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DCNL 4-Hour Report

N. E. Marks

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APEX GOLD

Delegate's Country National Laboratory - Nuclear Forensics Laboratory Brinia Seized Material 4-Hour Report

(Mock Data Report for Training Use Only)

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APEX GOLD

Delegate's Country National Laboratory - Nuclear Forensics Laboratory Brinia Seized Material 4-Hour Report

Laboratory: Delegate Country National Laboratory-Nuclear Forensics Laboratory

Code Name: Brinia Samples (BRS)

Current Status: Categorization is complete. Sample DCNL-BRS-001 is weapons-usable, highly enriched uranium with a ^{235}U isotopic abundance of 89.9 ± 2 % (1-standard deviation). The sample is solid and cylindrical, apparently metallic with a slightly oxidized appearance. The sample is approximately 11 mm in diameter and 13 mm in height. Sample DCNL-BRS-001 is consistent with data provided by the Spring Hill Fuel Fabrication Facility in Brinia for material historically produced at that site.

Potential Issues: The current analytical plan calls for division of the solid samples into 4 pieces: one for radiochemical analysis, one for mass spectrometry analysis, one for metallurgical analysis, and one for archiving. Due to the somewhat irregular shape of Sample DCNL-BRS-001, it may be difficult to obtain equal sized pieces from this sample. Additional forensic measurements will be required to definitively confirm the origin of sample DCNL-BRS-001.

Delivery Details

Shipment arrived at DCNL Materials Management: 28 January 2016
Samples delivered to DCNL Nuclear Forensics Team: 28 January 2016
Package Opened/Exercise Started/Chain of Custody Initiated: 14:45/ 28 January 2016

Sample Identification

Chain-of-custody was initiated on the sample in the container marked Brinia Siezure as "DCNL-BRS-001."

Initial Inspection and Photo Documentation

Figure 1 The samples arrived in a sealed can from the Brinia Law Enforcement Agency

Samples BRS-001 is a solid, roughly puck-shaped object.

Sample	Height	Diameter	Mass
	mm	mm	g
DCNL-BRS-001	13.24	11.29	101.4326

Sample DCNL-BRS-001 appears approximately cylindrical and appears to have been cracked on the top surface. Sample DCNL-BRS-001 appeared to have a slightly oxidized surface, and had some faint scratch or tool marks. Photos of the sample are below.

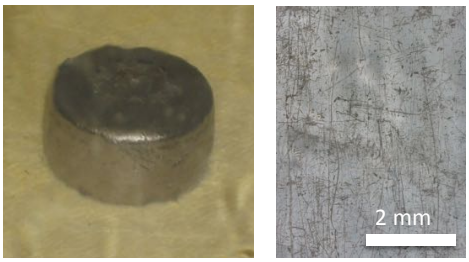

Figure 2 (Left) Sample DCNL-BRS-001 unknown "chunk" of HEU material seized at the Brinia border crossing. Sample appears somewhat oxidized and has faint scratch or tool marks. (Right) close up of sample surface showing oxidation and scratch marks.

Whole Sample Gamma Spectrometry Results

Whole Sample Gamma Spectrometry was performed for initial categorization only. Higher accuracy and precision data from whole solution gamma spectrometry and inductively coupled plasma/mass spectrometry will be provided in subsequent reporting.

Typical gamma-ray data collected using the safeguards type HPGe detection system are shown in Figure 3; the strong 185.7-keV gamma-ray (from U-235 decay) compared to the weak 1001-keV gamma-ray (from the decay of U-238 daughter) provide an indication the uranium in this sample is highly enriched with the assumption the uranium was not separated recently (i.e., the Th and Pa daughters are in equilibrium with the U-238 parent.)

