LAMPIRAN - A

(Data kalibrasi alat)

DATA KALIBRASI ALAT APN

DATA KONDISI ALAT

Fine Gain : 20

Coarse Gain : 0,5189

Shaping Time : Short

HV : 3000 v

Jarak Sumber dengan detektor : 4 cm

DATA KALIBRASI ALAT

✪ Kalibrasi Energi

Sumber Eu-152

A : 1,975 × 10^5 /s pada 15 Juni 1979

Kalibrasi dilakukan pada tanggal 21 Desember 1998 (09.50.58 wib)

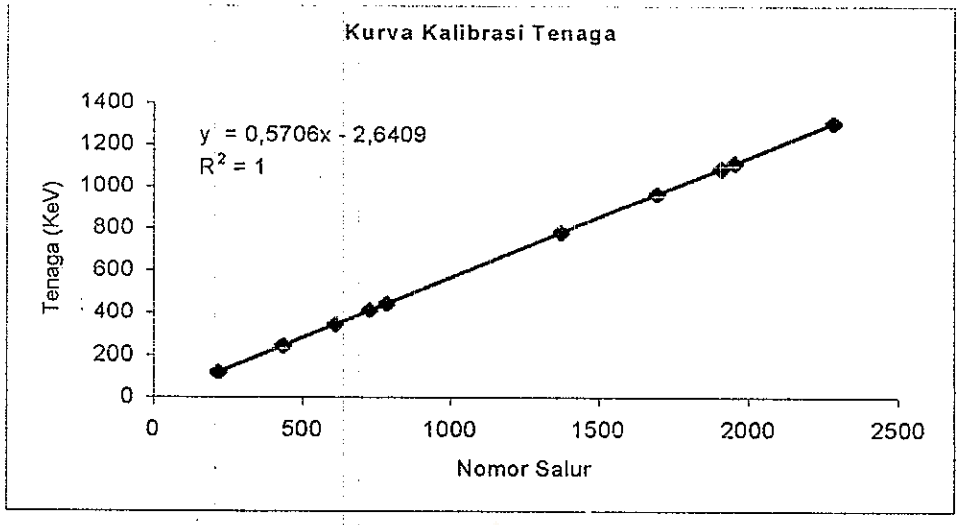
Nuklida	No Salur	Tenaga (keV)	Cacah latar	Cacah bersih	cps
Eu-152	217,53	121,51	47588	29405	103,052
	433,30	244,63	7339	4289	15,032
	608,09	344,35	15804	10290	36,032
	725,65	411,43	1863	640	2,242
	783,17	444,25	1873	782	2,740
	1371,31	779,82	3306	1475	5,168
	1526,60	868,42	1213	308	1,078
	1696,00	965,07	2076	389	1,364
	1909,00	1087,13	1348	324	1,135
	1956,00	1113,42	1575	344	1,206
	2284,00	1300,57	158	24	0,084
	2474,00	1408,97	771	0	0,000
	2561,00	1458,99	27	8	0,029
	2683,18	1528,32	21	2	0,007

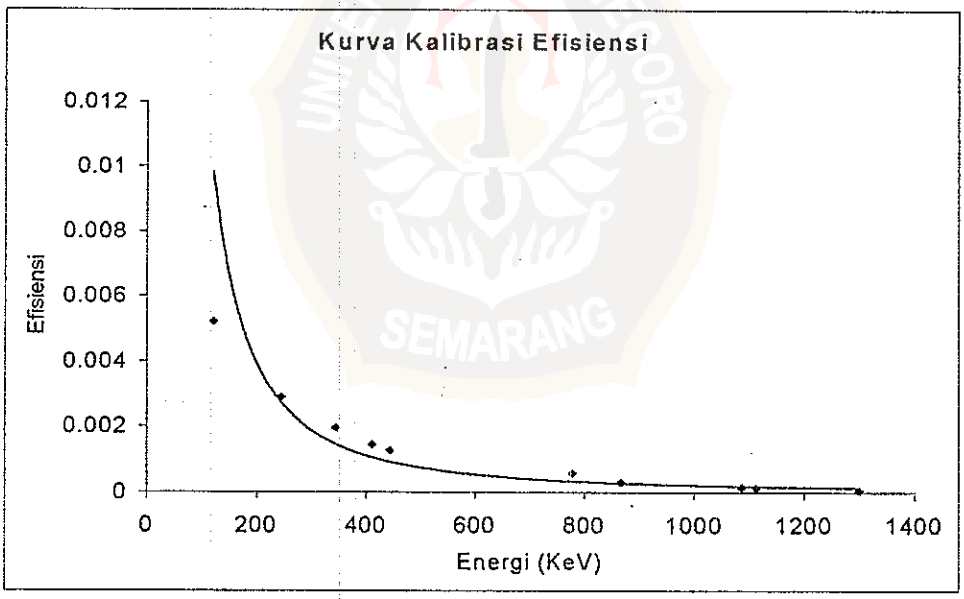
✪ **Kalibrasi Efisiensi**

$\varepsilon = \frac{L}{I \times A}$, dengan A = 66350,0787 dps

No Salur	Tenaga (keV)	Laju cacah (cps)	Yield	Efisiensi
217,53	121,51	98,017	0,2837	0,00521
433,30	244,63	14,297	0,0751	0,00287
608,09	344,35	34,300	0,2658	0,00194
725,65	411,43	2,133	0,0223	0,00144
783,17	444,25	2,607	0,0312	0,00126
1371,31	779,82	4,917	0,1299	0,00057
1526,60	868,42	1,027	0,0510	0,00030
1696,00	965,07	1,297	0,1462	0,00013
1909,00	1087,13	1,080	0,1016	0,00016
1956,00	1113,42	1,147	0,1356	0,00013
2284,00	1300,57	0,080	0,0190	0,00006
2474,00	1408,97	0,000	0,2085	0,00000
2561,00	1458,99	0,027	0,0059	0,00007
2683,18	1528,32	0,007	0,0041	0,00003

KURVA KALIBRASI ALAT





DATA KALIBRASI ALAT PNK

Kondisi Alat

Fine Gain : 0,8

Coarse Gain : 20

Low Level : 4

Up Level : 9,8

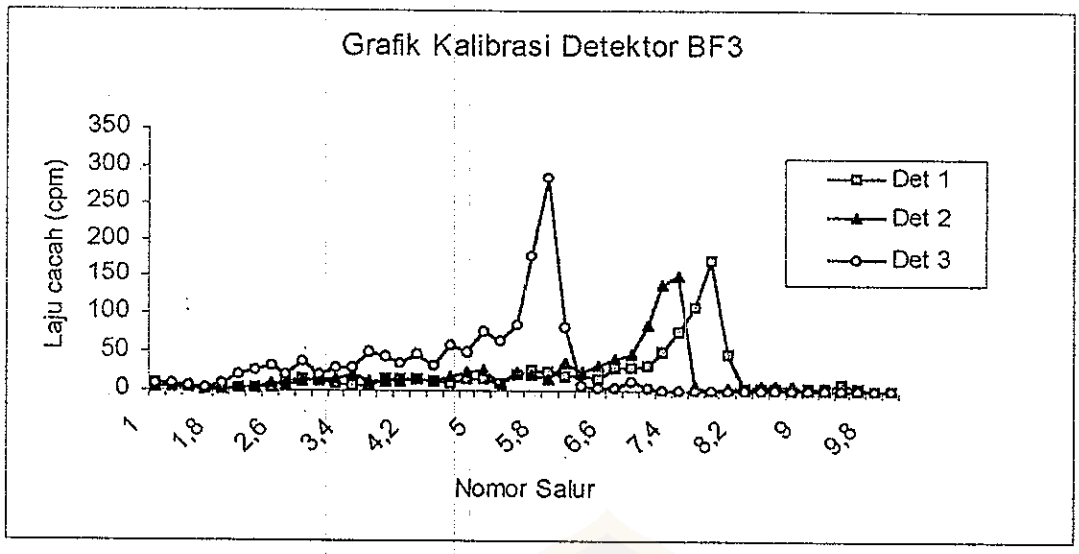
Timer : 300 sekon

HV : 1400 volt

	Det 1	Det 2	Det 3
1,0	8	4	8
1,2	3	5	9
1,4	3	5	7
1,6	1	3	3
1,8	1	0	9
2,0	2	4	20
2,2	3	2	27
2,4	3	9	33
2,6	13	7	22
2,8	14	11	38
3,0	12	14	22
3,2	8	15	29
3,4	7	20	29
3,6	7	11	49
3,8	15	11	44
4,0	15	11	37
4,2	14	15	48
4,4	12	13	33
4,6	10	18	58
4,8	15	25	50
5,0	14	27	78
5,2	10	8	65
5,4	21	25	85
5,6	27	22	179
5,8	24	14	286

