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ORNL/TM-2011/127

Data Compilation for AGR-3/4 Matrix Ring Blank Lot RDKRS

John D. Hunn, Michael P. Trammell, and Fred C. Montgomery

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Advanced Gas Reactor Fuel Development Program

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Data Compilation for AGR-3/4 Matrix Ring Blank Lot RDKRS

John D. Hunn, Michael P. Trammell, and Fred C. Montgomery
Oak Ridge National Laboratory

This document is a compilation of compacting and characterization data for the matrix ring blank lot RDKRS. These ring blanks were made using Hexion Durite SC-1008 resin mixed with natural and synthetic graphite flake. The 26 mm diameter, 63 mm long solid cylindrical ring blanks were shipped from Oak Ridge National Laboratory (ORNL) to Idaho National Laboratory (INL) for machining and insertion into the Advanced Gas Reactor Fuel Development and Qualification (AGR) program's third irradiation test (AGR-3/4).

In the AGR-3/4 irradiation experiment, each 12.3 mm diameter, 12.5 mm long cylindrical fuel compact will contain twenty designed-to-fail (DTF) particles distributed along the centerline of the compact. The DTF coating is a high density, high anisotropy pyrocarbon coating of nominal 20 μm thickness that is deposited directly on the kernel. This coating is designed to fail early in the AGR-3/4 irradiation test, resulting in a controlled release of fission products which can be analyzed to provide data on fission product transport. The DTF will be surrounded by standard tristructural isotropic (TRISO) "driver fuel" particles. Information on the DTF and driver fuel particles can be found in ORNL/TM-2011-109 " Data Compilation for AGR-3/4 Designed-to-Fail (DTF) Fuel Particle Batch LEU03-07DTF " and ORNL/TM-2007/019, "Data Compilation for AGR-3/4 Driver Fuel Coated Particle Composite LEU03-09T." Information on the fuel compacts can be found in ORNL/TM-2011/124, "Data Compilation for AGR-3/4 Designed-to-Fail (DTF) Fuel Compact Lot (LEU03-10T-OP2/LEU03-07DTF-OP1)-Z"

Each irradiation test capsule will contain four compacts stacked in a single column. Matrix ring blanks will be machined with a center bore diameter ~100-150 μm larger than the diameter of the fuel compacts, so that the fuel stack can be placed inside the matrix ring. The outer diameter and length of matrix rings will also be machined. A graphite sleeve will be machined to surround the matrix ring. During irradiation, fission products will migrate out of the compact into these surrounding matrix and graphite rings.

The matrix ring blank lot, RDKRS, was determined to meet the product specifications for compact matrix ring blanks in section 5 of the AGR-3/4 DTF Fuel and Capsule Component Material Specifications (SPC-1214, Rev. 0). Table 1 provides a summary of key properties of the ring blanks.

Table 1. Summary of key ring blank properties in comparison to product specifications.

Specified Parameters		RDKRS Ring Blanks	
		mean	standard deviation
Blank outer diameter (mm)	26.0 ± 1	26.01	0.03
Blank length (mm)	63.0 ± 2	62.9	0.2
Blank matrix density (g/cc)	1.60 ± 0.1	1.621	0.010
Heavy metal contamination (ppmw U)	≤ 0.5	0.016	0.003

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1 Material Identification Record for RDKRS Ring Blanks

Table 2 lists the materials used to make the RDKRS ring blanks, including intermediate batches and samples used for characterization. Thirty completed ring blanks were shipped to INL in February, 2011. Eight ring blanks were retained at ORNL and 12 ring blanks were consumed at ORNL by the QC acceptance testing. Table 3 lists the disposition of each ring blank.

Table 2. Material identification record for ring blank lot RDKRS

Sample ID	Parent Material	Notes
RD13371	Asbury Graphite Mills	Natural graphite
KRB2000	SGL Carbon	Synthetic graphite
SC1008	Hexion	Durite resin lot LKOLA7410
RDKrS-0121211	64 wt% RD13371 16 wt% KRB2000 20 wt% SC1008	Graphite/resin blend
RDKRS-G###	RDKrS-0121211	Ring blanks numbered G001 through G050
RDKRS-Z###	RDKRS-G###	Ring blanks, numbered Z001 through Z050 One to one correspondence to G### recorded on IRF20C (section 4)

Table 3. Disposition of RDKRS ring blanks

Sent to INL		Retained at ORNL	Consumed during analysis
RDKRS-Z001	RDKRS-Z024	RDKRS-Z006	RDKRS-Z003
RDKRS-Z002	RDKRS-Z028	RDKRS-Z008	RDKRS-Z014
RDKRS-Z004	RDKRS-Z029	RDKRS-Z012	RDKRS-Z015
RDKRS-Z005	RDKRS-Z031	RDKRS-Z016	RDKRS-Z019
RDKRS-Z007	RDKRS-Z032	RDKRS-Z030	RDKRS-Z025
RDKRS-Z009	RDKRS-Z033	RDKRS-Z038	RDKRS-Z026
RDKRS-Z010	RDKRS-Z034	RDKRS-Z049	RDKRS-Z027
RDKRS-Z011	RDKRS-Z037	RDKRS-Z050	RDKRS-Z035
RDKRS-Z013	RDKRS-Z039		RDKRS-Z036
RDKRS-Z017	RDKRS-Z042		RDKRS-Z040
RDKRS-Z018	RDKRS-Z043		RDKRS-Z041
RDKRS-Z020	RDKRS-Z045		RDKRS-Z044
RDKRS-Z021	RDKRS-Z046		
RDKRS-Z022	RDKRS-Z047		
RDKRS-Z023	RDKRS-Z048		

2 Fabrication of RDKRS Ring Blanks

Natural graphite (Asbury Graphite Mills RD13371), synthetic graphite (SGL Carbon KRB2000), and thermosetting resin (Hexion Durite SC1008-lot LKOLA7410) were combined in a weight ratio of 64:16:20 to make a matrix precursor graphite/resin blend. The blend was solvated with ethyl alcohol, mixed thoroughly, poured into pans, and allowed to dry. After drying, the caked powder was pulverized using a Holmes pulverizer. This process produced resin-coated (i.e., resinated) graphite particles. In order to ensure uniformity, one single batch of the graphite/resin blend (RDKrS-0121211) was produced for the fabrication of all the RDKRS ring blanks.

Compacting charges of the graphite/resin blend were weighed out and labeled RDKRS-G001 through G050. The compacting charges were formed into "green" ring blanks using a heated, single acting die and a manually operated Carver hydraulic press. Compacting was performed in accordance with AGR-COMP-SOP-11R0, "Standard Operating Procedures for Production of AGR 3/4 Matrix Ring Blanks." The compacting die, top punch, and bottom punch were heated to 50°C. With all parts at temperature and the bottom punch in place, the pre-measured compacting charge was poured into the die. The top punch was then inserted and compaction was initiated. A dial gauge was used to monitor the distance between the press platens during compaction. A target distance was predetermined during compacting development, which would yield ring blanks of the desired length after shrinkage during carbonization of the resin. Once this target distance was reached, pressing was halted and the ring blank was held in the die for an additional 5 minutes before ejecting from the die. The maximum pressure required to compact the ring blanks ranged from 9-15 MPa. The specific maximum pressure applied to each ring blank is recorded in Table 4. In total, 50 green ring blanks were fabricated. The green ring blanks retained the material designation of RDKRS-G001 through G050.

All 50 green ring blanks were carbonized and heat treated according to AGR-COMP-SOP-04R0, "Standard Operating Procedure for Carbonizing Compacts," and AGR-COMP-SOP-05R1, "Standard Operating Procedure for Heat-treating Compacts." Table 4 shows the process conditions used. Green ring blanks were slowly heated at 2ºC/min to 950°C in flowing helium atmosphere and then held at 950°C for 1 hour. The heating rate was less than used for smaller diameter AGR fuel compacts (~5ºC/min), because extra time was needed to allow evolved gases to diffuse out of the larger ring blank cylinders and prevent cracking. The carbonization furnace was allowed to cool to room temperature under no power before removing ring blanks for transfer to the heat-treatment furnace. Heat-treatment was performed under vacuum after back-filling with argon three times. Using the standard AGR compact heat-treatment process, carbonized ring blanks were heated at 20°C/min to 1800°C, held for 1 hour, cooled at <20°C/min to 700°C, then cooled under no power to room temperature before removing.