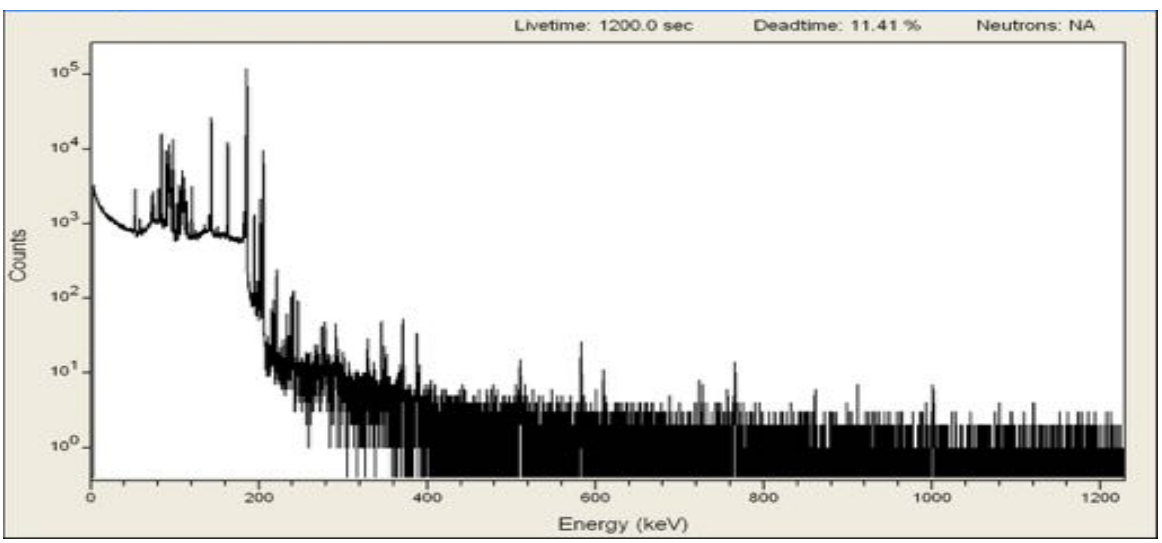

Figure 3 Typical gamma-ray data from sample DCNL-BRS-001 showing characteristic U235 peak at 185.7-keV

Figure 4 shows an overlay of gamma-ray data from sample DCNL-BRS-001 and gamma-ray data provided by the Spring Hill Fuel Fabrication Facility. Although the spectra differ slightly, they are similar within counting statistics, suggesting that the uranium in these samples similarly enriched.

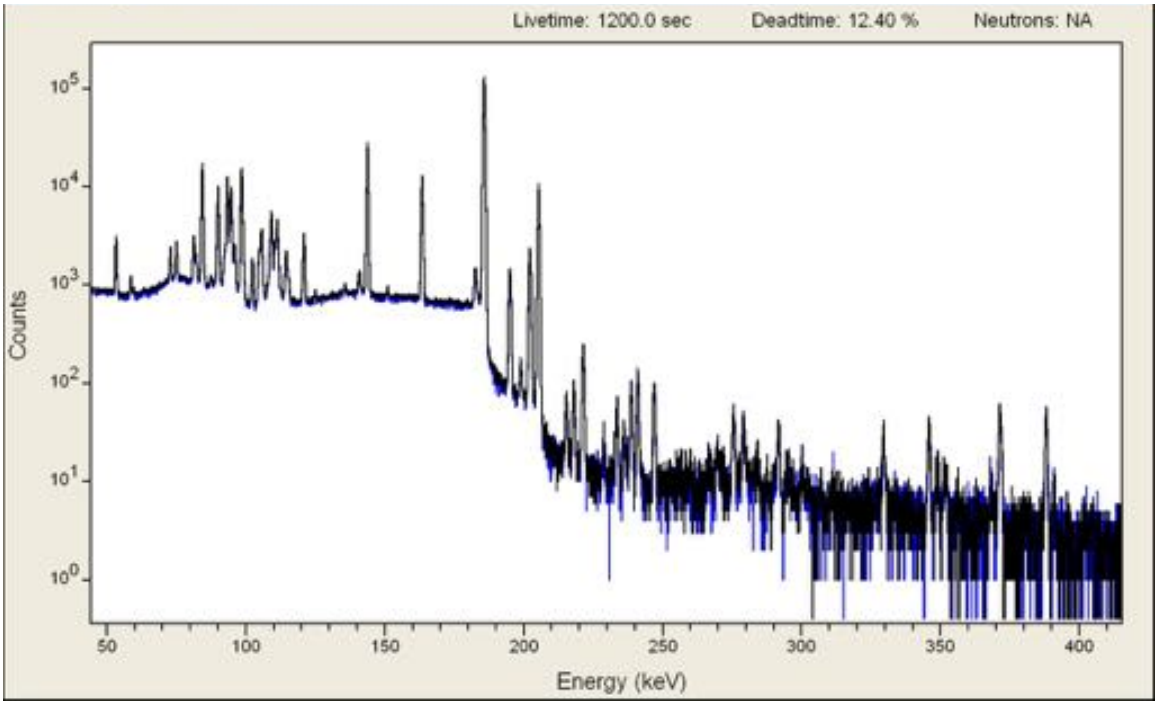

Figure 4 Overlay of gamma-ray data from DCNL-BRS-001 (unknown seized sample) and data provided by the Spring Hill Fuel Fabrication Facility. Data from these materials differ slightly but are similar within analytical uncertainty. Note characteristic U235 peak at 185.7-keV

The gamma ray day collected from the DCNL-BRS-001 sample was compared to the 100 keV gamma-ray data for very highly enriched uranium (HEU, >90% U-235). The results indicate average 235U concentration of (89.9 ± 2) %. This is comparable to the stated enrichment of materials at the Spring Hill Fuel Fabrication Facility (90.0 ± 2) %. The enrichment in these samples is identical within analytical uncertainty.