	Det 1	Det 2	Det 3
6,0	17	36	83
6,2	20	23	6
6,4	16	33	4
6,6	29	42	2
6,8	31	46	11
7,0	34	85	2
7,2	49	138	0
7,4	78	151	1
7,6	110	6	0
7,8	171	1	0
8,0	48	2	0
8,2	2	3	1
8,4	3	5	0
8,6	2	7	0
8,8	1	7	0
9,0	2	1	0
9,2	4	0	0
9,4	8	0	0
9,6	2	0	0
9,8	0	0	0
10,0	0	0	0

GRAFIK KALIBRASI ALAT



LAMPIRAN – B

(Perhitungan Uji Kualitas Hasil Analisis Metoda APN)

PERHITUNGAN UJI KUALITAS HASIL ANALISIS METODA APN

Tabel Laju cacah tiap berat torium standar sekunder

No	Berat Th (W) (g)	Laju cacah (cps)
1	0,0406 ± 0,0005	1715,062 ± 76,207
2	0,0488 ± 0,0005	2046,912 ± 80,563
3	0,0566 ± 0,0005	2355,649 ± 97,533
4	0,0631 ± 0,0005	2621,757 ± 103,897
5	0,0651 ± 0,0005	2696,562 ± 118,857

1. Uji Linieritas

Persamaan regresi linier: Y = 40254X + 78,859

dengan r = 0,9999 dan n = 5

$$t_0 = \frac{r\sqrt{n-2}}{\sqrt{1-r^2}}$$

$$t_0 = \frac{0,9999\sqrt{3}}{\sqrt{0,0001}}$$

$$t_0 = 173,188$$

$t_{0,05(3)}$ = 2,353 < t_0 = 173,188 berarti dapat disimpulkan bahwa pada tingkat kepercayaan 95% berat torium standar sekunder mempunyai hubungan linier dengan laju cacahnya.

2. Ketelitian (*Accuracy*)

Perbandingan berat torium standar sekunder dengan laju cacah

Berat Torium (µg)	Laju Cacah (cps)	Berat Torium / Laju Cacah (µg/cps)
40699,1387	1715,0617	23,7304
48838,9660	2046,9120	23,8598
56571,8020	2355,6498	24,0153
63083,6650	2621,7571	24,0616
65118,6220	2696,5621	24,1487
	Rerata	23,96316

Perbandingan laju cacah dengan berat standar primer DH1A

Berat Cuplikan (g)	Laju Cacah (cps)	Laju cacah / Berat Cuplikan (cps/µg)
0,107	5,6504	52,8075

Menggunakan rumus

$$K = \frac{C_C}{C_S} \times \frac{W_S}{B}$$

Dengan

$W_S / C_S = 23,96316$ µg/cps

$C_C / B = 52,8075$ cps/g

$$K = \frac{W_S}{C_S} \times \frac{C_C}{B}$$

$$K = 23,96316 \times 52,8075$$

$$K = 1265,434572 \text{ ppm}$$

$$Kesalahan\ relatif = \left|\frac{Ku - Ks}{Ks}\right| \times 100\%$$

$$= \frac{1265{,}434572 - 910}{910} \times 100\%$$

$$= 39{,}06\%$$

3. Kepekaan (*sensitivity*)

Perbandingan laju cacah (cps) dengan berat torium (μg)

Berat Torium (μg)	Laju Cacah (cps)	Kepekaan ($\times 10^{-3}$ cps/μg)
40699,138	1715,062	42,140
48838,966	2046,912	41,911
56571,802	2355,649	41,639
63083,665	2621,757	41,559
65118,622	2696,562	41,409

4. Keseksamaan (*precision*)

Perbandingan simpangan baku dengan laju cacah (S_x / X × 100%)

Berat Torium (μg)	Laju Cacah (cps)	Ketelitian (%)
40699,138	1715,062 ± 76,207	4,443
48838,966	2046,912 ± 80,563	3,936
56571,802	2355,649 ± 97,533	4,140
63083,665	2621,757 ± 103,897	3,963
65118,622	2696,562 ± 118,857	4,408

LAMPIRAN – C

(Perhitungan Uji Kualitas Hasil Analisis Metoda PNK)

PERHITUNGAN UJI KUALITAS HASIL ANALISIS METODA PNK

Tabel Laju cacah tiap berat torium standar sekunder

No	Berat Th (W) (g)	Laju cacah (cps)
1	0,0415 ± 0,0005	72,227 ± 8,667
2	0,0846 ± 0,0005	139,773 ± 16,432
3	0,1237 ± 0,0005	202,613 ± 27,448
4	0,1640 ± 0,0005	258,313 ± 35,896
5	0,2047 ± 0,0005	322,730 ± 45,013

1. Uji Linieritas

Persamaan regresi linier: Y = 1526,9X + 10,255

dengan r = 0,9997 dan n = 5

$$t_0 = \frac{r\sqrt{n-2}}{\sqrt{1-r^2}}$$

$$t_0 = \frac{0{,}9997\sqrt{3}}{\sqrt{0{,}0005}}$$

$$t_0 = 77{,}436$$

$t_{0,05(3)}$ = 2,353 < t_0 = 77,436 berarti dapat disimpulkan bahwa pada tingkat kepercayaan 95% berat torium standar sekunder mempunyai hubungan linier dengan laju cacahnya.

2. Ketelitian (*Accuracy*)

Perbandingan berat torium standar sekunder dengan laju cacah

Berat Torium (µg)	Laju cacah (cps)	Berat Torium / Laju Cacah (µg/cps)
41500	72,227	574,5774
84600	139,773	605,2671
123700	202,613	610,5235
164000	258,313	634,8887
204700	322,730	634,2763
	Rerata	611,9066

Perbandingan laju cacah dengan berat standar primer IGS 41

Berat Cuplikan (g)	Laju Cacah (cps)	Laju cacah / Berat Cuplikan (cps/g)
0,503	1,868	3,7137

Menggunakan rumus

$$K = \frac{C_C}{C_S} \times \frac{W_S}{B}$$

Dengan

$W_S / C_S = 611{,}9066$ µg/cps

$C_C / B = 3{,}7137$ cps/g

$$K = \frac{W_S}{C_S} \times \frac{C_C}{B}$$

$$K = 611{,}9066 \times 3{,}7137$$

$$K = 2272{,}43754 \text{ ppm}$$

$$Kesalahan\ relatif = \left|\frac{Ku - Ks}{Ks}\right| \times 100\%$$

$$= \frac{2272{,}43754 - 1210}{1210} \times 100\%$$

$$= 87{,}80\%$$

3. Kepekaan (*sensitivity*)

Perbandingan laju cacah (cps) dengan berat torium (μg)

Berat Torium (μg)	Laju cacah (cps)	Kepekaan ($\times 10^{-3}$ cps/μg)
41500	72,227	1,740
84600	139,773	1,652
123700	202,613	1,638
164000	258,313	1,575
204700	322,730	1,576

4. Keseksamaan (*precision*)

Perbandingan simpangan baku dengan laju cacah (S_x / X × 100%)

Berat Torium (μg)	Laju cacah (cps)	Ketelitian (%)
41500	72,227 ± 8,667	11,999
84600	139,773 ± 16,432	11,756
123700	202,613 ± 27,448	13,547
164000	258,313 ± 35,896	13,896
204700	322,730 ± 45,013	13,947

LAMPIRAN – D

(Perhitungan Kadar Torium)

