

RAS14512

## Army Anagnostopoulos Exh. # 1-K

[Originally Attached As EXHIBIT HWA # 12 to Witness  
Anagnostopoulos' pre-filed testimony]

U.S. NUCLEAR REGULATORY COMMISSION  
In the Matter of US Army (JEFFERSON PROVING GROUND)  
Docket No. 40-8838-ML Official Exhibit No. ARMY EXH. #1-K  
OFFERED by: (Applicant/Licensee) Intervenor \_\_\_\_\_  
NRC Staff \_\_\_\_\_ Other \_\_\_\_\_  
IDENTIFIED on \_\_\_\_\_ Witness/Panel \_\_\_\_\_  
Action Taken: **ADMITTED** **REJECTED** **WITHDRAWN**  
Reporter/Clerk \_\_\_\_\_

Examination and Analysis of Three Fired Depleted  
Uranium Penetrators, QINETIQ/FST/SMC/CR021209,  
QinetiQ Ltd., March, 2002.  
(item 4.5, 4,6, and Appendix A)

DOCKETED  
USNRC

October 25, 2007 (2:00pm)

OFFICE OF SECRETARY  
RULEMAKINGS AND  
ADJUDICATIONS STAFF

Docket No. 40-8838-ML

TEMPLATE = SECY-028

SECY-02

**Examination and analysis of  
three fired depleted uranium  
penetrators**

QINETIQ/FST/SMC/CR021209

Cover + vi + 72 pages  
March 2002

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printed on the reverse of this page**

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4 Discussion

- 4.1 The examination of the three penetrators has shown the corrosion products and corrosion mechanism to be essentially the same for all three rounds. The black corrosion product is  $\text{UO}_2$  (uraninite) and the yellow product is  $\text{UO}_3 \cdot 2\text{H}_2\text{O}$  (schoepite).
- 4.2 All three penetrators show attached debris from the target environment. In each case some of this material was easily removed by gentle brushing and in the case of sample 03/02 T material was rapidly falling away with sample handling. The examination shows that some of the corrosion products are attached to environmental debris particles. This is possibly due to the voluminous nature of the corrosion product expanding as the corrosion process proceeds, and therefore compacting with the debris in a confined space.
- 4.3 All three penetrators exhibit pitting corrosion and therefore it is very difficult to estimate the rate of corrosion due to the localised nature of attack. From the investigation we can conclude that the sample recovered from the soil environment is corroding faster than the other two. In the case of sample 02/01 T it can be seen that corrosion appears to be progressing at a faster rate within the concrete than the region exposed to air only.
- 4.4 The scuff marks observed on samples 01/01 T and 02/01 T are assumed to be produced on impact with the target, probably generated by the removal of the aluminium jacket on penetration of the target. This scuffing would expose a fresh metal surface that rapidly oxidises.
- 4.5 The radiochemical analysis results indicate that the transuranic content is low and comparable with that reported by US researchers who used similar analysis techniques to study the transuranic content of DU armour [ref. 1]. The data also compares favourably with an earlier analysis of DU transuranics that were supplied by Starmet Corporation, who produce the material. The results of this earlier analysis were provided to MoD and formed the technical basis of the 7<sup>th</sup> February 2001 written answers by Mr Spellar in the House of Commons as indicated in Table 6.
- 4.6 Table 6 summarises a comparison of the transuranic data supplied by Starmet with that provided from AEA in the programme reported here. It indicates that the levels of plutonium and americium isotopes are marginally lower in the recovered penetrators than in the Starmet specification, which are probably maximum allowable values for each isotope. Orders of magnitude differences in the transuranic content have been observed, however, between billets of DU armour for both americium and plutonium isotopes in the work referenced earlier [ref. 1]. Therefore, it is likely that the recovered penetrators were machined from the same billet or cast of material, as the transuranic content is similar in each.
- 4.7 Depleted uranium is defined as having less than 0.71% of  $\text{U}235$ . Typical penetrator materials have approximately 0.2%  $\text{U}235$  content. The measured levels of enrichment in this investigation, 0.2%  $\text{U}235$ , are therefore typical for this type of material.

