serial No. 06-94 1388

Activity 14 ci Units 2.22 E6 dpm

Date/ Time	Background (cpm, mR/hr)	Source Check (cpm, mR/hr)	Response Factor (RF)	Comments	OK/By
11-1-94		282266	0.1253		RP
0730	4100	~~157176~~			✓
0730		280942			✓
11-2 94	4031		0.1247		RP
11-3-94					✓
1000	3927	274791	0.122		RP
11-4-94					✓
0730	3916	276324	0.122		RP
~~1005~~					✓
11-7-94 0730	4244	284881	0.124		P
11-8-94					✓
0730	4161	277660	0.123		P
11-9-94					✓
0650	4154	278611	0.123		P
11-10-94					✓
0640	4257	276517	0.122		P
11-14-94					✓
0640	3585	279441	0.124		P
11-15-94					✓
0640	3864	278065	0.123		P
11-16-94		274485			✓
0640	3319	~~33183~~	0.122		P

Attachment 7.2

SOURCE CHECK LOG

Meter - Model 2221 Serial No. 97830

Detector - Model 44-10 Serial No. ~~765~~ 157

Calibrated 10-20-94 Due 4-20-95

Source Nuclide Cs137 Serial No. 06-94-1388

Activity 1 uci Units 2.22 e^6

Date/ Time	Background (cpm, mR/hr)	Source Check (cpm, mR/hr)	Response Factor (RF)	Comments	OK/By
11-17-94 0640	3662	278441	0.123		✓ P
11-~~16~~ 21-94 0640	3686	281863	0.125		— P
11-22-94 0700	4082	277238	0.123		✓ P
11-23-94 0640	4099	278022	0.123		✓ P
11-28-94 0630	4073	275280	0.122		✓ P
11-29-94 0630	3957	275237	0.122		✓ P
11-30-94 0630	3831	269414	0.12		✓ P
12-1-94 0630	4051	273539	0.121		✓ [illegible]
12-5-94 0630	3902	269174	0.12		— P

Attachment 7.2

SOURCE CHECK LOG

Meter - Model 2221 Serial No. 97830

Detector - Model 44-10 Serial No. ~~165~~ 157

Calibrated 10-20-94 Due ~~4-20-94~~ ~~4-20~~ 04-20-95

Source Nuclide Cs 137 Serial No. 12-94 #3609

Activity 2 uci Units 4.44 e6 dpm

Date/ Time	Background (cpm, mR/hr)	Source Check (cpm, mR/hr)	Response Factor (RF)	Comments	OK/By
12-5-94 1350	3902	526008	0.118	Work done using New Source	✓ P
12-6-94 0630	3941 ~~2160~~ P	541981	0.121		✓ P
12-7-94 0630	4006	547198	0.122		✓ P
12-8-94 0600	4172	548034	0.122		✓ P
12-12-94 0600	4110	541585 ~~541~~	0.121		✓ P
12-13-94 0600	3963	533927	0.111		✓ P
12-14-94 0600	3939	539509	0.112		✓ P
12-15-94 0700	4005	536728	0.1199		✓ P
12-19-94 0600	3983	526736	0.11		✓ P
12-20-94 0600	3733	538503	12.04 %		✓ P
12-21-94 0600	4172	538245	12.0 %		✓ P

Attachment 7.2

SOURCE CHECK LOG

Meter - Model 2221 Serial No. 97830

Detector - Model 44-10 Serial No. 157

Calibrated Due

Source Nuclide Serial No.

Activity 2 uC: Units 4.44 E 6 DPM

Date/ Time	Background (cpm, mR/hr)	Source Check (cpm, mR/hr)	Response Factor (RF)	Comments	OK/By
12-22-94			%		✓
0600	3873	542916	12.1 %		P
12-27-94			%		✓
0600	40850	545866	12.2 %		P
12-28-94			%		✓
0600	3565	544232	12.1 %		SW
12-29-94					
600	3919.8	54028	12 %		P
1-3-95					
0600	3735.1	541800	12.11 %		P
1-4-95					
0600	4303.4	531864	11.88 %		P

Attachment 7.2

SOURCE CHECK LOG

Meter - Model 2221 Serial No. 99136

Detector - Model 44-10 (2"x2" NaI) Serial No. 165

Calibrated 10-20-94 Due 4-20-95

Source Nuclide Cs 137 Serial No. 06-94 1388

Activity 1 uc: Units 2.22 E6 dpm

Date/ Time	Background (cpm, mR/hr)	Source Check (cpm, mR/hr)	Response Factor (RF)	Comments	OK/By
11-1-94					✓
0730	2200	157176	0.0698		BP
11-2-94					✓
0730	1949	154524	0.0687		BP
11-3-94					✓
0930	2157	155150	0.0689		BP
11-4-94					✓
0800	2078	151172	0.0671		BP
11-7-94					✓
0730	1653	148478	0.066		BP
11-8-94					✓
0730	1702	155416	0.069		BP
11-9-94					✓
0640	1675	156524	.0697		P
11-10-94					✓
0640	2034	153141	.068		P
11-14-94					✓
0640	1981	156977	0.0698		P
11-15-94					✓
0640	2091	155479	0.069		P
11-16-94					✓
0640	1846	155414	0.069		P