After heat-treatment, all 50 ring blanks were selected from RDKRS-G001 through G050 for use. As instructed in AGR-CHAR-PIP-20R1, "Product Inspection Plan for AGR-3/4 Ring Blank Lots," these 50 ring blanks were randomized and relabeled as RDKRS-Z001 through Z050. A record of the original G-number for each Z-numbered ring blank can be found in inspection report form IRF-20C (section 4). After relabeling, the ring blanks were characterized for product acceptance according to product inspection plan PIP-20. This plan calls for measurement of ring blank length, diameter, mass, matrix density, uranium content and impurity content.

Table 4. Summary of process conditions used in making RDKRS-Z ring blanks

Ring blank ID	Compacting and carbonization parameters					Heat-treatment parameters			
	Max. Pressure (MPa)	Heating Rate (°C/min)	Max. Temp. (°C)	Hold Time (hr)	Atmosphere	Heating Rate (°C/min)	Max. Temp. (°C)	Hold Time (hr)	Atmosphere
RDKRS-Z001	10.7	2	950	1	flowing He	20	1800	1	vacuum
RDKRS-Z002	11.3	2	950	1	flowing He	20	1800	1	vacuum
RDKRS-Z003	12.1	2	950	1	flowing He	20	1800	1	vacuum
RDKRS-Z004	12.7	2	950	1	flowing He	20	1800	1	vacuum
RDKRS-Z005	9.9	2	950	1	flowing He	20	1800	1	vacuum
RDKRS-Z006	12.5	2	950	1	flowing He	20	1800	1	vacuum
RDKRS-Z007	9.9	2	950	1	flowing He	20	1800	1	vacuum
RDKRS-Z008	10.0	2	950	1	flowing He	20	1800	1	vacuum
RDKRS-Z009	9.8	2	950	1	flowing He	20	1800	1	vacuum
RDKRS-Z010	14.3	2	950	1	flowing He	20	1800	1	vacuum
RDKRS-Z011	10.0	2	950	1	flowing He	20	1800	1	vacuum
RDKRS-Z012	9.9	2	950	1	flowing He	20	1800	1	vacuum
RDKRS-Z013	9.2	2	950	1	flowing He	20	1800	1	vacuum
RDKRS-Z014	12.2	2	950	1	flowing He	20	1800	1	vacuum
RDKRS-Z015	11.2	2	950	1	flowing He	20	1800	1	vacuum
RDKRS-Z016	9.5	2	950	1	flowing He	20	1800	1	vacuum
RDKRS-Z017	9.8	2	950	1	flowing He	20	1800	1	vacuum
RDKRS-Z018	9.6	2	950	1	flowing He	20	1800	1	vacuum
RDKRS-Z019	10.0	2	950	1	flowing He	20	1800	1	vacuum
RDKRS-Z020	9.8	2	950	1	flowing He	20	1800	1	vacuum
RDKRS-Z021	12.4	2	950	1	flowing He	20	1800	1	vacuum
RDKRS-Z022	9.9	2	950	1	flowing He	20	1800	1	vacuum
RDKRS-Z023	10.4	2	950	1	flowing He	20	1800	1	vacuum
RDKRS-Z024	10.3	2	950	1	flowing He	20	1800	1	vacuum
RDKRS-Z025	9.2	2	950	1	flowing He	20	1800	1	vacuum

Task Manager Review Michael Trammell Date 5/17/11

QAS Review Date 5/17/11

Table 4 (continued). Summary of process conditions used in making RDKRS-Z ring blanks

Ring blank ID	Compacting and carbonization parameters					Heat-treatment parameters			
	Max. Pressure (MPa)	Heating Rate (°C/min)	Max. Temp. (°C)	Hold Time (hr)	Atmosphere	Heating Rate (°C/min)	Max. Temp. (°C)	Hold Time (hr)	Atmosphere
RDKRS-Z026	10.7	2	950	1	flowing He	20	1800	1	vacuum
RDKRS-Z027	12.2	2	950	1	flowing He	20	1800	1	vacuum
RDKRS-Z028	13.3	2	950	1	flowing He	20	1800	1	vacuum
RDKRS-Z029	9.9	2	950	1	flowing He	20	1800	1	vacuum
RDKRS-Z030	9.4	2	950	1	flowing He	20	1800	1	vacuum
RDKRS-Z031	11.4	2	950	1	flowing He	20	1800	1	vacuum
RDKRS-Z032	12.3	2	950	1	flowing He	20	1800	1	vacuum
RDKRS-Z033	9.0	2	950	1	flowing He	20	1800	1	vacuum
RDKRS-Z034	13.7	2	950	1	flowing He	20	1800	1	vacuum
RDKRS-Z035	13.9	2	950	1	flowing He	20	1800	1	vacuum
RDKRS-Z036	12.6	2	950	1	flowing He	20	1800	1	vacuum
RDKRS-Z037	9.5	2	950	1	flowing He	20	1800	1	vacuum
RDKRS-Z038	12.2	2	950	1	flowing He	20	1800	1	vacuum
RDKRS-Z039	13.2	2	950	1	flowing He	20	1800	1	vacuum
RDKRS-Z040	9.6	2	950	1	flowing He	20	1800	1	vacuum
RDKRS-Z041	13.1	2	950	1	flowing He	20	1800	1	vacuum
RDKRS-Z042	10.0	2	950	1	flowing He	20	1800	1	vacuum
RDKRS-Z043	10.9	2	950	1	flowing He	20	1800	1	vacuum
RDKRS-Z044	9.5	2	950	1	flowing He	20	1800	1	vacuum
RDKRS-Z045	11.6	2	950	1	flowing He	20	1800	1	vacuum
RDKRS-Z046	10.2	2	950	1	flowing He	20	1800	1	vacuum
RDKRS-Z047	9.9	2	950	1	flowing He	20	1800	1	vacuum
RDKRS-Z048	9.5	2	950	1	flowing He	20	1800	1	vacuum
RDKRS-Z049	9.8	2	950	1	flowing He	20	1800	1	vacuum
RDKRS-Z050	10.0	2	950	1	flowing He	20	1800	1	vacuum

Task Manager Review Michael Snead Date 5/17/11

QAS Review Date 5/17/11

3 Impurity Analysis of Matrix, Resin, and Graphite

The AGR-3/4 Fuel Specification (SPC-1214, Rev. 0) specifies maximum limits on the elemental impurities Al, Ca, Ti + V, Cr, Mn, Fe, Co, Ni, and U. The natural graphite, synthetic graphite, and thermosetting resin used to make the matrix often contain measurable amounts of these impurities. It is beneficial if the graphite and resin have low concentrations of the impurities of interest to help ensure that the ring blanks made from the graphite/resin blend will be within specification. Part of the compacting development effort was selection of the natural graphite, synthetic graphite, and resin. One criterion for the acceptability of the graphite or resin was if it could produce a ring blank that was within specification on impurities. The selection process included receiving natural graphite and synthetic graphite and testing them via glow discharge mass spectrometry (GDMS) in order to establish their initial impurity concentrations. In addition to the as-received graphite samples, both the resin alone and the graphite/resin blend were carbonized and the carbonized powder was also measured by GDMS.

Table 5 is a summary of the as-received impurity levels for the natural graphite and synthetic graphite that were used to make the RDKRS ring blanks, as well as the impurity levels for the carbonized samples of the resin and the RDKrS-0121211 graphite/resin blend. All the specified impurities for all the components were below the specified limits.

Table 5. Matrix constituents that were used in AGR-3/4 RDKRS ring blanks

Element	Impurity concentration (ppm-wt)				
	Specification	Natural Graphite RD13371	Synthetic Graphite KRB2000	Carbonized Resin Durite SC-1008	Carbonized Matrix RDKrS-0121211
Al	≤ 20	8.3	0.13	3.3	4.3
Ca	≤ 45	10	0.31	3.1	4.8
Ti + V	≤ 85	1.01	<0.07	0.14	0.29
Cr	≤ 10	< 0.5	< 0.5	< 0.5	< 0.5
Mn	≤ 10	0.29	< 0.05	0.12	0.35
Fe	≤ 20	13	0.11	0.87	12
Co	≤ 10	< 0.05	< 0.05	< 0.05	< 0.05
Ni	≤ 10	1.4	0.12	0.33	0.18
U	≤ 0.5	< 0.05	< 0.05	< 0.05	< 0.05

The following pages show the impurity analysis reports for the natural graphite, synthetic graphite, resin, and matrix/resin blend samples listed in Table 5. Also attached is an additional certificate of analysis for the resin. Note that an expiration date of 6 months from the manufacture date was set for producing compacts from the resin. The resin manufacture date was 12/04/10 and RDKRS compacting was completed on 2/08/11.