PERHITUNGAN KADAR CUPLIKAN

1. Metoda **A P N**

Kode	Berat cuplikan (g)	Laju cacah (cps)	Kadar (ppm)	Kadar ± S_k (ppm)
IV A1	0,101 ± 0,0005	1,917	454,8255220	437,901 ± 28,496
		1,913	453,8764859	
		1,707	405,0011299	
IV A2	0,107 ± 0,0005	2,030	454,6281757	492,402 ± 33,018
		2,263	506,8096363	
		2,303	515,7678269	
IV A3	0,102 ± 0,0005	2,483	583,3384929	572,375 ± 23,178
		2,323	545,7492224	
		2,503	588,0371518	
IV A4	0,103 ± 0,0005	1,853	431,1042280	425,986 ± 21,403
		1,730	402,4880272	
		1,910	444,3653942	
IV A5	0,101 ± 0,0005	1,430	339,2803842	350,352 ± 9,615
		1,497	355,1767378	
		1,503	356,6002919	
IV A6 (g)	0,102 ± 0,0005	2,083	489,3653165	499,624 ± 26,994
		2,040	479,2632000	
		2,257	530,2436482	
IV A7	0,101 ± 0,0005	2,733	648,4288741	662,664 ± 12,555
		2,833	672,1547750	
		2,813	667,4095949	
IV A8	0,103 ± 0,0005	2,820	656,0787495	652,201 ± 4,367
		2,807	653,0542730	
		2,783	647,4706241	
IV A9	0,105 ± 0,0005	2,523	575,8005017	578,159 ± 9,689
		2,580	588,8090743	
		2,497	569,8667669	

2. Metoda **P N K**

Kode	Berat cuplikan (g)	Laju cacah (cps)	Kadar (ppm)	Kadar ± S_k (ppm)
IV A1	0,503 ± 0,0005	1,533	1864,916139	2057,125 ± 246,994
		1,920	2335,707101	
		1,620	1970,752867	
IV A2	0,501 ± 0,0005	1,503	1835,719800	1822,692 ± 134,824
		1,597	1950,528623	
		1,377	1681,827122	
IV A3	0,502 ± 0,0005	1,626	1981,992294	2025,874 ± 43,285
		1,663	2027,092980	
		1,697	2068,536853	
IV A4	0,501 ± 0,0005	1,803	2202,130938	1801,929 ± 350,272
		1,353	1652,514231	
		1,270	1551,140483	
IV A5	0,503 ± 0,0005	1,843	2242,035515	2035,634 ± 180,160
		1,570	1909,927161	
		1,607	1954,938183	
IV A6	0,504 ± 0,0005	1,410	1711,881560	2040,903 ± 284,972
		1,813	2201,164019	
		1,820	2209,662722	
IV A7	0,503 ± 0,0005	1,333	1621,613316	2196,213 ± 525,368
		2,180	2652,000771	
		1,903	2315,026361	
IV A8	0,505 ± 0,0005	1,140	1381,333711	1724,648 ± 308,524
		1,497	1813,909268	
		1,633	1978,699956	
IV A9	0,501 ± 0,0005	1,877	2292,512352	2134,548 ± 138,965
		1,663	2031,139073	
		1,703	2079,993892	

LAMPIRAN – E

(Uji Hipotesis Perbedaan Cuplikan)

UJI HIPOTESIS PERBEDAAN CUPLIKAN

Metoda	IVA1	IVA2	IVA3	IVA4	IVA5	IVA6	IVA7	IVA8	IVA9
APN	437,901	492,402	572,375	425,986	350,352	499,624	662,664	652,201	578,159
PNK	2057,125	1822,692	2025,874	1801,929	2035,634	2040,903	2196,213	1724,648	2134,548
$\bar{X}_j$	1247,513	1157,547	1299,1245	1113,9575	1192,993	1270,2635	1429,4385	1188,4245	1356,3535
$\bar{X}$	1250,623889								

$$S^2_{\bar{x}} = \frac{1}{k-1}\sum\left(\bar{X}_j - \bar{X}\right)^2 = \frac{1}{9-1}(80432{,}20947) = 10054{,}02618$$

$$nS^2_{\bar{X}} = 2 \times 10054{,}02618 = 20108{,}05237$$

$$\bar{S}^2 = \frac{1}{k(n-1)}\sum\sum\left(X_{ij} - \bar{X}_j\right)^2 = \frac{1}{9(2-1)}(9768707) = 1085411{,}918$$

$$F_0 = \frac{n\sum\left(\bar{X}_j - \bar{X}\right)^2 / k-1}{\sum\sum\left(X_{ij} - \bar{X}_j\right)^2 / k(n-1)} = \frac{20108{,}05237}{1085411{,}918} = 0{,}018$$

$F_{0,05(8)(9)} = 3{,}23$

Karena $F_0 < F_{0,05(8)(9)}$ maka H_0 diterima, berarti semua cuplikan memiliki kadar yang sama pada tingkat kepercayaan 95%.

LAMPIRAN – 7

(Uji Hipotesis Perbedaan Metoda)

UJI HIPOTESIS PERBEDAAN METODA

DENGAN UJI-t

No	Kode Cuplikan	Kadar (ppm)	
		Metoda APN	Metoda PNK
1	IV A1	437,901	2057,125
2	IV A2	492,402	1822,692
3	IV A3	572,375	2025,874
4	IV A4	425,986	1801,929
5	IV A5	350,352	2035,634
6	IV A6	499,624	2040,903
7	IV A7	662,664	2196,213
8	IV A8	652,201	1724,648
9	IV A9	578,159	2134,548
	Rerata	519,074	1982,174

$n_1 = n_2 = 9$

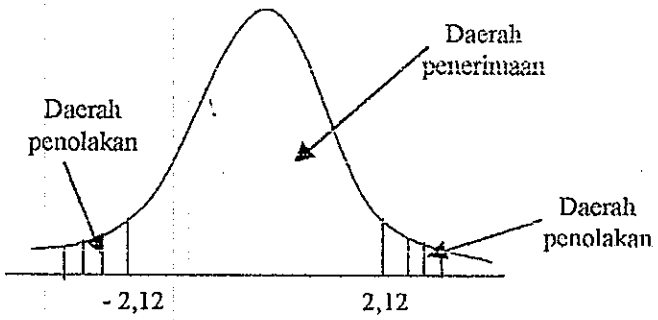
$$S_1^2 = \frac{\sum_{i=1}^{9}(\overline{X}_{i1} - \overline{X}_1)^2}{n_1 - 1} = 11185{,}520$$

$$S_2^2 = \frac{\sum_{i=1}^{9}(\overline{X}_{i2} - \overline{X}_2)^2}{n_2 - 1} = 25888{,}418$$

$$t_0 = \frac{\overline{X}_1 - \overline{X}_2}{\sqrt{(n_1 - 1)S_1^2 + (n_2 - 1)S_2^2}} \sqrt{\frac{n_1 . n_2 (n_1 + n_2 - 2)}{n_1 + n_2}} = -22{,}79611847$$

derajat bebas = $n_1 + n_2 - 2$

$t_{\alpha/2(n1+n2-2)} = t_{(0,025)(16)} = 2,12$ dan $-2,12$



Daerah penerimaan terletak antara $-t_{(0,025)(16)}$ dan $t_{(0,025)(16)}$

Karena $t_0 < -t_{(0,025)(16)}$, maka H_0 ditolak berarti ada perbedaan yang nyata antara hasil pengukuran kadar torium dengan metoda APN dan PNK.

LAMPIRAN – G

(Tabel Nilai t)

Tabel 5: Nilai *t*

d.f.	*t*.100	*t*.050	*t*.025	*t*.010	*t*.005	*d.f.*
1	3.078	6.314	12.706	31.821	63.657	1
2	1.886	2.920	4.303	6.965	9.925	2
3	1.638	2.353	3.183	4.541	5.841	3
4	1.533	2.132	2.776	3.747	4.604	4
5	1.476	2.015	2.571	3.365	4.032	5
6	1.440	1.943	2.447	3.143	3.707	6
7	1.415	1.895	2.365	2.998	3.499	7
8	1.397	1.860	2.306	2.896	3.355	8
9	1.383	1.833	2.262	2.821	3.250	9
10	1.372	1.812	2.228	2.764	3.169	10
11	1.363	1.796	2.201	2.718	3.106	11
12	1.356	1.782	2.179	2.681	3.055	12
13	1.350	1.771	2.160	2.650	3.012	13
14	1.345	1.761	2.145	2.624	2.977	14
15	1.341	1.753	2.131	2.602	2.947	15
16	1.337	1.746	2.120	2.583	2.921	16
17	1.333	1.740	2.110	2.567	2.898	17
18	1.330	1.734	2.101	2.552	2.878	18
19	1.328	1.729	2.093	2.539	2.861	19
20	1.325	1.725	2.086	2.528	2.845	20
21	1.323	1.721	2.080	2.518	2.831	21
22	1.321	1.717	2.074	2.508	2.819	22
23	1.319	1.714	2.069	2.500	2.807	23
24	1.318	1.711	2.064	2.492	2.797	24
25	1.316	1.708	2.060	2.485	2.787	25
26	1.315	1.706	2.056	2.479	2.779	26
27	1.314	1.703	2.052	2.473	2.771	27
28	1.313	1.701	2.048	2.467	2.763	28
29	1.311	1.699	2.045	2.462	2.756	29
inf.	1.282	1.645	1.960	2.326	2.576	inf.