Attachment 7.2

SOURCE CHECK LOG

Meter - Model 2221 Serial No. 99134

Detector - Model 44-10 Serial No. 165

Calibrated 10-20-94 Due 4-20-95

Source Nuclide Cs137 Serial No. 6-94-1388

Activity 1 uci Units 2.22 e6

Date/ Time	Background (cpm, mR/hr)	Source Check (cpm, mR/hr)	Response Factor (RF)	Comments	OK/By
11-17-94					✓
0640	2158	156086	0.069		P
11-21-94					✓
0630	2112	151985	0.0675		P
11-22-94					✓
0630	2334	154671	1068		P
11-23-94					✓
0630	2282	154840	0.687		P
11-28-94					✓
0630	2194	155160	0.69		P
11-29-94					✓
0630	2143	153439	0.068		P
11-30-94					✓
0630	2157	153885	0.068		P
12-1-94					✓
0630	2353	154254	0.068		P
12-5-94					✓
0630	2251	159536	0.071		P
12-6-94					✓
0630	2160	154466	0.068		P

Attachment 7.2

SOURCE CHECK LOG

Meter - Model 2221 Serial No. 99134

Detector - Model 44-10 Serial No. 165

Calibrated 10-20-94 Due ~~12-94 #3609~~ 10-20-94

Source Nuclide Cs137 Serial No. 12-94 #369

Activity 2 uci Units 4.448 dpm

Date/ Time	Background (cpm, mR/hr)	Source Check (cpm, mR/hr)	Response Factor (RF)	Comments	OK/By
12-6-94		293415		New Source work of	✓
P 1530	2160	~~294~~ RP	0.0654		P
12-7-94					✓
12-7-94	2215	309769	0.069		P
12-8-94					✓
0600	2230	313060	0.07		P
12-12-94			0.0687		✓
0600	2147	307310	~~0.687~~		P
12-13-94			0.07		✓
0600	2395	313260	~~7.0~~ P		P
12-14-94					✓
0600	2323	311700	.0696		P
12-15-94					✓
0700	2174	314280	.0703		P
12-19-94					✓
0600	2219	304137	.0679		[illegible]
12-20-94					✓
0600	21778	310278	.0693		P
12-21-94			%		✓
0600	24602	316763	7.07		P
12-22-94			%		✓
0600	2089	311647	6.97		P

Attachment 7.2

SOURCE CHECK LOG

Meter - Model 2221 Serial No. 99136

Detector - Model 44-10 Serial No. 165

Calibrated Due

Source Nuclide Serial No.

Activity Units

Date/ Time	Background (cpm, mR/hr)	Source Check (cpm, mR/hr)	Response Factor (RF)	Comments	OK/By
12-27-94			%		✓
0600	2239.5	309231	6.91		P
12-28-94			%		✓
0600	2545	305507	6.82		P
12-29-94					✓
0600	3285	310340	6.99%		P
1-3-95					✓
0600	2172.8	310418	6.94%		P
1-4-95					✓
0600	2681.6	304459	6.8%		P

Attachment 7.2

SOURCE CHECK LOG

Meter - Model 2221 Serial No. 102049

Detector - Model 4365 (ALPHA SCINTILLATOR) Serial No. 095044 (064)

Calibrated 10-20-94 Due 4-20-95

Source Nuclide Th 230 Serial No. 94 Th 4703169

Activity 16,800 RF = 0.1931 Units dpm

Date/ Time	Background (cpm, mR/hr)	Source Check (cpm, mR/hr)	Response Factor (RF)	Comments	OK/By
11-3-94 1440	1.8	3244	0.1931		✓ RB
11-4-94 0800	1.8	3289	0.1956		✓ P
11-7-94 0730	0.8	3249	0.1933		✓ P
11-8-94 0730	1.1	3196	0.190		✓ P
11-9-94 0730	Ø	3229	0.192		✓ P
11-16-94 0715	2.1	3153	0.188		✓ P
11-17-94 0650	1.1	3224	0.192		✓ P
11-21-94	1.1	3076	0.188 ~~102049~~ P		✓ [illegible]
11-22-94	1.7	3064	0.182		✓ [illegible]
11-30-94 0730	0.7	3012	0.179		✓ P
12-05-94	1.4	2877	0.171		✓ [illegible]

Attachment 7.2

SOURCE CHECK LOG

Meter - Model	LUDLUM 2221	Serial No.	102049
Detector - Model	43-65	Serial No.	095044 (044)
Calibrated	10-20-94	Due	04-20-95
Source Nuclide	Th 230	Serial No.	94 Th 4703169
Activity	16,800	Units	D.P.M.

Date/ Time	Background (cpm, mR/hr)	Source Check (cpm, mR/hr)	Response Factor (RF)	Comments	OK/By
12-01-94 0630	0.7	3056	0.184		✓ dev
12-05-94 0630	1.4	2877	0.171		✓ P
12-6-94 0630	1.0	3071	0.183		✓ P
12-7-94 0630	0.1	2864	0.170		✓ P
12-8-94 0600	0.6	2913	0.170		✓ P
12-12-94 0600	0.6	2900	0.170		✓ P
12-13-94 0600	0.7	2941	0.175		✓ P
12-14-94 0600	0.6	2902	0.172		✓ Lee
12-15-94 0700	0.3	2859	0.170		✓ P
12-19-94 0600	0.5	3360	0.20		✓ P
12-20-94 0600	1.4	3275 ~~2990~~ P	19.5 %		✓ P