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www.eaglabs.com

Customer: **UT-Battelle Oak Ridge** *P.O.#* **CC**
1 Bethel Valley Rd, Oak Ridge, TN 37823-6063 USA
Date: 24-Mar-11 *Job #* S0BCT802
Customer ID: **C powder** *Sample ID:* S110317086
RD# 13371

Element	Concentration [ppm wt]	Element	Concentration [ppm wt]
Li	0.02	Pd	< 0.1
Be	< 0.01	Ag	< 0.1
B	0.48	Cd	< 0.1
C	Matrix	In	Binder
N	-	Sn	< 0.5
O	-	Sb	< 0.5
F	=< 400	Te	< 0.1
Na	1.7	I	< 20
Mg	4.8	Cs	< 0.1
Al	8.3	Ba	19
Si	260	La	< 0.5
P	0.22	Ce	< 0.5
S	60	Pr	< 0.05
Cl	1.5	Nd	< 0.05
K	0.68	Sm	< 0.05
Ca	10	Eu	< 0.05
Sc	< 0.05	Gd	< 0.05
Ti	0.66	Tb	< 0.05
V	0.35	Dy	< 0.05
Cr	< 0.5	Ho	< 0.05
Mn	0.29	Er	< 0.05
Fe	13	Tm	< 0.05
Co	< 0.05	Yb	< 0.05
Ni	1.4	Lu	< 0.05
Cu	3.8	Hf	< 0.05
Zn	0.85	Ta	< 5
Ga	< 0.1	W	0.45
Ge	< 0.1	Re	< 0.05
As	< 0.1	Os	< 0.05
Se	< 0.1	Ir	< 0.05
Br	0.66	Pt	< 0.05
Rb	< 0.05	Au	< 0.1
Sr	0.14	Hg	< 0.5
Y	0.06	Tl	< 0.1
Zr	0.15	Pb	< 0.5
Nb	< 0.1	Bi	< 0.1
Mo	0.06	Th	< 0.05
Ru	< 0.1	U	< 0.05
Rh	< 0.1		

~ Semiquantitative Values

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Customer: **UT-Battelle Oak Ridge** *P.O.#* **CC**
1 Bethel Valley Rd, Oak Ridge, TN 37823-6063 USA
Date: 24-Mar-11 *Job #* S0BCT802
Customer ID: **C powder** *Sample ID:* S110317087
KRB 2000

Element	Concentration [ppm wt]	Element	Concentration [ppm wt]
Li	< 0.01	Pd	< 0.1
Be	< 0.01	Ag	< 0.1
B	0.19	Cd	< 0.1
C	Matrix	In	Binder
N	-	Sn	< 0.5
O	-	Sb	< 0.5
F	=< 10	Te	< 0.1
Na	0.92	I	< 20
Mg	< 0.5	Cs	< 0.1
Al	0.13	Ba	< 0.1
Si	3.1	La	< 0.5
P	< 0.1	Ce	< 0.5
S	5.4	Pr	< 0.05
Cl	9.3	Nd	< 0.05
K	< 0.1	Sm	< 0.05
Ca	0.31	Eu	< 0.05
Sc	< 0.05	Gd	< 0.05
Ti	0.06	Tb	< 0.05
V	< 0.01	Dy	< 0.05
Cr	< 0.5	Ho	< 0.05
Mn	< 0.05	Er	< 0.05
Fe	0.11	Tm	< 0.05
Co	< 0.05	Yb	< 0.05
Ni	0.12	Lu	< 0.05
Cu	< 0.1	Hf	< 0.05
Zn	< 0.1	Ta	< 5
Ga	< 0.1	W	0.09
Ge	< 0.1	Re	< 0.05
As	< 0.1	Os	< 0.05
Se	< 0.1	Ir	< 0.05
Br	< 0.1	Pt	< 0.05
Rb	< 0.05	Au	< 0.1
Sr	< 0.05	Hg	< 0.5
Y	< 0.05	Tl	< 0.1
Zr	< 0.05	Pb	< 0.5
Nb	< 0.1	Bi	< 0.1
Mo	< 0.05	Th	< 0.05
Ru	< 0.1	U	< 0.05
Rh	< 0.1		

~ Semiquantitative Values

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Accreditations: ISO/IEC 17025, Nadcap

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Customer: **UT-Battelle Oak Ridge** *P.O.#* **CC**
1 Bethel Valley Rd, Oak Ridge, TN 37823-6063 USA
Date: 24-Mar-11 *Job #* S0BCT802
Customer ID: **C powder** *Sample ID:* S110317088
Durite SC-1008

Element	Concentration [ppm wt]	Element	Concentration [ppm wt]
Li	0.42	Pd	< 0.1
Be	< 0.01	Ag	< 0.1
B	0.65	Cd	< 0.1
C	Matrix	In	Binder
N	-	Sn	< 0.5
O	-	Sb	< 0.5
F	=< 100	Te	< 0.1
Na	13	I	=< 30
Mg	0.84	Cs	< 0.1
Al	3.3	Ba	0.15
Si	14	La	=< 1
P	0.69	Ce	< 0.5
S	2.6	Pr	< 0.05
Cl	0.37	Nd	< 0.05
K	0.35	Sm	< 0.05
Ca	3.1	Eu	< 0.05
Sc	< 0.05	Gd	< 0.05
Ti	0.07	Tb	< 0.05
V	0.07	Dy	< 0.05
Cr	< 0.5	Ho	< 0.05
Mn	0.12	Er	< 0.05
Fe	0.87	Tm	< 0.05
Co	< 0.05	Yb	< 0.05
Ni	0.33	Lu	< 0.05
Cu	0.37	Hf	< 0.05
Zn	< 0.1	Ta	< 5
Ga	< 0.1	W	0.13
Ge	< 0.1	Re	< 0.05
As	< 0.1	Os	< 0.05
Se	< 0.1	Ir	< 0.05
Br	< 0.1	Pt	< 0.05
Rb	< 0.05	Au	< 0.1
Sr	< 0.05	Hg	< 0.5
Y	< 0.05	Tl	< 0.1
Zr	0.1	Pb	< 0.5
Nb	< 0.1	Bi	< 0.1
Mo	< 0.05	Th	< 0.05
Ru	< 0.1	U	< 0.05
Rh	< 0.1		

~ Semiquantitative Values

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Customer: **UT-Battelle Oak Ridge** *P.O.#* **CC**
1 Bethel Valley Rd, Oak Ridge, TN 37823-6063 USA
Date: 24-Mar-11 *Job #* S0BCT802
Customer ID: **C powder** *Sample ID:* S110317089
RDKRS 0121211

Element	Concentration [ppm wt]	Element	Concentration [ppm wt]
Li	0.05	Pd	< 0.1
Be	< 0.01	Ag	< 0.1
B	0.32	Cd	< 0.1
C	Matrix	In	Binder
N	-	Sn	< 0.5
O	-	Sb	< 0.5
F	< 5	Te	< 0.1
Na	0.82	I	< 20
Mg	3.5	Cs	< 0.1
Al	4.3	Ba	2.9
Si	190	La	< 0.5
P	0.42	Ce	< 0.5
S	30	Pr	< 0.05
Cl	0.89	Nd	< 0.05
K	< 0.1	Sm	< 0.05
Ca	4.8	Eu	< 0.05
Sc	< 0.05	Gd	< 0.05
Ti	0.27	Tb	< 0.05
V	0.02	Dy	< 0.05
Cr	< 0.5	Ho	< 0.05
Mn	0.35	Er	< 0.05
Fe	12	Tm	< 0.05
Co	< 0.05	Yb	< 0.05
Ni	0.18	Lu	< 0.05
Cu	0.28	Hf	< 0.05
Zn	< 0.1	Ta	< 5
Ga	< 0.1	W	0.18
Ge	< 0.1	Re	< 0.05
As	< 0.1	Os	< 0.05
Se	< 0.1	Ir	< 0.05
Br	< 0.1	Pt	< 0.05
Rb	< 0.05	Au	< 0.1
Sr	< 0.05	Hg	< 0.5
Y	< 0.05	Tl	< 0.1
Zr	< 0.05	Pb	< 0.5
Nb	< 0.1	Bi	< 0.1
Mo	0.05	Th	< 0.05
Ru	< 0.1	U	< 0.05
Rh	< 0.1		

~ Semiquantitative Values

J.SCHIEBLER (Analyst)

Accreditations: ISO/IEC 17025, Nadcap

Reviewed by

MOMENTIVE

Momentive Specialty Chemicals Inc.
Certificate of Analysis

Customer #: 32710
Customer Address:
CAPITAL RESIN CORPORATION
324 DERING AVENUE
COLUMBUS OH 43207
USA

Ship Date: 12/06/2010
DDN: 83099081
Customer - PO#: 901723
Date of MFG: 12/04/2010

Attention: KAY FREY
Customer Phone #: 614-445-7177
Customer Fax #: 614-445-7290

SAP Product #: 305922

Product Description: Durite(TM) SC-1008
DS3271/450#

Property	Value	Units	Specification Ranges		Test Method
Lot Number: I.K0LA7410					
pH, 25C	8.27		7.90	8.50	IR-034
Specific Gravity	1.0785		1.0700	1.1000	IR-026
Viscosity, Brookfield	220	cPs	180	300	IR-111
Solids, Phenolic (ISO)	60.36	%	60.00	64.00	IR-063

CERTIFICATE OF COMPLIANCE
It is hereby certified that Hexion's Phenolic Resin, SC-1008, shipped in this lot has been produced in accordance with Military specification (Resin, Phenolic, Laminating) MIL-R9299C, Grades A and B, dated December 3, 1968. It is recommended that SC-1008 be stored in a cool place. Storage life is materially increased by refrigerated storage. SC-1008 has a usable life of one month at 70 degrees F and six months at 40 degrees F.