Table 1 Isotopic ratios measured by 1-hr gamma spec compared to Data provided by the Spring Hill Fuel Fabrication Facility in Brinia

	BRS-001	Uncertainty	Spring Hill Typical Material	Exp. Uncert. (k=2)	
grams 235U	89.9	2.10%	0.9957	0.0025	U (g) / Metal (g)
atom ratios					

232U/235U	1.58E-10	6.30%	1.22E-10	5.7E-11
233U/235U	<1.0E-4		4.71E-07	4.40E-08
234U/235U	3.37E-03	15%	0.00289	4.30E-06
238U/235U	1.09E-01	26%	0.10900	0.000066
237Np/235U	4.17E-06	9%	4.58E-06	8.27E-08
231Pa/235U	<1.2E-7		<1.3E-7	
239Pu/235U	<5E-5		<1.1E-4	
235U enrichment	89.9%	2%	90.0%	2%

Bulk Composition by Handheld XRF

Samples DCNL-BRS-001 was subjected to chemical analysis by handheld XRF to determine rapid bulk compositional information (Table 2). Sample DCNL-BRS-001 is primarily U metal, with trace tungsten, Nb, and gold. No other major elements were present in this sample. The sample was compared to trace element quality control data provided by the Spring Hill Fuel Fabrication Facility. These values are tabulated in Table 3.

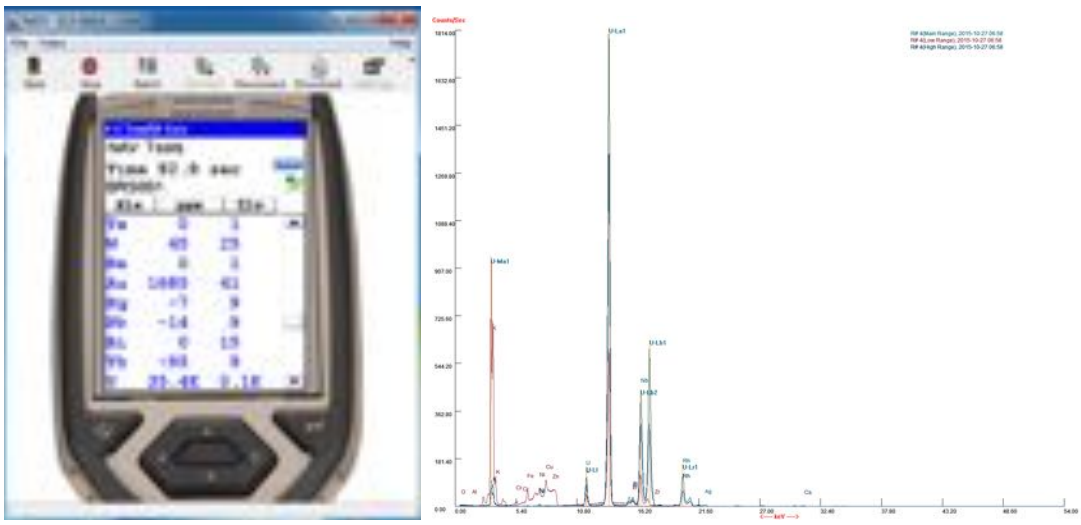

Figure 5 Data from handheld XRF showing a primarily U metal composition with minor alloying elements present.

Table 2 Semi-quantitative XRF data

	BRS-001 ppm	Error 1σ
As	8.5	5.5
Au	1685.5	41.5
Co	92.4	23.0
Cu	48.3	12.3
Mn	117.7	36.3
Nb	2732.8	29.5
Ni	103.5	21.8
Pd	143.5	4.7
Sc	994.0	24.8
Ti	1390.5	48.6
U	35410.7	121.2
W	45.2	25.5
Zn	312.4	11.7

Table 3 Quality Control Data provided for materials from the Spring Hill Fuel Fabrication Facility (SHFF).