Sumber: Tabel ini dikutip dari tabel 5 buku Supranto, J., 1995, *Statistik: Teori dan Aplikasi*, Jilid 2, Edisi kelima, Penerbit Erlangga, Jakarta.

LAMPIRAN – H

(Tabel Nilai $F_{\alpha=0,05}$)

Tabel 6b. Nilai F. 05

	Derajat kebebasan untuk pembilang																		
	1	2	3	4	5	6	7	8	9	10	12	15	20	24	30	40	60	120	∞
1	161	200	216	225	230	234	237	239	241	242	244	246	248	249	250	251	252	253	254
2	18.5	19.0	19.2	19.2	19.3	19.3	19.4	19.4	19.4	19.4	19.4	19.4	19.4	19.5	19.5	19.5	19.5	19.5	19.5
3	10.1	9.55	9.28	9.12	9.01	8.94	8.89	8.85	8.81	8.79	8.74	8.70	8.66	8.64	8.62	8.59	8.57	8.55	8.53
4	7.71	6.94	6.59	6.39	6.26	6.16	6.09	6.04	6.00	5.96	5.91	5.86	5.80	5.77	5.75	5.72	5.69	5.66	5.63
5	6.61	5.79	5.41	5.19	5.05	4.95	4.88	4.82	4.77	4.74	4.68	4.62	4.56	4.53	4.50	4.46	4.43	4.40	4.37
6	5.99	5.14	4.76	4.53	4.39	4.28	4.21	4.15	4.10	4.06	4.00	3.94	3.87	3.84	3.81	3.77	3.74	3.70	3.67
7	5.59	4.74	4.35	4.12	3.97	3.87	3.79	3.73	3.68	3.64	3.57	3.51	3.44	3.41	3.38	3.34	3.30	3.27	3.23
8	5.32	4.46	4.07	3.84	3.69	3.58	3.50	3.44	3.39	3.35	3.28	3.22	3.15	3.12	3.08	3.04	3.01	2.97	2.93
9	5.12	4.26	3.86	3.63	3.48	3.37	3.29	3.23	3.18	3.14	3.07	3.01	2.94	2.90	2.86	2.83	2.79	2.75	2.71
10	4.96	4.10	3.71	3.48	3.33	3.22	3.14	3.07	3.02	2.98	2.91	2.85	2.77	2.74	2.70	2.66	2.62	2.58	2.54
11	4.84	3.98	3.59	3.36	3.20	3.09	3.01	2.95	2.90	2.85	2.79	2.72	2.65	2.61	2.57	2.53	2.49	2.45	2.40
12	4.75	3.89	3.49	3.26	3.11	3.00	2.91	2.85	2.80	2.75	2.69	2.62	2.54	2.51	2.47	2.43	2.38	2.34	2.30
13	4.67	3.81	3.41	3.18	3.03	2.92	2.83	2.77	2.71	2.67	2.60	2.53	2.46	2.42	2.38	2.34	2.30	2.25	2.21
14	4.60	3.74	3.34	3.11	2.96	2.85	2.76	2.70	2.65	2.60	2.53	2.46	2.39	2.35	2.31	2.27	2.22	2.18	2.13
15	4.54	3.68	3.29	3.06	2.90	2.79	2.71	2.64	2.59	2.54	2.48	2.40	2.33	2.29	2.25	2.20	2.16	2.11	2.07
16	4.49	3.63	3.24	3.01	2.85	2.74	2.66	2.59	2.54	2.49	2.42	2.35	2.28	2.24	2.19	2.15	2.11	2.06	2.01
17	4.45	3.59	3.20	2.96	2.81	2.70	2.61	2.55	2.49	2.45	2.38	2.31	2.23	2.19	2.15	2.10	2.06	2.01	1.96
18	4.41	3.55	3.16	2.93	2.77	2.66	2.58	2.51	2.46	2.41	2.34	2.27	2.19	2.15	2.11	2.06	2.02	1.97	1.92
19	4.38	3.52	3.13	2.90	2.74	2.63	2.54	2.48	2.42	2.38	2.31	2.23	2.16	2.11	2.07	2.03	1.98	1.93	1.88
20	4.35	3.49	3.10	2.87	2.71	2.60	2.51	2.45	2.39	2.35	2.28	2.20	2.12	2.08	2.04	1.99	1.95	1.90	1.84
21	4.32	3.47	3.07	2.84	2.68	2.57	2.49	2.42	2.37	2.32	2.25	2.18	2.10	2.05	2.01	1.96	1.92	1.87	1.81
22	4.30	3.44	3.05	2.82	2.66	2.55	2.46	2.40	2.34	2.30	2.23	2.15	2.07	2.03	1.98	1.94	1.89	1.84	1.78
23	4.28	3.42	3.03	2.80	2.64	2.53	2.44	2.37	2.32	2.27	2.20	2.13	2.05	2.01	1.96	1.91	1.86	1.81	1.76
24	4.26	3.40	3.01	2.78	2.62	2.51	2.42	2.36	2.30	2.25	2.18	2.11	2.03	1.98	1.94	1.89	1.84	1.79	1.73
25	4.24	3.39	2.99	2.76	2.60	2.49	2.40	2.34	2.28	2.24	2.16	2.09	2.01	1.96	1.92	1.87	1.82	1.77	1.71
30	4.17	3.32	2.92	2.69	2.53	2.42	2.33	2.27	2.21	2.16	2.09	2.01	1.93	1.89	1.84	1.79	1.74	1.68	1.62
40	4.08	3.23	2.84	2.61	2.45	2.34	2.25	2.18	2.12	2.08	2.00	1.92	1.84	1.79	1.74	1.69	1.64	1.58	1.51
60	4.00	3.15	2.76	2.53	2.37	2.25	2.17	2.10	2.04	1.99	1.92	1.84	1.75	1.70	1.65	1.59	1.53	1.47	1.39
120	3.92	3.07	2.68	2.45	2.29	2.18	2.09	2.02	1.96	1.91	1.83	1.75	1.66	1.61	1.55	1.50	1.43	1.35	1.25
∞	3.84	3.00	2.60	2.37	2.21	2.10	2.01	1.94	1.88	1.83	1.75	1.67	1.57	1.52	1.46	1.39	1.32	1.22	1.00

Sumber: Tabel ini dikutip dari tabel 6b buku Supranto, J., 1995, *Statistik: Teori dan Aplikasi*, Jilid 2, Edisi kelima, Penerbit Erlangga, Jakarta.

LAMPIRAN – 1

(Daftar Tabel Isotop)