Jeff A LaDuke
Quality Assurance

An ISO9001:2000 Certified Company

SHIPPED FROM: Momentive Specialty Chemicals • 6200 Campground Road
Louisville, KY 40216 • Phone: 502-449-6563

4 Characterization of RDKRS Ring Blanks

This section contains characterization data for the RDKRS ring blanks. The data was obtained according to product inspection plan AGR-CHAR-PIP-20R1, "Product Inspection Plan for AGR-3/4 Matrix Ring Blank Lots." The matrix ring blank lot, RDKRS, was determined to meet the product specifications for compact matrix ring blanks in section 5 of the AGR-3/4 DTF Fuel and Capsule Component Material Specifications (SPC-1214, Rev. 0).

After compacting, carbonization, and heat-treatment, all 50 ring blanks were selected for use from the production batch, RDKRS-G001 through G050. As instructed in product inspection plan PIP-20, these 50 ring blanks were randomized and relabeled as RDKRS-Z001 through Z050. A record of the original G-number for each Z-numbered ring blank can be found on inspection report form IRF-20C, in this section. After relabeling, the ring blanks were characterized for product acceptance according to PIP-20. This plan calls for measurement of length, diameter, mass, matrix density, uranium content, and impurity content. Length, diameter, and matrix density were measured on every ring blank. To measure uranium and other specified impurities, ring blanks were burned in air and the ash was leached twice by boiling nitric acid. The acid was analyzed by inductively-coupled plasma mass spectrometry (ICP-MS) to determine the concentration of each impurity. This burn-leach analysis was performed on 12 ring blanks, in four sample groups with 3 ring blanks in each sample group.

After the completion of burn-leach analysis per AGR-CHAR-DAM-44R0, a white ash residue remained in the leaching vessel. The weight of this residue from each sample group (63-66 mg) was noted on DRF-44. The observed residue was expected to be mostly SiO_2, which is insoluble in nitric acid. Glow discharge mass spectrometry analysis (Section 3) showed that the carbonized RDKrS-0121211 graphite/resin blend had a relatively high silicon content (190 ppm-wt), which mostly came from the natural graphite. Based on this silicon content in the graphite/resin blend, the expected mass of SiO_2 residue after burn-off of 3 ring blanks would be ~66 mg. This is consistent with the observed weight of the white ash residue remaining after burn-leach of each sample group of ring blanks. For the purpose of the acceptance testing, this ash residue was ignored. Additional analysis of the residue was performed later and is reported in Section 6. It was verified that Si was the major element in the residue and inclusion of the data for the specified impurities would not affect the results of the acceptance testing.

The following pages show the inspection report forms (IRF-20A, IRF-20B, and IRF-20C) for the RDKRS ring blanks. Following the inspection report forms are the individual data report forms for the measurements that were performed. Inspection report form IRF-20B summarizes the burn-leach results. Inspection report form IRF-20A summarizes all the analyses and provides the statistically calculated acceptance test values for the impurity analyses. These acceptance test values were calculated using a 95% confidence Student's-t test. Uranium and other impurities were compared against the specification and all values were found to be well below the specified limits. The overall average diameter, length, and matrix density for the ring blank lot are reported on IRF-20A, but the product compliance to these specified parameters was determined on an individual basis for each ring blank (see DRF-43). All ring blanks were within the specified range for mean diameter, length, and matrix density, therefore the ring blank lot met these specification with 100% confidence.

Inspection Report Form IRF-20A: AGR-3/4 Matrix Ring Blanks

Procedure:	AGR-CHAR-PIP-20 Rev. 1
Ring blank lot ID:	RDKRS
Ring blank lot description:	Matrix blend with Hexion Durite SC-1008 resin

Property	Measured Data				Specification	Acceptance Criteria	Acceptance Test Value	Pass or fail	Data Records
	Mean (x)	Std. Dev. (s)	Measurements (n)	Student's t value	INL SPC-1214 Revision 0				
Ring blank diameter (mm)	26.01	0.03	50		mean 26.0 ± 1.0	see DRF-43		pass	DRF-43
					dispersion 0% < 24.5	see DRF-43		pass	
Ring blank length (mm)	62.9	0.2	50		mean 63.0 ± 2.0	see DRF-43		pass	DRF-43
Ring blank matrix density (g/cm3)	1.621	0.010	50		mean 1.60 ± 0.1	see DRF-43		pass	DRF-43
					dispersion 0% < 1.5	see DRF-43		pass	
Iron content (ppmw)	0.06	0.03	4	2.353	mean ≤ 20	$B = x + ts/\sqrt{n} \leq 20$	0.10	pass	IRF-20B DRF-44
Chromium content (ppmw Fe)	0.0030	0.0003	4	2.353	mean ≤ 10	$B = x + ts/\sqrt{n} \leq 10$	0.00	pass	IRF-20B DRF-44
Manganese content (ppmw Mn)	0.0009	0.0001	4	2.353	mean ≤ 10	$B = x + ts/\sqrt{n} \leq 10$	0.00	pass	IRF-20B DRF-44
Cobalt content (ppmw Co)	0.0007	0.0001	4	2.353	mean ≤ 10	$B = x + ts/\sqrt{n} \leq 10$	0.00	pass	IRF-20B DRF-44
Nickel content (ppmw Ni)	0.0045	0.0002	4	2.353	mean ≤ 10	$B = x + ts/\sqrt{n} \leq 10$	0.00	pass	IRF-20B DRF-44
Calcium content (ppmw Ca)	3.7	0.3	4	2.353	mean ≤ 45	$B = x + ts/\sqrt{n} \leq 45$	4.05	pass	IRF-20B DRF-44
Aluminum content (ppmw Al)	1.11	0.12	4	2.353	mean ≤ 20	$B = x + ts/\sqrt{n} \leq 20$	1.25	pass	IRF-20B DRF-44
Titanium plus Vanadium content (ppmw total Ti+V)	1.75	0.05	4	2.353	mean ≤ 85	$B = x + ts/\sqrt{n} \leq 85$	1.81	pass	IRF-20B DRF-44
Uranium contamination (ppmw U)	0.016	0.003	4	2.353	mean ≤ 0.5	$B = x + ts/\sqrt{n} \leq 0.5$	0.020	pass	IRF-20B DRF-44

Comments

After burning and leaching with nitric acid, a white ash remained in the leach vessel. These impurity analysis results do not include content of this ash. This ash was probably mostly silica and will be analyzed separately.