12-20-94

Attachment 7.2

SOURCE CHECK LOG

Meter - Model Ludlum 2221 Serial No. 102049

Detector - Model 43-65 Serial No. 095044 (064)

Calibrated 10-20-94 Due 04-20-95

Source Nuclide Th 230 Serial No. 94 Th 4703169

Activity 16,800 Units DPM

Date/ Time	Background (cpm, mR/hr)	Source Check (cpm, mR/hr)	Response Factor (RF)	Comments	OK/By
12-21-94 0600	0.7	3200	0.191		nm ✓
12-22-94 0600	0.5	3274	% 19.5		✓ P
12-27-94 0600	0.6	3318	% 19.75		✓ P
12-29-94 0600	0.4	3304	% 19.66		✓ P
12-29-94 0600	0.3	3247	19.4 %		✓ P
1-3-~~94~~ 95 0600	0.1	3304	19.66 %		✓ P
01-04-95 0600	0.7	3032	18.04 %		✓ P

Attachment 7.2

SOURCE CHECK LOG

Meter - Model 2221 Serial No. 117363

Detector - Model 449 (Pancake GM) Serial No. 116872

Calibrated 10-21-94 Due 10-21-95

Source Nuclide Sr 90 Serial No. 2235-91

Activity 4016 0.275 μCi Units dpm

Date/ Time	Background (cpm, mR/hr)	Source Check (cpm, mR/hr)	Response Factor (RF)	Comments	OK/By
11-1-94 0730	40	1033	0.247		OK
11-2-94 0730	30	1155	0.28		OK
11-3-94 0900	25	1121	0.2729		✓
11-4-94 0830	33	1049	0.253		✓
10-4-94 1200	31.2	1105.4	0.275	* See chart 2 of 2	✓
11-7-94 0730	30	1107	0.268		✓
~~12~~ 12-13-94 1000	30	1159	0.28	Returned to service	✓
12-14-94 0600	31	1099	1-27-95 ~~0.28~~ 0.267		✓
12-15-94 0700	29.3	1164	0.287 ~~0.287~~ 1-29-5		✓
12-19-94 0600	34.1	1121	0.27		✓
12-20-94 0600	24.6	1120	0.273		✓

Attachment 7.2

SOURCE CHECK LOG

Meter - Model Ludlum 2221 Serial No. 117363

Detector - Model 44-9 Serial No. 116872

Calibrated 10-21-94 Due 10-21-95

Source Nuclide Sr 90 Serial No. 2235-91

Activity 4016 Units DPM

Date/ Time	Background (cpm, mR/hr)	Source Check (cpm, mR/hr)	Response Factor (RF)	Comments	OK/By
12-21-94 0600	31.0	1144	0.277		WM ✓
12-22-94 0600	31.0	1187	0.288		[illegible] ✓
27 DEC 94 0600	29.0	1091	0.264		[illegible] ✓
28 DEC 94 0600	36.9	1129	0.272		WM ✓
29 Dec 94 0600	32.8	1088	0.263		WM ✓
03 JAN 95 0600	28.9	1076	0.261		✓ [illegible]
04 JAN 95 0600	35.4	1105	0.264		[illegible] ✓

Attachment 7.2

SOURCE CHECK LOG

Meter - Model 2221 Serial No. 117366

Detector - Model 44-9 (PANCAKE GM) Serial No. 116878

Calibrated 10-21-94 Due 10-21-95

Source Nuclide Sr90 Serial No. 2275-91

Activity 4016 Units dpm

Date/ Time	Background (cpm, mR/hr)	Source Check (cpm, mR/hr)	Response Factor (RF)	Comments	OK/By
11-1-94 0730	40	1033	0.247		✓ PP
11-2-94 0730	28	1072	0.259		✓ PH
11-3-94 0900	27.5	1164	0.268		✓ PB
11-4-94 0830	29	1188	0.288		✓ PB
11-4-94 1200	35.7	1067.65	0.266	* See chart 2052	✓ PB
11-7-94 0730	27	1027	0.25		✓ PB
11-21-94 0600	34	1031	0.248		✓ P
11-22-94 0600	32	1174	0.28		✓ P
11-23-94 0600	35	1095	0.26		✓ P
11-29-94 0600	33	1037	0.25		✓ P
11-30-94 0600	32	1085	0.262		✓ [illegible]

Attachment 7.2

SOURCE CHECK LOG

Meter - Model: Ludlum 2221 Serial No.: 117366
Detector - Model: 44-9 Serial No.: 116878
Calibrated: 10-21-94 Due: 10-21-95
Source Nuclide: Sr 90 Serial No.: 2235-91
Activity: 40uC Units: D.P.M.

Date/ Time	Background (cpm, mR/hr)	Source Check (cpm, mR/hr)	Response Factor (RF)	Comments	OK/By
12-01-94 0600	29	1071	0.26		✓
12-5-94 0630	31	1111	0.27		✓
12-6-94 0630	31	1134	0.28		✓
12-7-94 0630	32.8	1079	0.26		✓
12-8-94 0600	31.9	1088	0.26		✓
12-12-94 0600	36	1149	0.277		✓
12-13-94 0600	30.5	1031	24.9%		✓
12-14-94 0600	31	1099	26.5%		✓
12-15-94 0700	29.3	1041	0.252		✓
12-19-94 0600	29.0	1048	0.254		✓
12-20-94 0600	32.8	1129	0.273		✓