$^{152}_{63}Eu$

0.27278	0.03720 A
0.28499	0.16180 A
0.28629	0.21850 A
0.29805	0.62400 A
0.30569	0.03255 A
0.31081	0.02883 A
0.31500	0.01674 A
0.33396	93.00000 A
0.33568	0.03534 A
0.34037	0.15160 A
0.34255	0.16460 A
0.34595	0.38590 A
0.37071	0.10420 A
0.37272	0.23150 A
0.37772	0.10970 A
0.38198	0.10880 A
0.40214	0.75610 A
0.40400	0.23250 A
0.40651	0.13580 A
0.43939	77.84000 A
0.44878	0.24740 A
0.45100	0.00558 A
0.45300	0.02511 A
0.45836	0.04278 A
0.46175	0.79980 A
0.46435	0.44730 A
0.46477	
0.47449	0.14040 A
0.47688	0.01767 A
0.48592	0.16000 A
0.50551	4.55900 A
0.51007	0.11620 A
0.51578	0.95790 A
0.52007	0.45010 A
0.53318	0.03162 A
0.54053	0.06370 A
0.54296	0.13020 A
0.54700	0.01023 A
0.54826	50.96000 A
0.57125	0.39990 A
0.57550	0.02976 A
0.59064	0.03069 A
0.59651	0.07151 A
0.60731	0.16180 A
0.61263	0.09021 A
0.62555	0.30040 A
0.63782	0.01395 A
0.65829	0.05115 A
0.66264	0.01488 A
0.66703	0.25300 A
0.67584	0.49320 A
0.67682	0.01860 A
0.70000	0.00558 A
0.71219	1.05400 A
0.73120	0.32740 A
0.73744	9.30900 A
0.74060	
0.74145	0.83140 A
0.74804	4.99400 A
0.74978	0.65190 A
0.75105	2.07400 A
0.75649	0.10970 A
0.75955	0.07440 A
0.76202	0.02697 A
0.77326	0.58870 A
0.77700	0.00651 A
0.78800	0.00372 A
0.81642	0.04743 A
0.82854	0.56640 A
0.83080	0.51520 A
0.83192	0.06417 A
0.83656	0.29480 A
0.83838	0.05394 A
0.85985	0.56820 A
0.86923	1.79500 A
0.89905	0.91140 A
0.91086	0.08649 A
0.91600	0.01581 A
0.92324	0.29760 A
0.94400	0.00744 A
0.95334	0.04371 A
0.95825	0.01581 A
0.97845	0.01953 A
1.04571	0.96720 A<D
1.04615	0.96720 A<D
1.04902	5.18000 A
1.07098	0.13760 A
1.08103	0.02790 A
1.08331	0.15720 A
1.11532	0.01488 A
1.12283	0.32080 A
1.16571	0.09858 A
1.17056	1.29300 A
1.19380	0.76910 A
1.19708	1.09700 A
1.20946	0.00326 A
1.24694	1.85100 A
1.25122	0.15810 A
1.26195	0.44640 A
1.26500	0.02325 A
1.30364	0.86400 A
1.32188	0.16370 A
1.33403	0.40270 A
1.34374	2.51100 A
1.34636	0.02790 A
1.35025	0.16460 A
1.37912	0.03813 A
1.40600	0.00186 A
1.41700	0.00023 A
1.42000	0.00651 A
1.45000	0.00233 A
1.48545	1.77600 A
1.49931	0.01302 A
1.63300	0.00744 A
1.63649	0.69750 A
1.69063	0.09858 A
1.70500	0.00019 A
1.71000	0.00056 A
1.73596	0.00019 A
1.76400	0.00019 A
1.78315	0.09951 A
1.81800	0.00372 A
1.83300	0.00251 A

63 EU 152

HALF LIFE: 12.7A

GEN: NTH EU151
NFA GD152
NFA EU153

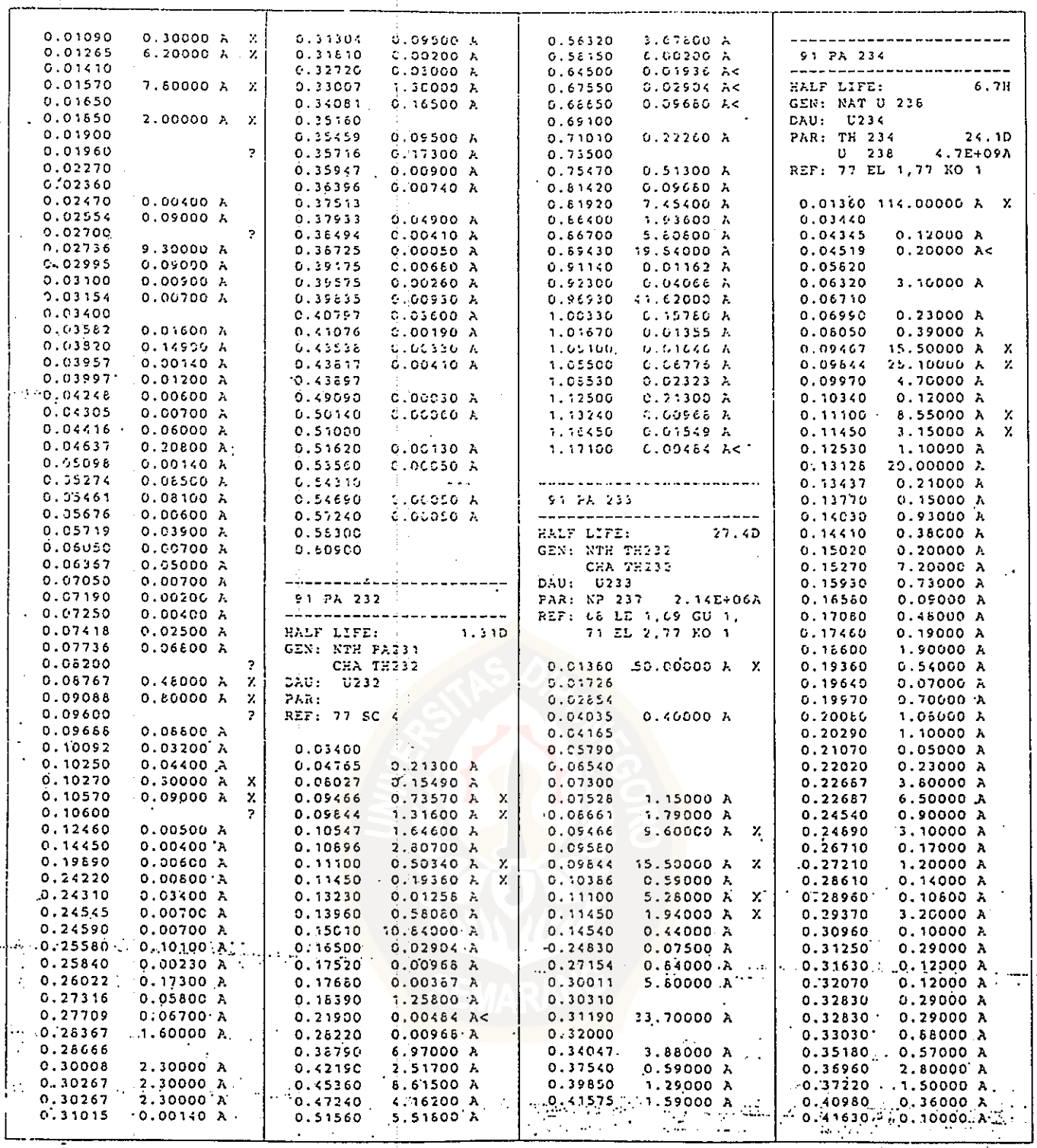
DAU:

PAR:

REF: 75 DE 1,72 BA 2

0.03952	16.00000 A	X
0.04012	30.00000 A	X
0.04231	0.30000 A	X
0.04300	0.50000 A	X
0.04540	9.00000 A	X
0.04660	2.10000 A	X
0.04870	0.15000 A	X
0.05000	0.04000 A	X
0.12176	29.34000 A	
0.14800	0.00546 A<	
0.20740	0.00737 A	
0.20920	0.00819 A	
0.21240	0.02075 A	
0.23880	0.06824 A	
0.24467	7.61600 A	
0.25162	0.07643 A	
0.26540	0.00328 A	
0.27103	0.07643 A	
0.27540	0.03276 A	
0.28580	0.00682 A<	
0.29595	0.43950 A	
0.31518	0.04368 A	
0.31600	0.00491 A	
0.32490	0.07780 A	
0.32941	0.12690 A	
0.33090	0.00628 A	
0.34050	0.02320 A	
0.34430	27.00000 A	
0.35200	0.01829 A	
0.36773	0.87350 A	
0.38570	0.02320 A	
0.41109	2.26400 A	
0.41607	0.10650 A	
0.42370	0.00546 A<	
0.44400	0.31390 A	
0.44400	2.83900 A	
0.48270	0.02730 A	
0.48846	0.40950 A	
0.49350	0.04095 A	
0.49370	0.02621 A	
0.49390	0.01556 A	
0.49630	0.00546 A	
0.49640	0.00273 A	
0.50337	0.15010 A	
0.52022	0.05459 A	
0.52320	0.01092 A	
0.52730	0.00955 A	
0.53410	0.01822 A	
0.53530	0.00546 A	
0.55650	0.02047 A	
0.56140	0.00273 A	
0.56397	0.51590 A	
0.56650	0.12280 A	
0.58622	0.47220 A	
0.61690	0.01092 A	
0.64430	0.00819 A	
0.65651	0.15010 A	
0.66430	0.00546 A	
0.67130	0.02184 A	
0.67460	0.13650 A	
0.67500	0.02730 A	
0.67861	0.47770 A	
0.68680	0.03276 A	
0.68860	0.84620 A	
0.70360	0.01556 A	
0.71200	0.01365 A<	
0.71270	0.09008 A	
0.71940	0.06005 A	
0.71940	0.27300 A	
0.72790	0.00923 A	
0.76492	0.19110 A	
0.76915	0.07643 A	
0.77890	12.99000 A	
0.79470	0.03003 A	
0.80520	0.01365 A	
0.81051	0.32760 A	
0.83970	0.01692 A	
0.84140	0.16380 A	
0.86739	4.17600 A	
0.90104	0.07643 A	
0.91940	0.40950 A	
0.91960	0.00546 A	
0.92622	0.27300 A	
0.93075	0.07370 A	
0.93680	0.00218 A	
0.95950	0.01365 A	
0.96340	0.12010 A	
0.96400	14.58000 A	
0.97440	0.01092 A	
0.99005	0.03276 A	
1.00506	0.65510 A	
1.08580	10.29000 A	
1.08982	1.72000 A	
1.10920	0.17740 A	
1.11207	13.58000 A	
1.17100	0.03549 A	
1.20610	0.00819 A	
1.21289	1.44700 A	
1.24980	0.17740 A	
1.26124	0.03549 A	
1.29274	0.10100 A	
1.29919	1.70600 A	
1.31350	0.00382 A	
1.33430	0.00137 A	
1.34790	0.01774 A	
1.36384	0.02730 A	
1.39040	0.00410 A	
1.40308	21.21000 A	
1.45795	0.51860 A	
1.52865	0.30030 A	
1.53820	0.00218 A	
1.55820	0.00082 A	
1.60562	0.00792 A	
1.60833	0.00546 A	
1.64733	0.00655 A	
1.76913	0.00901 A	