Element	SHFF	uncert. k=2	Element	SHFF	uncert. k=2	Element	SHFF	uncert. k=2	Element	SHFF	uncert. k=2
Ag	< 0.009	---	**Fe**	1	0	**Ni**	86.03	3.14	**Th**	< 0.015	---
Al	3	1	**Ga**	< 0.06	---	**Pb**	< 0.037	---	**Ti**	1429	3.8
As	4.12	0.45	**Gd**	< 0.006	---	**Pd**	139.7	0.04	**Tl**	< 0.015	---
Au	1718.634	4	**Ge**	< 0.27	---	**Pr**	< 0.002	---	**Tm**	< 0.006	---
Ba	< 0.054	---	**Hf**	< 0.052	---	**Pt**	0.4	0.1	**V**	1.2	0.6
Be	< 0.006	---	**Ho**	< 0.0024	---	**Rb**	< 0.029	---	**W**	24.8	0.5
Ca	< 2.7	---	**Ir**	0.35	0.03	**Re**	1.2	0.1	**Y**	< 0.0024	---
Cd	< 0.069	---	**K**	< 6	---	**Rh**	< 0.052	---	**Yb**	< 0.006	---
Ce	< 0.0024	---	**La**	< 0.012	---	**Ru**	< 0.027	---	**Zn**	303.05	0.12
Co	74.012	0.18	**Lu**	< 0.0024	---	**Sb**	< 0.036	---	**Zr**	10.5	0.5
Cr	23	3	**Mg**	< 0.36	---	**Se**	< 0.09	---			
Cs	< 0.031	---	**Mn**	146.7	0.93	**Sm**	< 0.015	---			
Cu	38.438	1.31	**Mo**	51	1	**Sn**	< 0.178	---			
Dy	< 0.012	---	**Na**	< 84	---	**Sr**	< 0.009	---			
Er	0.45	0.04	**Nb**	2756.38	0.1	**Ta**	0.594	---			
Eu	< 0.0048	---	**Nd**	< 0.009	---	**Tb**	< 0.002	---			

Technical Interpretation

Note: Technical interpretations are technical judgments based upon current results and will evolve as more results are obtained.

The material is HEU of (89.9 ± 2%) ^{235}U isotopic abundance. The $^{234}U/^{235}U$ ratio indicates likely isotopic enrichment via a gaseous diffusion or centrifuge process, rather than electromagnetic or laser isotope separation. The presence of ^{232}U and ^{237}Np indicates that some of the enrichment feed stock was irradiated in a reactor, which is more consistent with known gaseous diffusion operations. The Np presence is consistent with some Brinia HEU samples. The seized U material (DCNL-BRS-001) appears generally consistent with data provided for material produced at the Spring Hill Fuel Fabrication Facility in Brinia, however further forensics investigation will be required to definitively confirm the origin of DCNL-BRS-001. Additional analyses will include mass spectrometry, and these additional measurements will take up to three weeks.

Appendix A
Chain of Custody Forms

1. Title to the Nuclear material as listed below has been transferred	2. Title to the Nuclear Material as listed below is transferred to DCAL and dispatch for transport has been accepted by the Operator/Authorized Offical at the Facility	3. Package identification Transport Container type	5. Samples received at
From: Facility Name: MBA code: Brinin State Dhlm Country:	Bilcrand Underhill Operator/Authorized Offical at the Facility	Type A GB/2904 Total No. of Packages 1 Cusotdy Seal No. 5551212	Date Facility Operator State Authority Consignee
To: Delagate Country Analtycial Laboratory 6022 Avogadro Street 123-NEM Delagate City, DELAGATE COUNTRY	Date 2016/27/15	4. Expected Shipment date	(Signature)
End user: Delagate Country Analytical Lab -Nuclear forensics Lab	Signature	Means of transport ☐ air ☐ sea ☒ land	

	6	7	8			9					10
	Batch/ Item ID	Sample Bottle No.	Description of Material in the Sample			Amount of Material in the Sample					Activity (MBq)
			Physical Form	Chemical Form	Special Properties	U total (g)	U fissle (g)	Pu (g)	Pu total (g)	Th (g)	
1	Chunk Sample	1	Solid	Unetal	HEU	102 g	90 g				~7 MBq
2											
3											
4											
5											
6											
7											
8											
9											
10											
						102 g	90 g				7 MBq