Attachment 7.2

SOURCE CHECK LOG

Meter - Model LUDLUM 2221 Serial No. 117366

Detector - Model 44-9 Serial No. 116878

Calibrated 10-21-94 Due 10-21-95

Source Nuclide Sr 90 Serial No. 2235-91

Activity 4016 Units DPM

Date/ Time	Background (cpm, mR/hr)	Source Check (cpm, mR/hr)	Response Factor (RF)	Comments	OK/By
21 DEC 94 0600	32.0	1060	0.256		✓
22 DEC 94 0600	29.6	1249	0.304		✓
27 DEC 94 0600	28.5	1115	0.271		✓
28 DEC 94 0600	31.1	1037	0.250		✓
29 DEC 94 0600	28.3	1076	0.261		✓
03 JAN 95 0600	27.9	1076	0.262		✓
04 JAN 95 0600	29.2	1061 ~~1022~~ 1-4-95	0.257		✓

Attachment 7.2

SOURCE CHECK LOG β-

Meter - Model Lud 2221 Serial No. 108881

Detector - Model Lud 44-9 (Pancake GM) Serial No. 116881

Calibrated 10-21-94 Due 10-21-95

Source Nuclide Sr-90 Serial No. 2235-91

Activity ~~4,410~~ 4016 Units dpm

Date/ Time	Background (cpm, mR/hr)	Source Check (cpm, mR/hr)	Response Factor (RF)	Comments	OK/By
~~09 10-1-94~~ 0730	25	1017	0.247 ~~0.225~~	20% - RF ~~0.224~~ RF = .247	ok
11-2-94 0800	33	1122	0.2469		ok
11-2-94 1154	29	1159	0.256		✓
11-3-94 1000	28.9	1151	0.279		✓
11-4-94 0830	30	1195	0.29		✓
11-4-94 1200	33.4	1089.6	0.270	* See Chart 2 of 2	✓
11-7-94 0730	43	1102	0.264		✓
11-21-94 0600	32	1082	0.261		✓
11-22-94 0600	33	1066	0.26		✓
11-29-94 0600	29	1054	0.26		✓
11-30-94 0600	32	1119	0.271		✓

Attachment 7.2

SOURCE CHECK LOG

Meter - Model	LUDLUM 2221	Serial No.	108881
Detector - Model	LUD 44-9	Serial No.	116881
Calibrated	10-21-94	Due	10-21-95
Source Nuclide	Sr-Y 90	Serial No.	2235-91
Activity	4016	Units	D.P.M.

Date/ Time	Background (cpm, mR/hr)	Source Check (cpm, mR/hr)	Response Factor (RF)	Comments	OK/By
12-01-94	—	—	—		NS
0630				OOS	P
12-1-94					✓
1015	23	1028	0.290		P
12-5-94					✓
0630	30	1157	0.28		P
12-6-94					✓
0630	31	1132	0.27		P
12-7-94					✓
0630	27.8	1099	0.26		P
12-8-94					✓
0600	34.5	1121	0.27		P
12-12-94					✓
0600	32	1174	0.29		P
12-13-94					✓
~~0600~~ 10	31	1120	0.27		P
12-14-94					✓
0600	30	1160	0.280		P
12-15-94					✓
0600	29.8	1022	0.247		P
12-19-94					✓
0600	31.9	1129	0.27		[illegible]

Attachment 7.2

SOURCE CHECK LOG

Meter - Model Ludlum 2221 Serial No. 108881

Detector - Model Ludlum 44-9 Serial No. 116881

Calibrated 10-21-94 Due 10-21-95

Source Nuclide Sr 90 Serial No. ~~2234~~ 2235-91

Activity 4016 Units DPM

Date/ Time	Background (cpm, mR/hr)	Source Check (cpm, mR/hr)	Response Factor (RF)	Comments	OK/By
12-20-94	32.7	1117	0.269		WJM
0600					✓
12-21-94	29.9	1118	0.271		WJM
0600					✓
12-22-94	31.2	1243	0.302		[illegible]
0600					✓
27 DEC 94	29.0	1037	0.251		[illegible]
0600					✓
28 Dec 94	34.9	1170	0.283		WJM
0600					✓
29 Dec 94	30.9	1183	0.287		WJM
0600					✓
03 JAN 95	37.3	1110	0.270		[illegible]
0600					✓
04 JAN 95	32.4	1091	0.264		[illegible]
0600					✓

Attachment 7.2

SOURCE CHECK LOG

Meter - Model 2221 Serial No. 115123

Detector - Model 44-9 (Pancake GM) Serial No. 116876

Calibrated 10-21-94 Due 10-21-95

Source Nuclide Sr 90 Serial No. 2236-91

Activity 41016 Units dpm

Date/ Time	Background (cpm, mR/hr)	Source Check (cpm, mR/hr)	Response Factor (RF)	Comments	OK/By
11-1-94					OK
0730	30	1026	22.5 %	21.0	RP
11-2-94					not
073	35	1131	27.29 %		RP
11-3-94					✓
0500	40	1087	0.241		RP
11-4-94					—
0830	32	1035	0.257		RP
11-4-94				* see graph	✓
1200	31.7	1044.8	0.260	2 of 2	RP
11-7-94					✓
0730	33	1045	0.252		RP
11-16-94					✓
0700	28	1075	0.26		RP
11-17-94					✓
0650	33.6	1040	0.25		RP
11-21-94					✓
0600	30	1092	0.264		RP
11-22-94					✓
0600	30	1041	0.25		RP
11-23-94					✓
0600	30	1095	0.264		RP