Sumber: Erdtmann, G., Soyka, W., 1979, *The Gamma Rays of The Radionuclides*, Vol. 7, Verlag Chemie, New York.

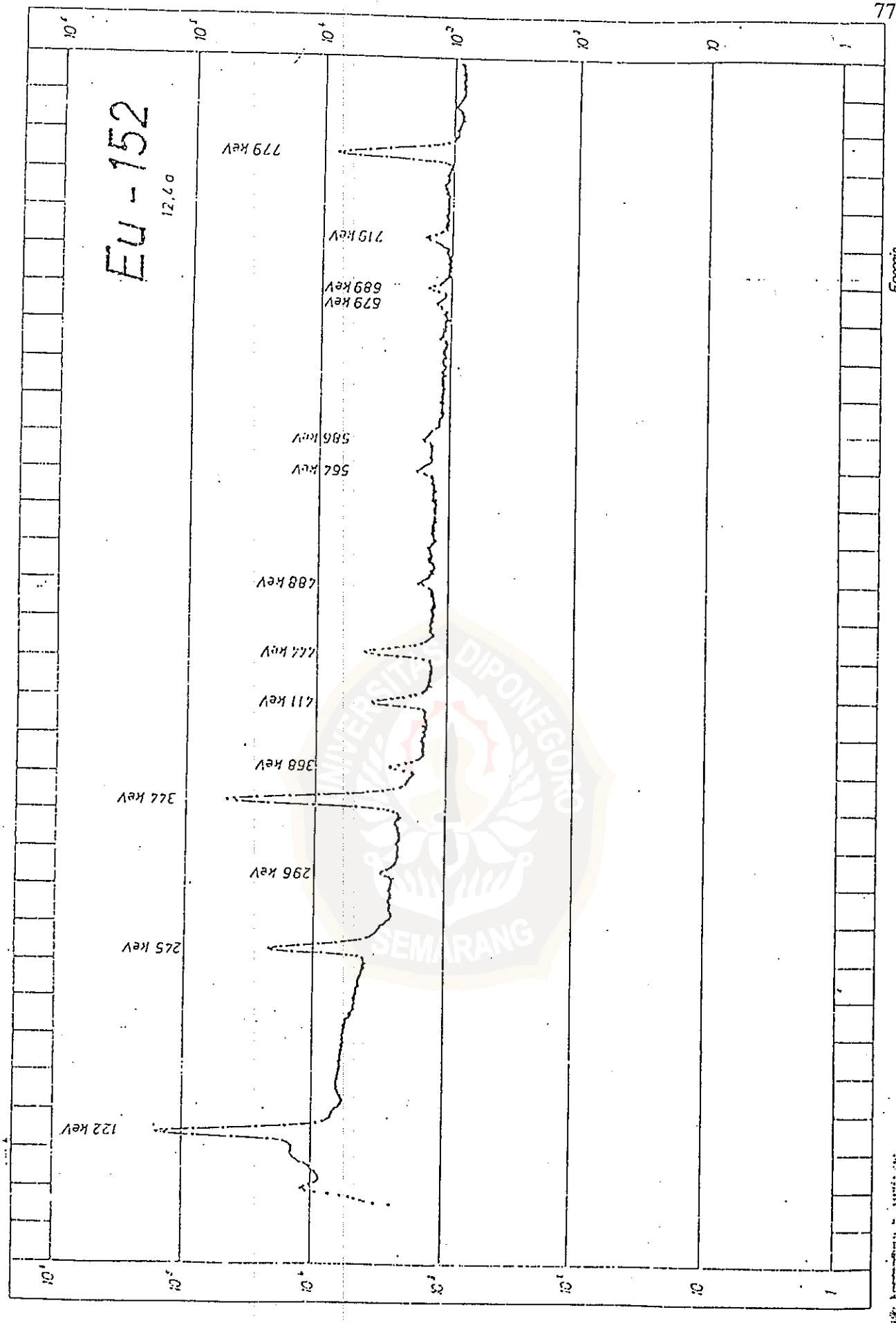


0.01090	0.30000	A	X	0.31304	0.09500	A	0.56320	3.67600	A	91 PA 234	
0.01265	6.20000	A	X	0.31610	0.00200	A	0.56150	6.00200	A	91 PA 234	
0.01410				0.32720	0.03000	A	0.64500	0.01936	A<	HALF LIFE:	6.7H
0.01570	7.60000	A	X	0.33007	1.30000	A	0.67550	0.02904	A<	GEN: NAT U 226	
0.01650				0.34081	0.16500	A	0.68650	0.09680	A<	DAU: U234	
0.01850	2.00000	A	X	0.35160			0.69100			PAR: TH 234	24.1D
0.01900				0.35459	0.09500	A	0.71010	0.22260	A	U 238	4.7E+09A
0.01960			?	0.35716	0.17300	A	0.73500			REF: 77 EL 1,77 KO 1	
0.02270				0.35947	0.00900	A	0.75470	0.51300	A		
0.02360				0.36396	0.00740	A	0.81420	0.09680	A	0.01360	114.00000 A X
0.02470	0.00400	A		0.37513			0.81920	7.45400	A	0.03440	
0.02554	0.09000	A		0.37933	0.04900	A	0.86400	1.93600	A	0.04345	0.12000 A
0.02700			?	0.38494	0.00410	A	0.86700	5.80800	A	0.04519	0.20000 A<
0.02736	9.30000	A		0.38725	0.00050	A	0.89430	19.54000	A	0.05820	
0.02995	0.09000	A		0.39175	0.00660	A	0.91140	0.01162	A	0.06320	3.10000 A
0.03100	0.00900	A		0.39575	0.00260	A	0.92300	0.04066	A	0.06710	
0.03154	0.00700	A		0.39835	0.00930	A	0.96930	41.62000	A	0.06990	0.23000 A
0.03400				0.40797	0.03600	A	1.00330	0.15760	A	0.08050	0.39000 A
0.03582	0.01600	A		0.41076	0.00190	A	1.01670	0.01355	A	0.09467	15.50000 A X
0.03820	0.14900	A		0.43536	0.00330	A	1.03100	0.01646	A	0.09644	20.10000 A X
0.03957	0.00140	A		0.43617	0.00410	A	1.05500	0.06775	A	0.09970	4.70000 A
0.03997	0.01200	A		0.43897			1.08530	0.02323	A	0.10340	0.12000 A
0.04248	0.00600	A		0.49090	0.00030	A	1.12500	0.21300	A	0.11100	8.55000 A X
0.04305	0.00700	A		0.50140	0.00060	A	1.13240	0.00968	A	0.11450	3.15000 A X
0.04416	0.06000	A		0.51000			1.18450	0.01549	A	0.12530	1.10000 A
0.04637	0.20800	A		0.51620	0.00130	A	1.17100	0.00484	A<	0.13126	20.00000 A
0.05098	0.00140	A		0.53560	0.00050	A				0.13437	0.21000 A
0.05274	0.06500	A		0.54310						0.13770	0.15000 A
0.05461	0.08100	A		0.54690	0.00050	A	91 PA 233			0.14030	0.93000 A
0.05676	0.00600	A		0.57240	0.00050	A				0.14410	0.38000 A
0.05719	0.03900	A		0.58300			HALF LIFE:		27.4D	0.15020	0.20000 A
0.06050	0.00700	A		0.60900			GEN: NTH TH232			0.15270	7.20000 A
0.06367	0.05000	A					CHA TH233			0.15930	0.73000 A