John Kramer — **QC Supervisor**

5-16-11 — **Date**

Accept ring blank lot (Yes or No)?	**Yes**

M. Pa... — **QA Reviewer**

5/16/11 — **Date**

Inspection Report Form IRF-20B: Summary of Impurities in Ring Blanks

Procedure:	AGR-CHAR-PIP-20 Rev. 1
Operator:	Fred Montgomery
Ring blank lot ID:	RDKRS
Ring blank lot description:	Matrix blend with hexion Durite SC-1008 resin

Ring blank ID numbers:	Z026, Z015, Z014	Z003, Z041, Z025	Z035, Z027, Z040	Z019, Z036, Z044	Mean	Standard Deviation
Uranium					**Uranium**	
Average impurity content in ring blanks (ppmw)	0.016	0.020	0.014	0.014	0.016	0.003
Iron					**Iron**	
Average impurity content in ring blanks (ppmw)	< 0.048	< 0.052	< 0.041	0.101	< 0.06	0.03
Chromium					**Chromium**	
Average impurity content in ring blanks (ppmw)	< 0.0031	< 0.0034	< 0.0026	< 0.0029	< 0.0030	0.0003
Manganese					**Manganese**	
Average impurity content in ring blanks (ppmw)	< 0.0008	< 0.0008	< 0.0009	< 0.0010	< 0.0009	0.0001
Cobalt					**Cobalt**	
Average impurity content in ring blanks (ppmw)	< 0.0007	< 0.0007	< 0.0007	< 0.0008	< 0.0007	0.0001
Nickel					**Nickel**	
Average impurity content in ring blanks (ppmw)	< 0.0046	< 0.0045	< 0.0042	< 0.0048	< 0.0045	0.0002
Calcium					**Calcium**	
Average impurity content in ring blanks (ppmw)	3.574	3.483	3.731	4.188	3.7	0.3
Aluminum					**Aluminum**	
Average impurity content in ring blanks (ppmw)	1.218	1.168	0.934	1.134	1.11	0.12
Titanium					**Titanium**	
Average impurity content in ring blanks (ppmw)	0.567	0.551	0.576	0.614	0.58	0.03
Vanadium					**Vanadium**	
Average impurity content in ring blanks (ppmw)	1.149	1.164	1.152	1.215	1.17	0.03
Titanium plus Vanadium					**Titanium plus Vanadium**	
Average impurity content in ring blanks (ppmw)	1.715	1.716	1.728	1.829	1.75	0.05

Comments
After burning and leaching with nitric acid, a white ash remained in the leach vessel. This ash was probably mostly silica and will be analyzed separately.

QC Supervisor

5-16-11

Date

Inspection Report Form IRF-20C: Ring Blank Tracking

Procedure:	AGR-CHAR-PIP-20 Rev. 1
Ring blank lot ID:	RDKRS
Ring blank lot description:	Matrix blend with Hexion Durite SC-1008 resin

Ring Blank Z Number	Ring Blank G Number	Ring Blank Z Number	Ring Blank G Number	Ring Blank Z Number	Ring Blank G Number	Ring Blank Z Number	Ring Blank G Number
Z001	G016	Z016	G019	Z031	G033	Z046	G013
Z002	G042	Z017	G030	Z032	G044	Z047	G006
Z003	G031	Z018	G026	Z033	G023	Z048	G020
Z004	G036	Z019	G012	Z034	G048	Z049	G027
Z005	G007	Z020	G008	Z035	G038	Z050	G015
Z006	G050	Z021	G032	Z036	G047	Z051	
Z007	G017	Z022	G002	Z037	G029	Z052	
Z008	G009	Z023	G010	Z038	G040	Z053	
Z009	G001	Z024	G011	Z039	G037	Z054	
Z010	G039	Z025	G018	Z040	G024	Z055	
Z011	G004	Z026	G014	Z041	G045	Z056	
Z012	G005	Z027	G049	Z042	G003	Z057	
Z013	G021	Z028	G034	Z043	G041	Z058	
Z014	G035	Z029	G028	Z044	G025	Z059	
Z015	G046	Z030	G022	Z045	G043	Z060	

Comments

Operator	Date
[signature]	5-13-11

Data Report Form DRF-43: Matrix Ring Blank Diameter, Length, and Matrix Density

Procedure:	AGR-CHAR-DAM-43 Rev. 0
Operator:	Dunbar
Ring blank lot ID:	RDKRS
Ring blank lot description:	Matrix blend with Hexion Durite SC-1008 resin
Filename:	\\mc-agr\AGR\CompactDimensions\RDKRS_DRF43R0.xls

Vertical height gauge calibration due date:	3/22/11
Digital caliper calibration due date:	5/11/11
Gauge blocks calibration due date:	2/27/13
Analytical balance calibration due date:	11/3/11

Acceptance criteria for ring blank length:	≥61.0 and ≤65.0 mm
Acceptance criteria for ring blank diameter:	≥25.0 and ≤27.0 mm
Acceptance criteria for ring blank matrix density:	≥1.50 and ≤1.70 g/cm3

Ring Blank Z Number	Weight (g)	Length (mm)	Diameter (mm)			Volume (cm3)	Matrix Density (g/cm3)	Accept? (pass or fail)
			Middle 1	Middle 2	Average			
Z001	54.2801	62.746	26.00	26.02	26.01	33.339	1.63	pass
Z002	54.1014	62.969	26.03	26.04	26.04	33.522	1.61	pass
Z003	54.2923	63.140	26.02	26.01	26.02	33.562	1.62	pass
Z004	54.2285	63.125	26.01	26.01	26.01	33.541	1.62	pass
Z005	54.3762	62.661	26.00	26.00	26.00	33.269	1.63	pass
Z006	53.9965	62.462	25.98	25.99	25.99	33.125	1.63	pass
Z007	54.0788	63.007	26.00	26.00	26.00	33.452	1.62	pass
Z008	54.3745	62.945	26.00	26.00	26.00	33.419	1.63	pass
Z009	53.9434	62.988	25.98	25.98	25.98	33.391	1.62	pass
Z010	53.9241	63.157	26.03	26.04	26.04	33.622	1.60	pass
Z011	54.4230	63.066	25.95	25.97	25.96	33.381	1.63	pass
Z012	54.3891	62.956	25.96	25.96	25.96	33.322	1.63	pass
Z013	53.8372	62.769	25.99	25.97	25.98	33.275	1.62	pass
Z014	54.2390	62.924	26.03	26.02	26.03	33.472	1.62	pass
Z015	54.2444	62.908	26.03	26.10	26.07	33.567	1.62	pass
Z016	53.8742	62.927	25.99	25.99	25.99	33.384	1.61	pass
Z017	54.2725	62.941	26.02	26.04	26.03	33.494	1.62	pass
Z018	54.0182	63.026	25.98	25.99	25.99	33.424	1.62	pass
Z019	54.2684	62.462	26.00	26.00	26.00	33.163	1.64	pass
Z020	54.3393	63.252	25.97	25.98	25.98	33.518	1.62	pass
Z021	54.3331	62.906	26.02	26.02	26.02	33.450	1.62	pass
Z022	53.9615	62.877	25.97	25.97	25.97	33.306	1.62	pass
Z023	54.1593	62.857	25.98	25.98	25.98	33.321	1.63	pass
Z024	54.2871	62.717	26.00	25.99	26.00	33.285	1.63	pass
Z025	54.0344	62.757	26.00	26.00	26.00	33.320	1.62	pass
Z026	54.2972	62.484	26.01	26.01	26.01	33.200	1.64	pass
Z027	54.3196	62.972	26.05	26.05	26.05	33.562	1.62	pass
Z028	54.2519	62.931	26.02	26.03	26.03	33.476	1.62	pass
Z029	54.2012	62.967	26.01	26.00	26.01	33.444	1.62	pass
Z030	53.8570	62.967	26.00	26.00	26.00	33.431	1.61	pass

Comments

Operator — Date: 2-16-11

QC Supervisor — Date: 2-16-11

QA Reviewer — Date: 4/21/11

Data Report Form DRF-43: Matrix Ring Blank Diameter, Length, and Matrix Density

Procedure:	AGR-CHAR-DAM-43 Rev. 0
Operator:	Dunbar
Ring blank lot ID:	RDKRS
Ring blank lot description:	Matrix blend with Hexion Durite SC-1008 resin
Filename:	\\mc-agr\AGR\CompactDimensions\RDKRS_DRF43R0.xls

Vertical height gauge calibration due date:	3/22/11
Digital caliper calibration due date:	5/11/11
Gauge blocks calibration due date:	2/27/13
Analytical balance calibration due date:	11/3/11

Acceptance criteria for ring blank length:	≥61.0 and ≤65.0 mm
Acceptance criteria for ring blank diameter:	≥25.0 and ≤27.0 mm
Acceptance criteria for ring blank matrix density:	≥1.50 and ≤1.70 g/cm3