Attachment 7.2

SOURCE CHECK LOG

Meter - Model	2221	Serial No.	1:5123
Detector - Model	44-9	Serial No.	116876
Calibrated	10-21-94	Due	10-21-95
Source Nuclide	Sr 90	Serial No.	2236-91
Activity	4016	Units	DPM

Date/ Time	Background (cpm, mR/hr)	Source Check (cpm, mR/hr)	Response Factor (RF)	Comments	OK/By
11-28-94 0600	30	1049 ~~1112~~	0.253		✓ [illegible]
11-29-94 0600	31	1060	0.256		✓ [illegible]
11-30-94 0600	33	1070	0.258		✓ [illegible]

N A

Attachment 7.2

SOURCE CHECK LOG

Meter - Model	Ludlum 2221	Serial No.	115123
Detector - Model	44-9	Serial No.	116876
Calibrated	10-21-94	Due	10-21-95
Source Nuclide	Sr 90	Serial No.	2236-91
Activity	4016	Units	D.P.M.

Date/ Time	Background (cpm, mR/hr)	Source Check (cpm, mR/hr)	Response Factor (RF)	Comments	OK/By
12-01-94 0700	28.0	1058	0.256		✓ [illegible]
12-5-94 0630	33.3	1061	0.256		✓ P
12-6-94 0630	29	1051	0.254		✓ P
12-7-94 0630	28.6	1005	0.24		✓ P
12-8-94 0600	29.0	1058	0.256		✓ P
12-12-94 0600	28.1	1041	0.25		✓ P
12-13-94 0600	30.9	1063	24.2 %		✓ P
12-14-94 0600	30.7	1112	26.9 %		✓ P
12-15-94 0700	32.5	1069	25.8 %		✓ P
12-19-94 0600	29.3	1005	24.3 %		✓ [illegible]
12-20-94 0600	24.5	1099	0.267		[illegible] ✓

Attachment 7.2

SOURCE CHECK LOG

Meter - Model LudLum 2221 Serial No. 115123

Detector - Model 44-9 Serial No. 116876

Calibrated 10-21-94 Due 10-21-95

Source Nuclide Sr-90 Serial No. 2236-91

Activity 4016 Units DPM

Date/ Time	Background (cpm, mR/hr)	Source Check (cpm, mR/hr)	Response Factor (RF)	Comments	OK/By
12-21-94 0600	30.6	1108	0.268		[illegible] ✓
12-22-94 0600	27.2	1179	0.286		[illegible] ✓
27 DEC 94 0600	30.4	1039	0.251		[illegible] ✓
28 Dec 94 0600	32.4	1001	0.241		[illegible] ✓
29 Dec 94 0600	31.5	1101	0.266		[illegible] ✓
03 JAN 95 0600	28.9	1041	0.252		✓ [illegible]
04 JAN 95 0600	30.1	1029	0.249		[illegible] ✓

ADDENDUM

Bechtel

Interoffice Memorandum

PRELIMINARY

To	H. Bauer	File No.	
Subject	Portable Survey Instrument Response to Residual Radium-226 Activity	Date	February 3, 1995
		From	E. Walker
		Of	Navy RAC
Copies To	R. B. Barber R. L. Freemerman M. H. Haghighi E. M. McNamee	At	Oak Ridge Ext 2202

To characterize the residual radium-226 activity in situ at NAS-JAX, the field instrument readings must be combined with a conversion factor appropriate to the geometry of the residual source. For radium-226, gamma measurement is the most sensitive technique for characterization. Two portable survey meters are utilized for gamma measurement on this site:

- 2" × 2" NaI detector: Ludlum 44-10
- MicroR Meter: Ludlum-19

Two in situ source configurations have been considered in the determination of conversion factors:

- distributed (infinite) source
- point source

A. Distributed Source Response

The primary instrument to be used for final verification shall be the 2" × 2" NaI detector. The MicroR Meter may be used to support the conclusions based on the 2" × 2" NaI detector. For performing final verificatin surveys, assume that the residual activity is comprised of an infinite source of uniform activity distribution The response of the 2" × 2" NaI detector to radium-226 uniformly distributed in the soil is shown on Figure 1. The normal protocol is to measure on the surface—the upper response curve. Note from this curve that for large excavations (> 5m radius), the response of the detector is approximately:

$$K = \frac{950 cpm}{(pCi / gm)}$$

The criteria for unrestricted release (≤ 5 pCi/gm) would be met for a 2" × 2" NaI detector response of:

$$R_o < 4{,}750 \text{ cpm above background}$$

This curve may also be used to approximate the radium content of excavated material. For example, an excavated volume of 1 ft^3, reading 15,000 cpm above background, could be established by:

$$K \cong \frac{500cpm}{(pCi/gm)}$$

$$S_o\left(\frac{pCi}{gm}\right) = 15{,}000cpm / 500cpm / pCi / gm = 30pCi / gm$$

The response of the MicroR meter is based on the relationships derived from the background comparison with the Reuter-Stokes pressurized ion chamber. These relationships were as follows:

Meter No. 95487 $R_o = 0.76\ D\gamma$ (μR/hr)

Meter No. 109899 $R_o = 0.53\ D\gamma$ (μR/hr)

The measured dose rates (Dγ) from the instrument response (R_o) may then be converted into an equivalent infinite source of radium-226 using a conversion factor estimated from the shielding code - Microshield:

$$\Gamma\gamma = 1.7\frac{(\mu R/hr)}{(pCi/gm)}$$

For meter No. 95487:

$$S_o\frac{(pCi)}{gm} = \frac{R_o(\mu R/hr)}{(0.76)(1.7)} = 0.77R_o$$

A MicroR meter reading of 10 μR/hr above background would be equivalent to a residual distributed activity of:

$$S_o = \frac{7.7pCi}{gm}$$

NOTE: This protocol is only valid for "infinite sources and should not be used to estimate activities in excavated material.