0.07050	0.00700	A					DAU: U233			0.16560	0.09000 A
0.07190	0.00200	A		91 PA 232			PAR: NP 237	2.14E+06A		0.17080	0.48000 A
0.07250	0.00400	A					REF: 66 LE 1,69 GU 1,			0.17460	0.19000 A
0.07418	0.02500	A		HALF LIFE:		1.31D	71 EL 2,77 KO 1			0.18600	1.90000 A
0.07736	0.06600	A		GEN: NTH PA231						0.19360	0.54000 A
0.08200			?	CHA TH232			0.01360	50.00000	A X	0.19649	0.07000 A
0.08767	0.48000	A	X	DAU: U232			0.01726			0.19970	0.70000 A
0.09088	0.80000	A	X	PAR:			0.02654			0.20086	1.06000 A
0.09600			?	REF: 77 SC 4			0.04035	0.40000	A	0.20290	1.10000 A
0.09666	0.08600	A					0.04165			0.21070	0.05000 A
0.10092	0.03200	A		0.03400			0.05790			0.22020	0.23000 A
0.10250	0.04400	A		0.04765	0.21300	A	0.06540			0.22667	3.80000 A
0.10270	0.30000	A	X	0.06027	0.15490	A	0.07300			0.22687	6.50000 A
0.10570	0.09000	A	X	0.09466	0.73570	A X	0.07528	1.15000	A	0.24540	0.90000 A
0.10600			?	0.09844	1.31600	A X	0.08661	1.79000	A	0.24690	3.10000 A
0.12460	0.00500	A		0.10547	1.64600	A	0.09466	9.60000	A X	0.26710	0.17000 A
0.14450	0.00400	A		0.10696	2.80700	A	0.09580			0.27210	1.20000 A
0.19890	0.00600	A		0.11100	0.50340	A X	0.09844	15.50000	A X	0.28610	0.14000 A
0.24220	0.00800	A		0.11450	0.19360	A X	0.10386	0.59000	A	0.28960	0.10600 A
0.24310	0.03400	A		0.13230	0.01256	A	0.11100	5.28000	A X	0.29370	3.20000 A
0.24545	0.00700	A		0.13960	0.58080	A	0.11450	1.94000	A X	0.30960	0.10000 A
0.24590	0.00700	A		0.15010	10.64000	A	0.14540	0.44000	A	0.31250	0.29000 A
0.25580	0.10100	A		0.16500	0.02904	A	0.24830	0.07500	A	0.31630	0.12900 A
0.25840	0.00230	A		0.17520	0.00968	A	0.27154	0.64000	A	0.32070	0.12000 A
0.26022	0.17300	A		0.17660	0.00367	A	0.30011	5.60000	A	0.32830	0.29000 A
0.27316	0.05800	A		0.18390	1.25800	A	0.30310			0.32830	0.29000 A
0.27709	0.06700	A		0.21900	0.00484	A<	0.31190	33.70000	A	0.33030	0.68000 A
0.28367	1.60000	A		0.26220	0.00968	A	0.32000			0.35180	0.57000 A
0.28666				0.36790	6.97000	A	0.34047	3.88000	A	0.36960	2.80000 A
0.30008	2.30000	A		0.42190	2.51700	A	0.37540	0.59000	A	0.37220	1.50000 A
0.30267	2.30000	A		0.45360	8.61500	A	0.39850	1.29000	A	0.40980	0.36000 A
0.30267	2.30000	A		0.47240	4.16200	A	0.41575	1.59000	A	0.41630	0.10000 A
0.31015	0.00140	A		0.51560	5.51600	A					

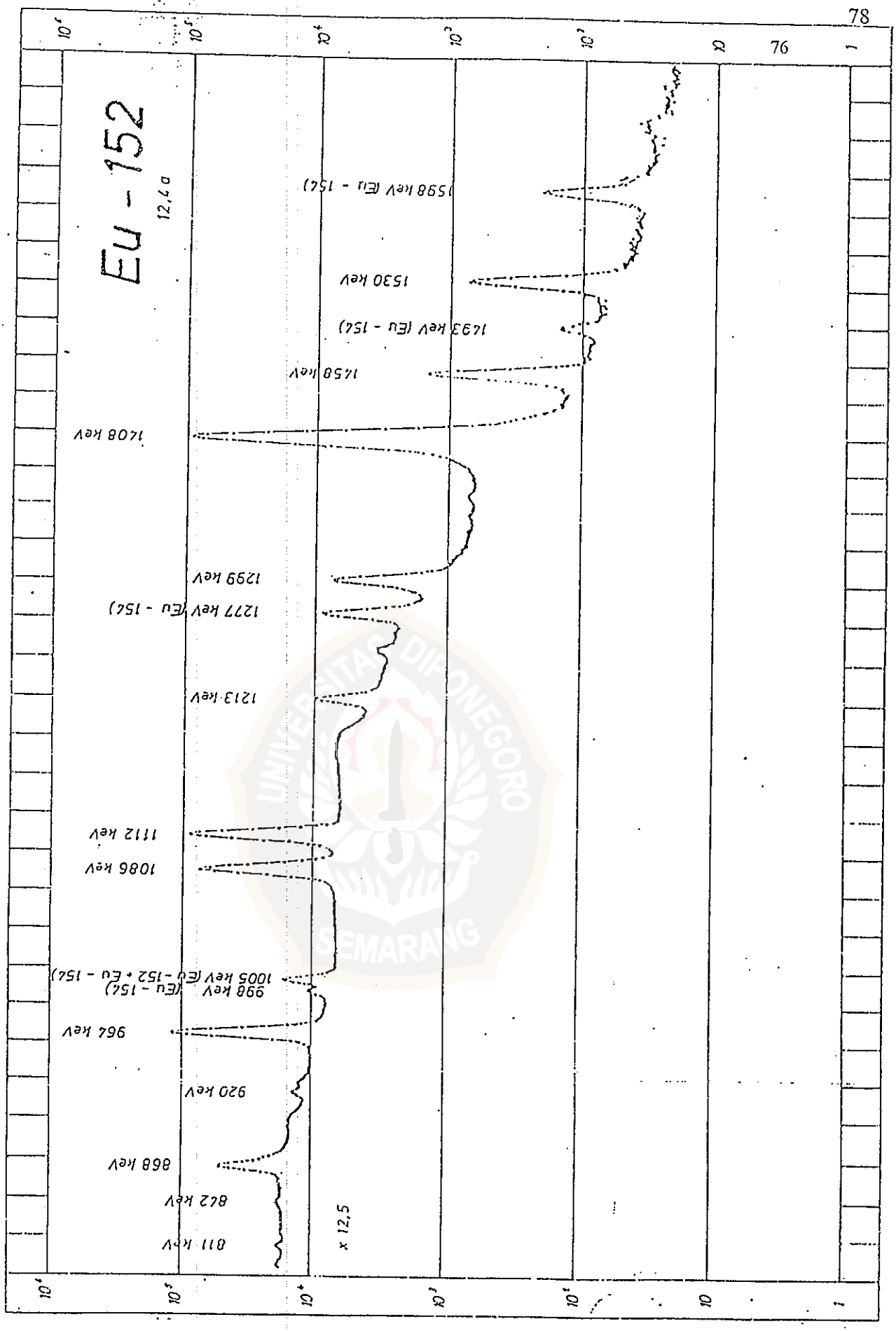
Sumber: Erdtmann, G., Soyka, W., 1979, *The Gamma Rays of The Radionuclides*, Vol. 7, Verlag Chemie, New York.