Brinia Bureau of Investigation
EVIDENCE CHAIN-OF-CUSTODY

Evidence Type: ☒ General ☐ Drug ☐ Valuable RADIOACTIVE

Special Handling Instructions	Initial Receipt	Date and Time
☐ Batteries ☐ Bulletins ☐ Computer ☐ PDF ☐ Firearms ☒ RADIAT ☐ Lasers ☐ Refrigerate ☐ Requires Charging ☐ Other _____ ☐ None	Signature: [signature] Printed Name: [illegible] ☐ Collected at Scene ☐ Recovered ☐ Seized ☐ Constituted	27/15/2016

Relinquished Custody	Accepted Custody	Date and Time
Signature: [signature]	Signature: [signature]	27/15/2016
Printed Name: [illegible]	Printed Name: [illegible]	
Reason:	Reason: [illegible]	

Relinquished Custody	Accepted Custody	Date and Time
Signature: [signature]	Signature: [signature]	27/15/2016
Printed Name: [illegible]	Printed Name: [illegible]	
Reason: [illegible]	Reason:	

Relinquished Custody	Accepted Custody	Date and Time
Signature:	Signature:	
Printed Name:	Printed Name:	
Reason:	Reason:	

Relinquished Custody	Accepted Custody	Date and Time
Signature:	Signature:	
Printed Name:	Printed Name:	
Reason:	Reason:	

Relinquished Custody	Accepted Custody	Date and Time
Signature:	Signature:	
Printed Name:	Printed Name:	
Reason:	Reason:	

Firearms Certification
Printed Name _____ Signature _____ Date _____

Case ID: _____ ID: _____ Barcode _____

Appendix B

Data Transferred from Spring Hill Fuel Fabrication Facilty in Brinia

From: underhill23@springhill.co.bx
To: twhitfoot@dcnl.co.dc
Subject: Production QA/QC data
Attachment: raw_gamma_spec.xls

Dear Dr. Whitfoot,

The following analytical data is available for the material in recent production at the Spring Hill Fuel Fabrication Facility. I have also attached the raw gamma spectrum from material produced in our facility. Feel free to contact me with any questions.

Sincerely,

Bilcuzal Underhill
Quality Control/Quality Assurance Manager
Spring Hill Fuel Fabrication Facility
R Fontainhas 115
7638-038, Brejo Kaas, BRINIA

TYPICAL PRODUCT COMPOSITION

HEU metal pucks 15.15 mm height, 11.3 mm diameter, ± .2 mm tolerance in either dimension

Typical puck mass is 105 g ± 1 g

U Assay	0.9957	0.0025	U (g) / Metal (g)
atom ratios			
232U/235U	1.22E-10	5.7E-11	
233U/235U	4.40E-08		
234U/235U	0.00289	4.30E-06	
238U/235U	0.10900	0.000066	
237Np/235U	4.58E-06	8.27E-08	
231Pa/235U	<1.3E-7		
239Pu/235U	<1.1E-4		

235U enrichment 90.0% 2%

Trace elements

Element	QA/QC	uncert. k=2
Ag	< 0.009	---
Al	3	1
As	4.12	0.45
Au	1718.634	4
Ba	< 0.054	---
Be	< 0.006	---
Ca	< 2.7	---
Cd	< 0.069	---
Ce	< 0.0024	---
Co	74.012	0.18302521
Cr	23	3
Cs	< 0.031	---
Cu	38.438	1.362079511
Dy	< 0.012	---
Er	0.45	0.04
Eu	< 0.0048	---
Fe	1	0
Ga	< 0.06	---
Gd	< 0.006	---
Ge	< 0.27	---
Hf	< 0.052	---
Ho	< 0.0024	---
Ir	0.35	0.03
K	< 6	---
La	< 0.012	---
Lu	< 0.0024	---
Mg	< 0.36	---
Mn	146.754	0.935455349
Mo	51	1
Na	< 84	---
Nb	2756.382	0.1
Nd	< 0.009	---
Ni	86.034	3.142490372
Pb	< 0.037	---

Pd	139.748	0.04
Pr	< 0.0024	---
Pt	0.4	0.1
Rb	< 0.029	---
Re	1.2	0.1
Rh	< 0.052	---
Ru	< 0.027	---
Sb	< 0.036	---
Se	< 0.09	---
Sm	< 0.015	---
Sn	< 0.178	---
Sr	< 0.009	---
Ta	0.594	---
Tb	< 0.0024	---
Th	< 0.015	---
Ti	1429.33	3.8
Tl	< 0.015	---
Tm	< 0.006	---
V	1.2	0.6
W	24.8	0.5
Y	< 0.0024	---
Yb	< 0.006	---
Zn	303.05	0.12
Zr	10	