B. Point Source Response

Conversion factors were derived for both the 2" × 2" NaI detector and the MicroR meter for estimating the amount of activity in a radium-226 point source. These relationships were derived from point source attenuation theory and the response of each meter to a cesium-137 point source. These response relationships are shown on Figure 2 for the 2" × 2" NaI detector and on Figure 3 for the MicroR meter. Note that for both detectors, the measured response deviates from theoritical point source theory at distances approaching contact with the source. This is due to "finite" detector volume, which approaches a point with increasing distance from the soure until the effective source-detector geometry is point-point (theoretical). When using these curves to estimate the activity of a point source from the meter reading, the curves labeled "response" should be used. For example, a 2" × 2" NaI detector on "contact" with an unshielded point source "device" that is reading 70,000 cpm above background will result in an estimated source activity of

$$S_o = \frac{70{,}000 cpm}{35{,}000 cpm / \mu Ci} = 2 \mu Ci$$

It should be noted that this protocol will not be applicable for estimating the amount of activity in a point source that is shielded (e.g., buried). To use an approach such as this, the contact readings of the hot spot areas in the PSCs would require correlation with supplimental measurements, taken at distances above the surface (e.g., 1.0 ft and 3.0 ft). The normal procedure for subsurface characterization is borehole logging, which was outside the scope of this task.

If you have further questions on this, call me at (615) 220-2202.

E. Walker

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K+E LOGARITHMIC 3 x 3 CYCLES
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DETECTOR RESPONSE - $\frac{CPM}{pCi/gm}$