LAMPIRAN – J

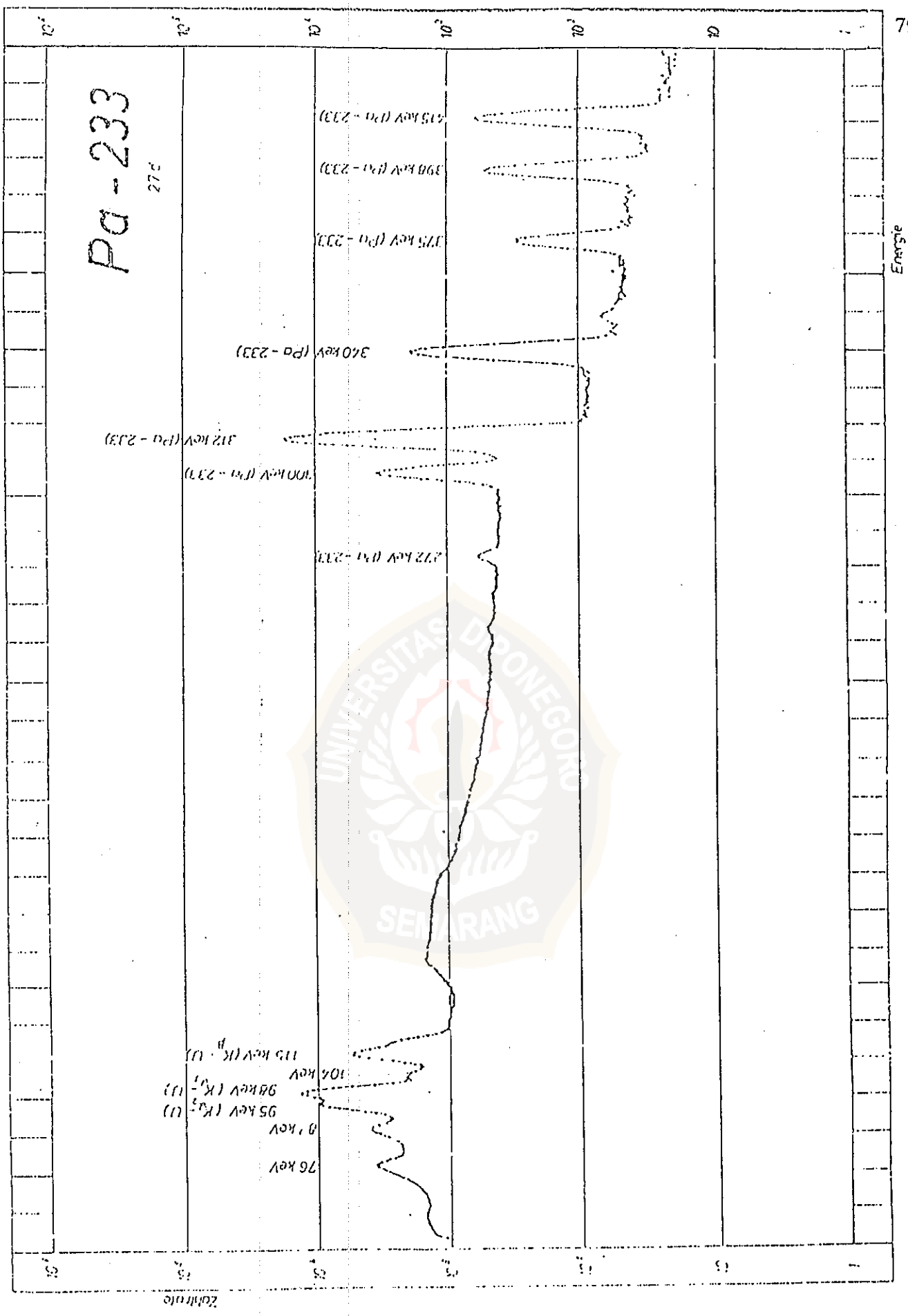
(Gambar Spektrum Tenaga-γ)



Sumber: Erdtmann, G., Soyka, W., 1979, *The Gamma Rays of The Radionuclides*, Vol. 7, Verlag Chemie, New York.



Sumber: Erdtmann, G., Soyka, W., 1979, *The Gamma Rays of The Radionuclides*, Vol. 7, Verlag Chemie, New York.



Sumber: Erdtmann, G., Soyka, W., 1979, *The Gamma Rays of The Radionuclides*, Vol. 7, Verlag Chemie, New York.

LAMPIRAN – K

(Sertifikat Cuplikan Standar)

CANADA CENTRE FOR MINERAL AND ENERGY TECHNOLOGY

REFERENCE URANIUM-THORIUM ORE DH-1a

CERTIFICATE OF ANALYSIS

	Recommended Value	95% Confidence Interval
U	0.2629%	± 0.0003%
Th	0.091%	± 0.003%
Ra-226	31.5 Bq/g	± 1.1 Bq/g
Pb-210	30.8 Bq/g	± 0.9 Bq/g

DESCRIPTION

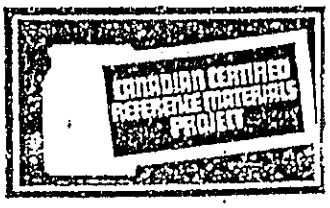
DH-1a is intended as a replacement for DH-1 of which the stock is exhausted. It is ore typical of the property of Denison Mines Limited in Elliot Lake, Ontario, and is a sericitic feldspathic quartzite containing approximately 10% pyrite. The radioactive minerals are uraninite and brannerite and possibly traces of monazite and uranothorite.

The bulk material was dry-ground to minus 74 µm, blended and bottled in 200-g units. The homogenity of DH-1 was confirmed using the volumetric-umpire method for uranium.

CERTIFICATION

The certified value of uranium is the mean of 45 determinations by the volumetric-umpire method performed at CANMET to confirm the homogenity of DH-1a. In addition, a sufficient number of results for uranium were submitted by nine laboratories to give a consensus value of 0.260% and 95% confidence intervals of ± 0.003%. Herein, instrumental techniques, X-ray fluorescence and neutron activation analysis, were predominant.

The consensus value for thorium is the unweighted mean of 66 accepted analytical determinations by 12 laboratories. Methods included colorimetry, X-ray fluorescence, neutron activation analysis and radiometry.



BRITISH GEOLOGICAL SURVEY, KEYWORTH, NOTTINGHAM NG12 5GG
UNITED KINGDOM

ANALYSED SAMPLES/IGS 41

Bastnäsite, unleached concentrate [1]
Source: Molycorp, Inc. Mountain Pass, California
Mesh size: 99.5% -200 (75μm)
Moisture content: 0.030%

ANALYSIS (dry basis)

Determination	Number of results, n	Accepted value, % (or ppm)	95% confidence limits		
REO	80	64.21	64.00	64.48	R
ThO_2	40	0.121[3]	0.10	0.14	P [3]
La_2O_3	49	20.90	20.72	21.11	R
CeO_2	56	32.24	32.00	33.09	P
Pr_6O_{11}	44	2.74	2.68	2.79	R
Nd_2O_3	54	7.61	7.50	7.77	P
Sm_2O_3	44	0.52	0.43	0.56	P
Eu_2O_3	20	0.075	0.071	0.078	P
Gd_2O_3	26	0.151	0.149	0.153	P
Tb_4O_7	10	0.068	-	-	poss
Dy_2O_3	4	157ppm	-	-	poss
Ho_2O_3	4	34ppm	-	-	poss
Er_2O_3	4	49ppm	-	-	poss
Tm_2O_3	10	10.5ppm	-	-	poss
Lu_2O_3	4	500ppm	-	-	poss
Yb_2O_3	4	800ppm	-	-	poss
Y_2O_3	27	664ppm	-	-	poss
SiO_2	35	0.82	-	-	poss
Al_2O_3	10	0.073	-	-	poss
Fe_2O_3	20	0.42	0.34	0.45	P
MgO	12	0.265	0.225	0.305	P
CaO	20	4.52	-	-	poss
Na_2O	6	0.135	-	-	poss
K_2O	6	97ppm	-	-	poss
CO_2	20	20.12	20.01	20.26	P
P_2O_5	6	1.265	-	-	poss
SO_3	22	1.215	1.17	1.24	P
Cl	4	0.41	-	-	poss
F	26	4.37	4.23	4.70	P
MnO	14	0.06	-	-	poss
BaO	28	1.58	1.50	1.65	P
SrO	13	2.26	-	-	poss
PbO	10	0.13	-	-	poss

1. Drying conditions varied widely between laboratories and the range in moisture values are wide. The value given is based on the median.

2. Where results are based on analyses from five or more laboratories and they are in good agreement, a recommended value, R, is given. Where agreement is less, a more cautious probable value, P is given. With fewer data, a possible value, poss, is given as a guide only.

3. The mean can be a poor estimate of a true value if data are few in number or are a poor approximation to a normal distribution. Robust estimates such as the median, the Gastwirth median and the 25% trimmed mean can be much more reliable. After eliminating any highly discrepant data, five of these have been calculated in addition to the mean. The accepted value has been based on whichever estimate seems best for each set of data. Confidence limits for the mean are based on the standard error of the mean x the t-statistic for n-1 degrees of freedom; for the median, they are based on the binomial distribution or its normal approximation.