Ring Blank Z Number	Weight (g)	Length (mm)	Diameter (mm)			Volume (cm3)	Matrix Density (g/cm3)	Accept? (pass or fail)
			Middle 1	Middle 2	Average			
Z031	54.2780	62.861	26.02	25.99	26.01	33.388	1.63	pass
Z032	53.8416	63.079	26.03	26.02	26.03	33.555	1.60	pass
Z033	53.9316	63.281	26.01	26.01	26.01	33.624	1.60	pass
Z034	54.1667	62.621	26.02	26.04	26.03	33.324	1.63	pass
Z035	54.2288	62.923	26.03	26.05	26.04	33.511	1.62	pass
Z036	54.2473	62.660	25.99	26.02	26.01	33.281	1.63	pass
Z037	54.1392	62.887	26.02	26.02	26.02	33.440	1.62	pass
Z038	54.0811	62.927	26.03	26.03	26.03	33.487	1.61	pass
Z039	54.2564	62.967	25.98	26.01	26.00	33.418	1.62	pass
Z040	53.9318	62.965	26.00	26.00	26.00	33.430	1.61	pass
Z041	54.0419	62.782	26.01	26.01	26.01	33.358	1.62	pass
Z042	54.0318	62.722	25.94	25.95	25.95	33.160	1.63	pass
Z043	54.0469	63.284	26.04	26.04	26.04	33.703	1.60	pass
Z044	53.9990	63.157	26.01	26.00	26.01	33.545	1.61	pass
Z045	54.3641	63.002	26.03	26.06	26.05	33.565	1.62	pass
Z046	54.2171	62.411	25.97	25.97	25.97	33.059	1.64	pass
Z047	54.3226	62.533	25.96	25.98	25.97	33.124	1.64	pass
Z048	53.8618	63.332	25.99	26.08	26.04	33.715	1.60	pass
Z049	53.9414	63.009	25.99	25.99	25.99	33.428	1.61	pass
Z050	54.2839	62.651	26.00	26.00	26.00	33.263	1.63	pass
Z051								
Z052								
Z053								
Z054								
Z055								
Z056								
Z057								
Z058								
Z059								
Z060								

Comments

Operator — Date: 2-16-11

QC Supervisor — Date: 2-16-11

QA Reviewer — Date: 4/21/11

Data Report Form DRF-44: Measurement of Impurities in Matrix Ring Blanks by the Burn-Leach Method

Procedure:	AGR-CHAR-DAM-44 Rev. 0
Operator:	Fred Montgomery
Ring blank lot ID:	RDKRS
Ring blank lot description:	Matrix blend with hexion Durite SC-1008 resin
Ring blank ID numbers:	Z026, Z015, Z014
DRF filename:	\\mc-agr\AGR\LeachBurnLeach\RDKRS_DRF44R0.xls

		First Leach	Second Leach	Total
	Leach solution ID:	BL11030201	BL11030401	
	Number of ring blanks in sample group:	3		
	Total weight of ring blanks in sample group (g):	162.8		
	Total volume of leach solution (ml):	36.3	35.5	
	Radiochemical laboratory analysis number:	3580-001	3580-006	
U	Measured concentration of impurity in solution (µg/ml):	6.95E-02	2.78E-03	U
	Weight of impurity in sample group (µg):	2.52	0.10	
	Average concentration of impurity in ring blanks (ppmw):	0.0155	0.0006	0.0161
Fe	Measured concentration of impurity in solution (µg/ml):	1.74E-01	< 4.12E-02	Fe
	Weight of impurity in sample group (µg):	6.32	< 1.46	
	Average concentration of impurity in ring blanks (ppmw):	0.0388	< 0.0090	< 0.0478
Cr	Measured concentration of impurity in solution (µg/ml):	1.18E-02	< 2.00E-03	Cr
	Weight of impurity in sample group (µg):	0.43	< 0.07	
	Average concentration of impurity in ring blanks (ppmw):	0.0026	< 0.0004	< 0.0031
Mn	Measured concentration of impurity in solution (µg/ml):	< 1.91E-03	< 1.91E-03	Mn
	Weight of impurity in sample group (µg):	< 0.07	< 0.07	
	Average concentration of impurity in ring blanks (ppmw):	< 0.0004	< 0.0004	< 0.0008
Co	Measured concentration of impurity in solution (µg/ml):	< 1.62E-03	< 1.62E-03	Co
	Weight of impurity in sample group (µg):	< 0.06	< 0.06	
	Average concentration of impurity in ring blanks (ppmw):	< 0.0004	< 0.0004	< 0.0007
Ni	Measured concentration of impurity in solution (µg/ml):	1.26E-02	< 8.00E-03	Ni
	Weight of impurity in sample group (µg):	0.46	< 0.28	
	Average concentration of impurity in ring blanks (ppmw):	0.0028	< 0.0017	< 0.0046
Ca	Measured concentration of impurity in solution (µg/ml):	1.55E+01	5.37E-01	Ca
	Weight of impurity in sample group (µg):	562.65	19.06	
	Average concentration of impurity in ring blanks (ppmw):	3.4565	0.1171	3.5736
Al	Measured concentration of impurity in solution (µg/ml):	5.20E+00	2.66E-01	Al
	Weight of impurity in sample group (µg):	188.76	9.44	
	Average concentration of impurity in ring blanks (ppmw):	1.1596	0.0580	1.2176
Ti	Measured concentration of impurity in solution (µg/ml):	2.51E+00	3.28E-02	Ti
	Weight of impurity in sample group (µg):	91.11	1.16	
	Average concentration of impurity in ring blanks (ppmw):	0.5597	0.0072	0.5669
V	Measured concentration of impurity in solution (µg/ml):	5.14E+00	1.06E-02	V
	Weight of impurity in sample group (µg):	186.58	0.38	
	Average concentration of impurity in ring blanks (ppmw):	1.1462	0.0023	1.1485

Comments

Weight of ash after nitric acid leaching was 0.0661 g.
Data checked against the official results of analyses for RMAL3580 by FCM on 4/21/2011.

Fred C. Montgomery
Operator

4-21-2011
Date

Data Report Form DRF-44: Measurement of Impurities in Matrix Ring Blanks by the Burn-Leach Method

Procedure:	AGR-CHAR-DAM-44 Rev. 0
Operator:	Fred Montgomery
Ring blank lot ID:	RDKRS
Ring blank lot description:	Matrix blend with hexion Durite SC-1008 resin
Ring blank ID numbers:	Z003, Z041, Z025
DRF filename:	\\mc-agr\AGR\LeachBurnLeach\RDKRS_DRF44R0.xls

		First Leach	Second Leach	Total
	Leach solution ID:	BL11030202	BL11030402	
	Number of ring blanks in sample group:	3		
	Total weight of ring blanks in sample group	162.4		
	Total volume of leach solution (ml):	34.5	31.3	
	Radiochemical laboratory analysis number:	3580-002	3580-007	
U	Measured concentration of impurity in solution (µg/ml):	8.71E-02	6.63E-03	U
	Weight of impurity in sample group (µg):	3.00	0.21	
	Average concentration of impurity in ring blanks (ppmw):	0.0185	0.0013	0.0198
Fe	Measured concentration of impurity in solution (µg/ml):	2.08E-01	< 4.12E-02	Fe
	Weight of impurity in sample group (µg):	7.18	< 1.29	
	Average concentration of impurity in ring blanks (ppmw):	0.0442	< 0.0079	< 0.0521
Cr	Measured concentration of impurity in solution (µg/ml):	1.41E-02	< 2.00E-03	Cr
	Weight of impurity in sample group (µg):	0.49	< 0.06	
	Average concentration of impurity in ring blanks (ppmw):	0.0030	< 0.0004	< 0.0034
Mn	Measured concentration of impurity in solution (µg/ml):	< 1.91E-03	< 1.91E-03	Mn
	Weight of impurity in sample group (µg):	< 0.07	< 0.06	
	Average concentration of impurity in ring blanks (ppmw):	< 0.0004	< 0.0004	< 0.0008
Co	Measured concentration of impurity in solution (µg/ml):	< 1.62E-03	< 1.62E-03	Co
	Weight of impurity in sample group (µg):	< 0.06	< 0.05	
	Average concentration of impurity in ring blanks (ppmw):	< 0.0003	< 0.0003	< 0.0007
Ni	Measured concentration of impurity in solution (µg/ml):	1.37E-02	< 8.00E-03	Ni
	Weight of impurity in sample group (µg):	0.47	< 0.25	
	Average concentration of impurity in ring blanks (ppmw):	0.0029	< 0.0015	< 0.0045
Ca	Measured concentration of impurity in solution (µg/ml):	1.59E+01	5.42E-01	Ca
	Weight of impurity in sample group (µg):	548.55	16.96	
	Average concentration of impurity in ring blanks (ppmw):	3.3784	0.1045	3.4829
Al	Measured concentration of impurity in solution (µg/ml):	5.29E+00	2.28E-01	Al
	Weight of impurity in sample group (µg):	182.51	7.14	
	Average concentration of impurity in ring blanks (ppmw):	1.1240	0.0440	1.1680
Ti	Measured concentration of impurity in solution (µg/ml):	2.55E+00	5.01E-02	Ti
	Weight of impurity in sample group (µg):	87.98	1.57	
	Average concentration of impurity in ring blanks (ppmw):	0.5418	0.0097	0.5515
V	Measured concentration of impurity in solution (µg/ml):	5.46E+00	2.15E-02	V
	Weight of impurity in sample group (µg):	188.37	0.67	
	Average concentration of impurity in ring blanks (ppmw):	1.1601	0.0041	1.1643

Comments

Weight of ash after nitric acid leaching was 0.0632 g,
Data checked against the official results of analyses for RMAL3580 by FCM on 4/21/2011.