## Appendix



AEA Technology plc

## Interim Test Report.

**Customer:** QINETIQ, Cody Technology Park, Room 2008, Building A7, Farnborough, Hants.

**Testing Facility:** AEA Technology Nuclear Science  
Analytical Chemistry Department  
(Radiochemistry)  
A50, Winfrith Technology Centre  
Dorchester Tel: 01305 20 3550  
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<b>Our Ref:</b>	REPG1114.doc	<b>Samples Received:</b>	10/10/01
<b>Customer Ref:</b>	See Below	<b>Analysis Completed:</b>	09/11/01
		<b>Interim Report Date:</b>	15/11/01
		<b>Final Report Date:</b>	11/01/02
		<b>Amendment:</b>	12/03/02 (Data in Table 2.1 amended due to spreadsheet calculation error)

## 1. Test Details.

**The Radiochemical Analysis of Three Depleted Uranium Solid Samples for Actinide Analysis and Isotopic Evaluation by ICPMS.**

## 1.1 Sample Preparation:

The three samples were dissolved in the minimum volume of Aqua Regia and the solutions filtered through 3-micron filters. The residue and filter was ashed at 450°C, prior to further dissolution in a 1:1 ratio of HF to HNO<sub>3</sub>. This resultant solution was recombined with the original leachate, and made up to 100mL. The following analytical techniques were applied:

- Analysis of Pu, U and Am isotopes by alpha spectroscopy.
- Isotopic quantification using ICPMS.

## 1.2 Pu, U and Am Analysis by Alpha Spectroscopy

Internal tracers were added to one of two sample digest aliquots, i.e., Pu-242, Am-243 and U-232. The respective nuclide fractions were then separated and purified using anion exchange chromatography and prepared for alpha spectrometry by electro-deposition onto stainless steel discs.

The activity concentrations of the unknown nuclides could then be calculated by reference to the added internal tracer.

## 1.3 Elemental Analysis using ICPMS:

The samples were analysed for actinide isotopic content by ICPMS and calibrated against traceable reference standards.

Analytical Results are detailed below:

**2.0 Results:**

**2.1 Alpha Spectroscopy Analysis:**

All results are expressed as Bq.g<sup>-1</sup>

Analytical I.D	G1114	G1115	G1116
Client I.D	01/01T	02/01T	03/01T
Sample Description	Solid Metal Sample	Solid Metal Sample	Solid Metal Sample
Pu-242	<0.007	0.045±0.018	0.023±0.014
Pu-239/240	0.141±0.031	0.138±0.032	1.172±0.112
Pu-238	0.011±0.009	0.124±0.030	0.037±0.018
U-232	<0.26	<0.40	<0.75
U-234	1375±45	1485±47	1483±43
U-235	151±8	160±8	168±8
U-238	11888±348	12060±324	11882±307
Am-243	0.090±0.027	<0.011	0.089±0.025
Am-241	0.161±0.036	0.186±0.029	0.276±0.044

All errors are quoted at the 2-sigma level of uncertainty based on counting statistics. All limits of detection reported at the 3-sigma level of uncertainty based on counting statistics.

All positive results expressed at the 2-sigma level of uncertainty (95% confidence level) based on counting statistics.

**2.2 ICPMS Isotopic Analysis:**

All results expressed as wt/wt.

Analytical I.D	G1114	G1115	G1116
Client I.D	01/01T	02/01T	03/01T
U-232	<10 ppm	<10 ppm	<10 ppm
U-234	<100 ppm	<100 ppm	<100 ppm
U-235	0.18%	0.20%	0.20%
U-236	<100 ppm	<100 ppm	<100 ppm
U-238	99.81%	99.79%	99.80%
Pu-239	<100 ppm	<100 ppm	<100 ppm
Pu-240	<10 ppm	<10 ppm	<10 ppm
Pu-242	<10 ppm	<10 ppm	<10 ppm
Th-228	<1 ppm	<1 ppm	<1 ppm
Np-237	<10 ppm	<10 ppm	<10 ppm

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Analytical I.D	G1114	G1115	G1116
Client I.D	01/01T	02/01T	03/01T
Level of Enrichment by Alpha Spectrometry (%)	0.20	0.21	0.22
Level of Enrichment by ICPMS (%)	0.18	0.20	0.20

The level of enrichment is the ratio by mass of U-235:U-238 expressed as a percentage.

Author:



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D Rishehri

Date: 11/01/02

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