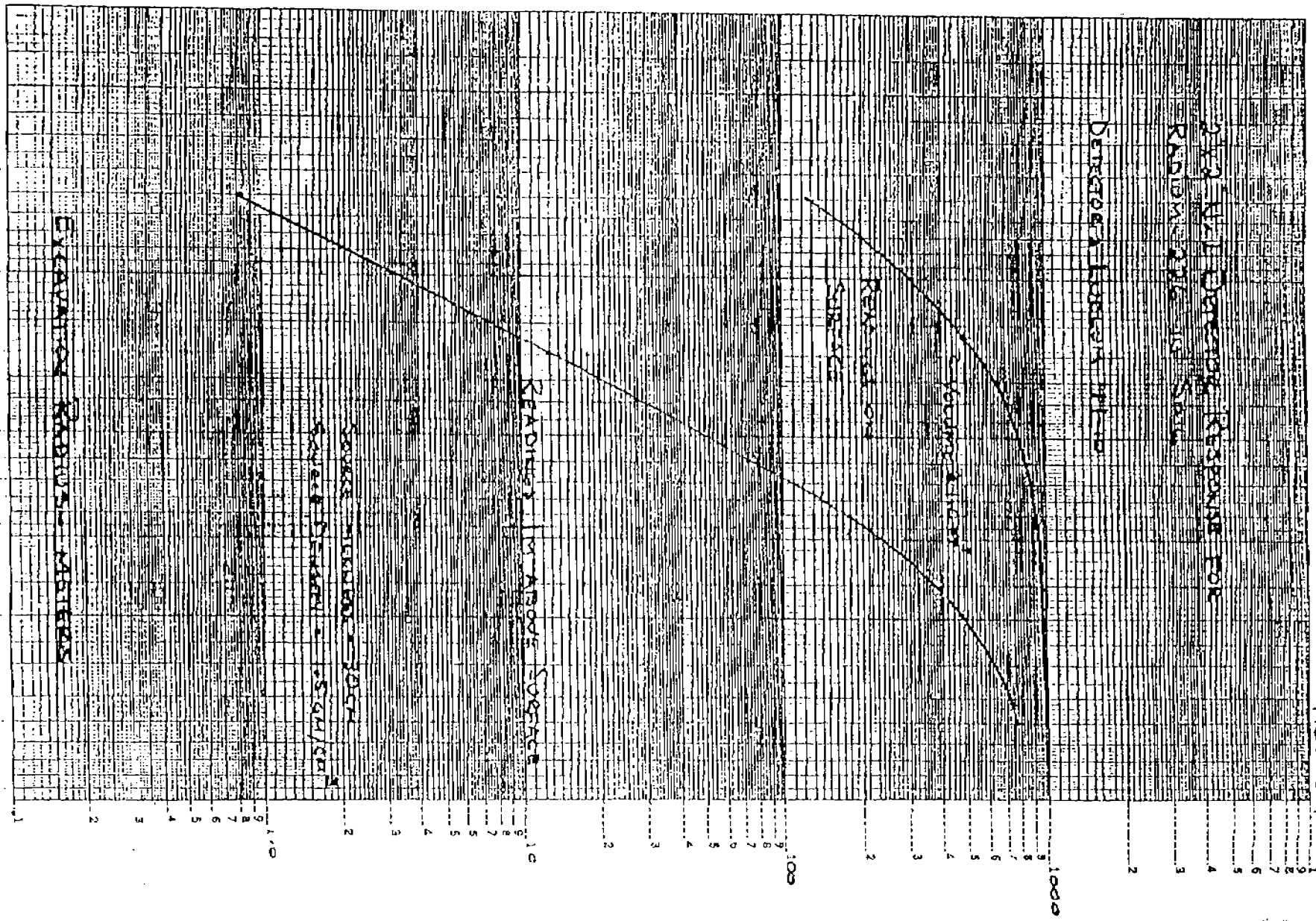
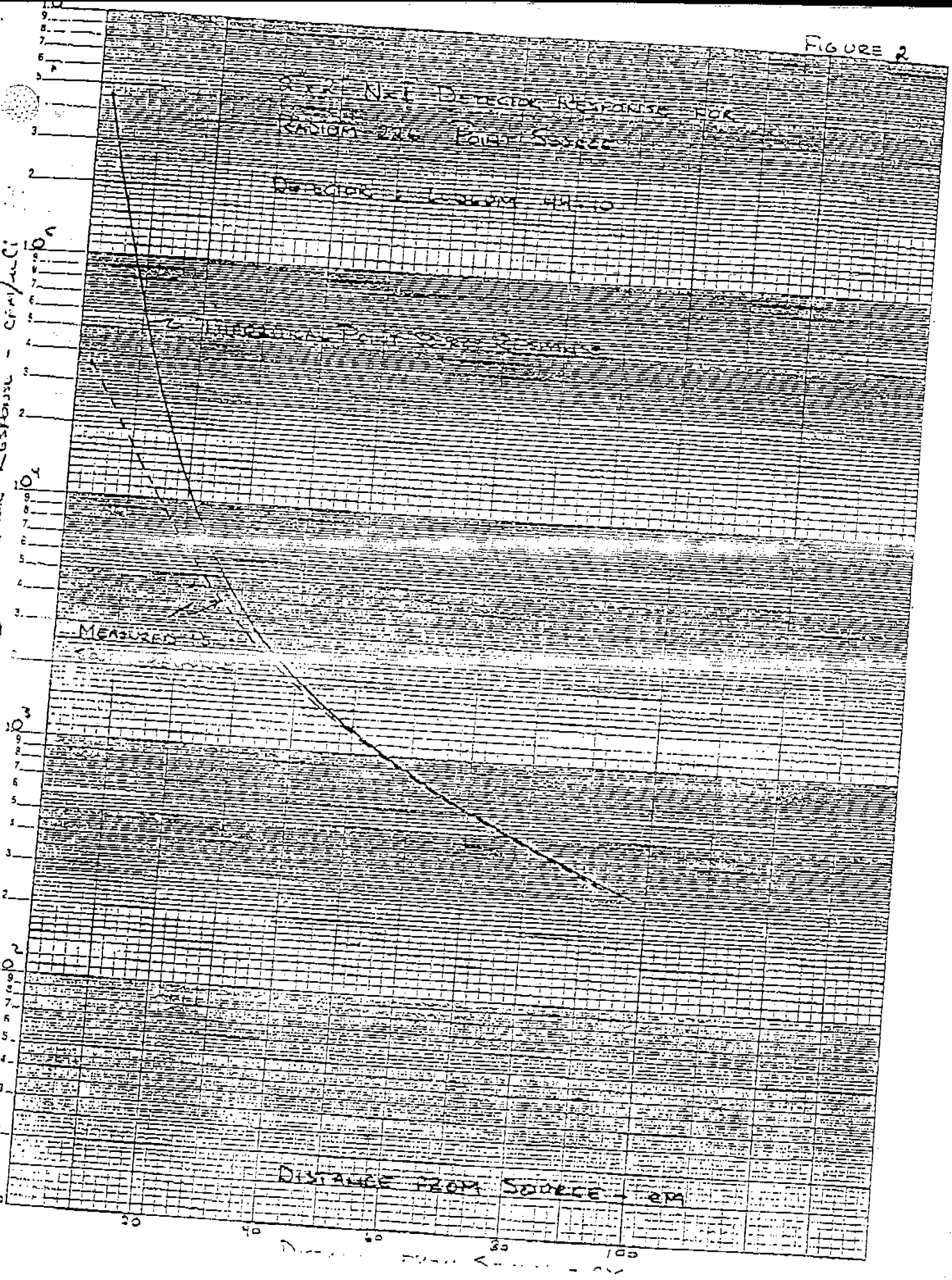
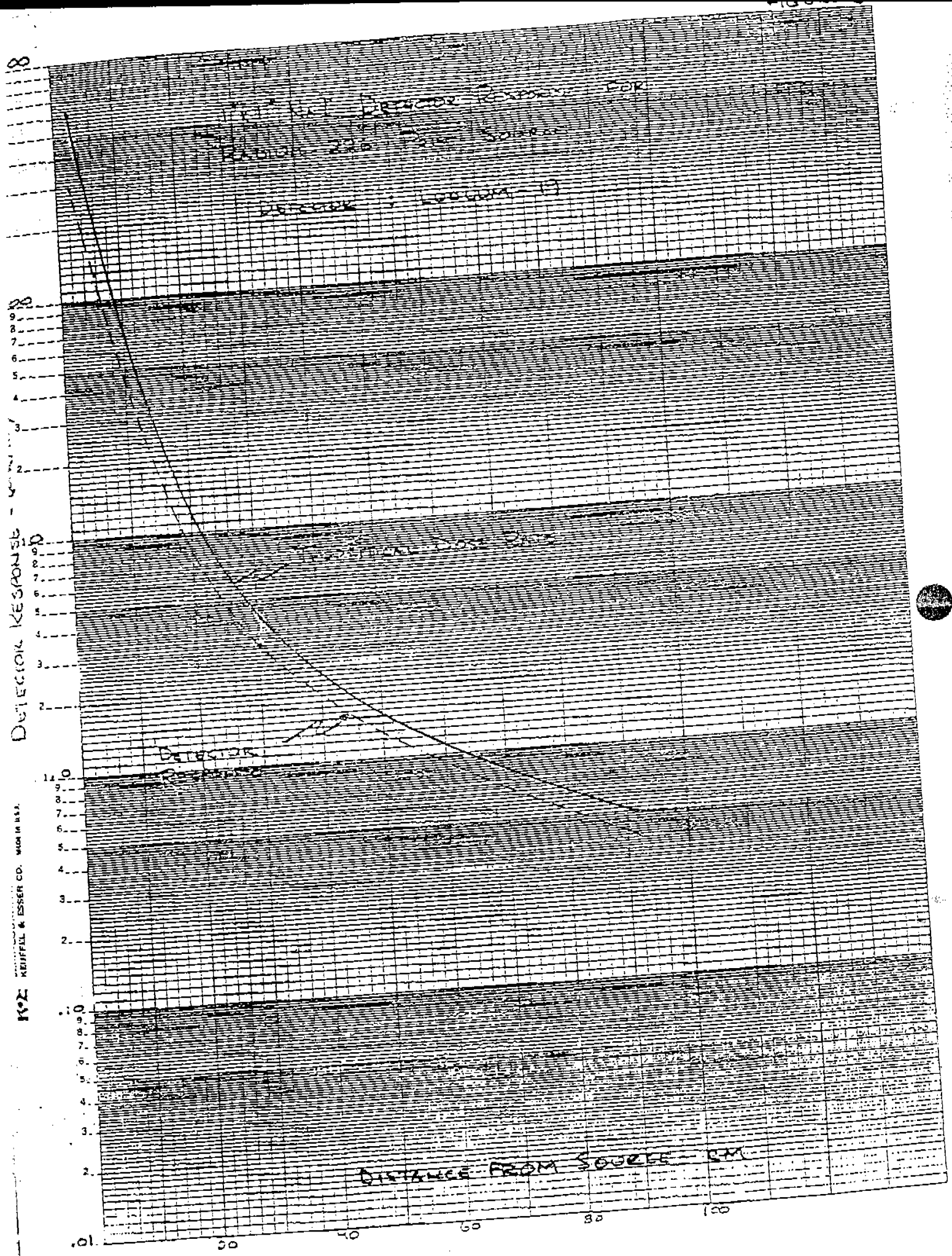