Fred C. Montgomery
Operator

4-21-2011
Date

Data Report Form DRF-44: Measurement of Impurities in Matrix Ring Blanks by the Burn-Leach Method

Procedure:	AGR-CHAR-DAM-44 Rev. 0
Operator:	Fred Montgomery
Ring blank lot ID:	RDKRS
Ring blank lot description:	Matrix blend with hexion Durite SC-1008 resin
Ring blank ID numbers:	Z035, Z027, Z040
DRF filename:	\\mc-agr\AGR\LeachBurnLeach\RDKRS_DRF44R0.xls

		First Leach	Second Leach	Total
	Leach solution ID:	BL11030203	BL11030403	
	Number of ring blanks in sample group:	3		
	Total weight of ring blanks in sample group	162.5		
	Total volume of leach solution (ml):	39.0	35.3	
	Radiochemical laboratory analysis number:	3580-003	3580-008	
U	Measured concentration of impurity in solution (µg/ml):	5.69E-02	2.04E-04	U
	Weight of impurity in sample group (µg):	2.22	0.01	
	Average concentration of impurity in ring blanks (ppmw):	0.0137	0.0000	0.0137
Fe	Measured concentration of impurity in solution (µg/ml):	1.32E-01	< 4.12E-02	Fe
	Weight of impurity in sample group (µg):	5.15	< 1.45	
	Average concentration of impurity in ring blanks (ppmw):	0.0317	< 0.0090	< 0.0406
Cr	Measured concentration of impurity in solution (µg/ml):	9.00E-03	< 2.00E-03	Cr
	Weight of impurity in sample group (µg):	0.35	< 0.07	
	Average concentration of impurity in ring blanks (ppmw):	0.0022	< 0.0004	< 0.0026
Mn	Measured concentration of impurity in solution (µg/ml):	< 1.91E-03	< 1.91E-03	Mn
	Weight of impurity in sample group (µg):	< 0.07	< 0.07	
	Average concentration of impurity in ring blanks (ppmw):	< 0.0005	< 0.0004	< 0.0009
Co	Measured concentration of impurity in solution (µg/ml):	< 1.62E-03	< 1.62E-03	Co
	Weight of impurity in sample group (µg):	< 0.06	< 0.06	
	Average concentration of impurity in ring blanks (ppmw):	< 0.0004	< 0.0004	< 0.0007
Ni	Measured concentration of impurity in solution (µg/ml):	1.04E-02	< 8.00E-03	Ni
	Weight of impurity in sample group (µg):	0.41	< 0.28	
	Average concentration of impurity in ring blanks (ppmw):	0.0025	< 0.0017	< 0.0042
Ca	Measured concentration of impurity in solution (µg/ml):	1.52E+01	3.82E-01	Ca
	Weight of impurity in sample group (µg):	592.80	13.48	
	Average concentration of impurity in ring blanks (ppmw):	3.6484	0.0830	3.7314
Al	Measured concentration of impurity in solution (µg/ml):	3.78E+00	1.22E-01	Al
	Weight of impurity in sample group (µg):	147.42	4.31	
	Average concentration of impurity in ring blanks (ppmw):	0.9073	0.0265	0.9338
Ti	Measured concentration of impurity in solution (µg/ml):	2.34E+00	6.56E-02	Ti
	Weight of impurity in sample group (µg):	91.26	2.32	
	Average concentration of impurity in ring blanks (ppmw):	0.5617	0.0143	0.5759
V	Measured concentration of impurity in solution (µg/ml):	4.79E+00	1.27E-02	V
	Weight of impurity in sample group (µg):	186.81	0.45	
	Average concentration of impurity in ring blanks (ppmw):	1.1497	0.0028	1.1525

Comments

Weight of ash after nitric acid leaching was 0.0656 g.
Data checked against the official results of analyses for RMAL3580 by FCM on 4/21/2011.

Fred C. Montgomery
Operator

4-21-2011
Date

Data Report Form DRF-44: Measurement of Impurities in Matrix Ring Blanks by the Burn-Leach Method

Procedure:	AGR-CHAR-DAM-44 Rev. 0
Operator:	Fred Montgomery
Ring blank lot ID:	RDKRS
Ring blank lot description:	Matrix blend with hexion Durite SC-1008 resin
Ring blank ID numbers:	Z019, Z036, Z044
DRF filename:	\\mc-agr\AGR\LeachBurnLeach\RDKRS_DRF44R0.xls

		First Leach	Second Leach	Total
	Leach solution ID:	BL11030204	BL11030404	
	Number of ring blanks in sample group:	3		
	Total weight of ring blanks in sample group	162.5		
	Total volume of leach solution (ml):	40.7	40.9	
	Radiochemical laboratory analysis number:	3580-004	3580-009	
U	Measured concentration of impurity in solution (µg/ml):	5.43E-02	4.12E-04	U
	Weight of impurity in sample group (µg):	2.21	0.02	
	Average concentration of impurity in ring blanks (ppmw):	0.0136	0.0001	0.0137
Fe	Measured concentration of impurity in solution (µg/ml):	2.56E-01	1.48E-01	Fe
	Weight of impurity in sample group (µg):	10.42	6.05	
	Average concentration of impurity in ring blanks (ppmw):	0.0641	0.0372	0.1014
Cr	Measured concentration of impurity in solution (µg/ml):	9.72E-03	< 2.00E-03	Cr
	Weight of impurity in sample group (µg):	0.40	< 0.08	
	Average concentration of impurity in ring blanks (ppmw):	0.0024	< 0.0005	< 0.0029
Mn	Measured concentration of impurity in solution (µg/ml):	< 1.91E-03	< 1.91E-03	Mn
	Weight of impurity in sample group (µg):	< 0.08	< 0.08	
	Average concentration of impurity in ring blanks (ppmw):	< 0.0005	< 0.0005	< 0.0010
Co	Measured concentration of impurity in solution (µg/ml):	< 1.62E-03	< 1.62E-03	Co
	Weight of impurity in sample group (µg):	< 0.07	< 0.07	
	Average concentration of impurity in ring blanks (ppmw):	< 0.0004	< 0.0004	< 0.0008
Ni	Measured concentration of impurity in solution (µg/ml):	1.10E-02	< 8.00E-03	Ni
	Weight of impurity in sample group (µg):	0.45	< 0.33	
	Average concentration of impurity in ring blanks (ppmw):	0.0028	< 0.0020	< 0.0048
Ca	Measured concentration of impurity in solution (µg/ml):	1.44E+01	2.31E+00	Ca
	Weight of impurity in sample group (µg):	586.08	94.48	
	Average concentration of impurity in ring blanks (ppmw):	3.6063	0.5814	4.1876
Al	Measured concentration of impurity in solution (µg/ml):	4.28E+00	2.48E-01	Al
	Weight of impurity in sample group (µg):	174.20	10.14	
	Average concentration of impurity in ring blanks (ppmw):	1.0719	0.0624	1.1343
Ti	Measured concentration of impurity in solution (µg/ml):	2.38E+00	7.08E-02	Ti
	Weight of impurity in sample group (µg):	96.87	2.90	
	Average concentration of impurity in ring blanks (ppmw):	0.5960	0.0178	0.6139
V	Measured concentration of impurity in solution (µg/ml):	4.84E+00	1.26E-02	V
	Weight of impurity in sample group (µg):	196.99	0.52	
	Average concentration of impurity in ring blanks (ppmw):	1.2121	0.0032	1.2153

Comments

Weight of ash after nitric acid leaching was 0.0630 g.
Data checked against the official results of analyses for RMAL3580 by FCM on 4/21/2011.