FIGURE 1

FIGURE 2


3" x 3" NaI Detector Response for
Radium-226 Point Source
Detector - Model 44-10
Theoretical Point Source Response
Measured
Detector Response - cpm/μCi
Distance from Source - cm
10
20
30
40
50
60
70
80
90
100


Detector Response - %
Detector Response
Distance from Source - cm
30
40
60
80
100
.01
.10
1.0
10
100
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NAVY CLEAN - JACKSONVILLE SAMPLE PLAN

AUG 1994

PSC	AREA	PROTOCOL	SOURCE OF CONTAMINATION	NO-GO PHOTO	WATER	SEDIMENT BIAS	SEDIMENT RANDOM	SOIL BIAS	SOIL RANDOM	TCLP
3	15 A	NON-SUSPECT	SLUDGE FROM WEST WASTEWATER TREATMENT SYSTEM						25	
4										
41	12500 FT²									
42	200 000 FT²				1		5 (1)			
43	625 FT²									
5	660 000 FT²	NON-SUSPECT	DREDGE SPOILS FROM PSC-40			5 (2)			20	
8	4.7 A									
16			DREDGE FROM EAST WASTEWATER TREATMENT SYSTEM		1		5 (1)			
40	~100 000 FT²				1		5 (1)			
9	~20 000 FT²	NON-SUSPECT							5 (1)	
13	2000 FT²	SUSPECT		100%				10 (3)	30 (4)	1
15	~45 000 FT²	NON-SUSPECT							5 (1)	
17		SUSPECT		100%	1	10 (3)	5 (2)	10 (3)	30 (4)	1
18										
25	~5000	NON-SUSPECT							5 (1)	
26		SUSPECT		100%	1	7 (3)	3 (2)	20 (3)		1
29	~60,000 FT²	NON-SUSPECT							5 (1)	
32	1.8 A	NON-SUSPECT							5 (1)	
			TOTAL		5		45		170	3

(1) NUMBER OF SAMPLES BASED ON ASSUMPTION THAT NON-PARAMETRIC STATISTICS SUFFICIENT TO CHARACTERIZE
(2) SAMPLES TAKEN ONLY IF ACTIVITY FOUND ON SHORELINE
(3) SAMPLES TAKEN TO SUPPORT CHARACTERIZATION
(4) SAMPLES TAKEN FOR VERIFICATION AFTER MATERIAL REMOVAL

BACKGROUND 30

TOTAL SOIL + SEDIMENT = 245

SOT 10-91