Fred C. Montgomery — Operator

4-21-2011 — Date

Data Report Form DRF-44: Measurement of Impurities in Matrix Ring Blanks by the Burn-Leach Method

Procedure:	AGR-CHAR-DAM-44 Rev. 0
Operator:	Fred Montgomery
Ring blank lot ID:	RDKRS
Ring blank lot description:	Matrix blend with hexion Durite SC-1008 resin
Ring blank ID numbers:	Blank
DRF filename:	\\mc-agr\AGR\LeachBurnLeach\RDKRS_DRF44R0.xls

		First Leach	Second Leach	Total
	Leach solution ID:	BL11030205	BL11030405	
	Number of ring blanks in sample group:	1		
	Total weight of ring blanks in sample group			
	Total volume of leach solution (ml):	34.7	32.7	
	Radiochemical laboratory analysis number:	3580-005	3580-010	
U	Measured concentration of impurity in solution (µg/ml):	6.76E-03	9.72E-04	U
	Weight of impurity in sample group (µg):	0.23	0.03	
	Average concentration of impurity in ring blanks (ppmw):			
Fe	Measured concentration of impurity in solution (µg/ml):	1.95E-01	< 4.12E-02	Fe
	Weight of impurity in sample group (µg):	6.77	< 1.35	
	Average concentration of impurity in ring blanks (ppmw):			
Cr	Measured concentration of impurity in solution (µg/ml):	1.17E-02	< 2.00E-03	Cr
	Weight of impurity in sample group (µg):	0.41	< 0.07	
	Average concentration of impurity in ring blanks (ppmw):			
Mn	Measured concentration of impurity in solution (µg/ml):	< 1.91E-03	< 1.91E-03	Mn
	Weight of impurity in sample group (µg):	< 0.07	< 0.06	
	Average concentration of impurity in ring blanks (ppmw):			
Co	Measured concentration of impurity in solution (µg/ml):	< 1.62E-03	< 1.62E-03	Co
	Weight of impurity in sample group (µg):	< 0.06	< 0.05	
	Average concentration of impurity in ring blanks (ppmw):			
Ni	Measured concentration of impurity in solution (µg/ml):	8.40E-03	< 8.00E-03	Ni
	Weight of impurity in sample group (µg):	0.29	< 0.26	
	Average concentration of impurity in ring blanks (ppmw):			
Ca	Measured concentration of impurity in solution (µg/ml):	2.48E-01	1.81E-01	Ca
	Weight of impurity in sample group (µg):	8.61	5.92	
	Average concentration of impurity in ring blanks (ppmw):			
Al	Measured concentration of impurity in solution (µg/ml):	1.78E-01	7.28E-02	Al
	Weight of impurity in sample group (µg):	6.18	2.38	
	Average concentration of impurity in ring blanks (ppmw):			
Ti	Measured concentration of impurity in solution (µg/ml):	4.62E-02	9.60E-03	Ti
	Weight of impurity in sample group (µg):	1.60	0.31	
	Average concentration of impurity in ring blanks (ppmw):			
V	Measured concentration of impurity in solution (µg/ml):	< 2.00E-03	< 2.00E-03	V
	Weight of impurity in sample group (µg):	< 0.07	< 0.07	
	Average concentration of impurity in ring blanks (ppmw):			

Comments

Data checked against the official results of analyses for RMAL3580 by FCM on 4/21/2011.

Fred C. Montgomery
Operator

4-21-2011
Date

5 Additional Characterization of RDKRS Ring Blanks for Information Only

Additional analysis of the burn-leach solutions was performed to measure Ba and lanthanide impurities. The following pages include a modified version of IRF-20B, which summarizes the results, and the individual modified data report forms (DRF-44) for each sample group. A significant amount (40 ppm-wt) of barium was detected.

Inspection Report Form IRF-20B: Summary of Impurities in Ring Blanks

Procedure:	AGR-CHAR-PIP-20 Rev. 1
Operator:	Fred Montgomery
Ring blank lot ID:	RDKRS
Ring blank lot description:	Matrix blend with hexion Durite SC-1008 resin

Ring blank ID numbers:	Z026, Z015, Z014	Z003, Z041, Z025	Z035, Z027, Z040	Z019, Z036, Z044	Mean	Standard Deviation
Barium					**Barium**	
Average impurity content in ring blanks (ppmw)	49.6	41.0	32.0	36.3	39.7	7.6
Lanthanum					**Lanthanum**	
Average impurity content in ring blanks (ppmw)	0.586	0.581	0.581	0.599	0.587	0.009
Cerium					**Cerium**	
Average impurity content in ring blanks (ppmw)	0.205	0.204	0.203	0.209	0.205	0.003
Neodymium					**Neodymium**	
Average impurity content in ring blanks (ppmw)	0.106	0.103	0.104	0.108	0.105	0.002
Europium					**Europium**	
Average impurity content in ring blanks (ppmw)	0.0198	0.0191	0.0198	0.0192	0.0195	0.0004
Gadolinium					**Gadolinium**	
Average impurity content in ring blanks (ppmw)	0.056	0.049	0.042	0.049	0.049	0.006
Dysprosium					**Dysprosium**	
Average impurity content in ring blanks (ppmw)	< 0.0097	< 0.0096	< 0.0099	< 0.0100	< 0.0098	0.0002
Erbium					**Erbium**	
Average impurity content in ring blanks (ppmw)	< 0.0075	< 0.0074	< 0.0076	< 0.0077	< 0.0075	0.0001
Lutetium					**Lutetium**	
Average impurity content in ring blanks (ppmw)	< 0.0013	< 0.0013	< 0.0014	< 0.0014	< 0.00136	0.00003

Comments
Additional analysis of Ba and Lanthanides was performed for information only. After burning and leaching with nitric acid, a white ash remained in the leach vessel. This ash was probably mostly silica and will be analyzed separately.

QC Supervisor

5-16-11

Date

Data Report Form DRF-44: Measurement of Impurities in Matrix Ring Blanks by the Burn-Leach Method

Procedure:	AGR-CHAR-DAM-44 Rev. 0
Operator:	Fred Montgomery
Ring blank lot ID:	RDKRS
Ring blank lot description:	Matrix blend with hexion Durite SC-1008 resin
Ring blank ID numbers:	Z026, Z015, Z014
DRF filename:	\\mc-agr\AGR\LeachBurnLeach\RDKRS_DRF44R0.xls

		First Leach	Second Leach	Total
	Leach solution ID:	BL11030201	BL11030401	
	Number of ring blanks in sample group:	3		
	Total weight of ring blanks in sample group (g):	162.8		
	Total volume of leach solution (ml):	36.3	35.5	
	Radiochemical laboratory analysis number:	3580-001	3580-006	
Ba	Measured concentration of impurity in solution (µg/ml):	1.13E+02	1.12E+02	**Ba**
	Weight of impurity in sample group (µg):	4101.90	3976.00	
	Average concentration of impurity in ring blanks (ppmw):	25.1987	24.4253	49.6240
La	Measured concentration of impurity in solution (µg/ml):	2.62E+00	9.84E-03	**La**
	Weight of impurity in sample group (µg):	95.11	0.35	
	Average concentration of impurity in ring blanks (ppmw):	0.5843	0.0021	0.5864
Ce	Measured concentration of impurity in solution (µg/ml):	9.16E-01	2.60E-03	**Ce**
	Weight of impurity in sample group (µg):	33.25	0.09	
	Average concentration of impurity in ring blanks (ppmw):	0.2043	0.0006	0.2048
Nd	Measured concentration of impurity in solution (µg/ml):	4.76E-01	9.20E-04	**Nd**
	Weight of impurity in sample group (µg):	17.28	0.03	
	Average concentration of impurity in ring blanks (ppmw):	0.1061	0.0002	0.1063
Eu	Measured concentration of impurity in solution (µg/ml):	8.76E-02	1.28E-03	**Eu**
	Weight of impurity in sample group (µg):	3.18	0.05	
	Average concentration of impurity in ring blanks (ppmw):	0.0195	0.0003	0.0198
Gd	Measured concentration of impurity in solution (µg/ml):	1.23E-01	1.32E-01	**Gd**
	Weight of impurity in sample group (µg):	4.46	4.69	
	Average concentration of impurity in ring blanks (ppmw):	0.0274	0.0288	0.0562
Dy	Measured concentration of impurity in solution (µg/ml):	4.35E-02	< 2.00E-04	**Dy**
	Weight of impurity in sample group (µg):	1.58	< 0.01	
	Average concentration of impurity in ring blanks (ppmw):	0.0097	< 0.0000	< 0.0097
Er	Measured concentration of impurity in solution (µg/ml):	3.34E-02	< 2.00E-04	**Er**
	Weight of impurity in sample group (µg):	1.21	< 0.01	
	Average concentration of impurity in ring blanks (ppmw):	0.0074	< 0.0000	< 0.0075
Lu	Measured concentration of impurity in solution (µg/ml):	5.84E-03	< 2.00E-04	**Lu**
	Weight of impurity in sample group (µg):	0.21	< 0.01	
	Average concentration of impurity in ring blanks (ppmw):	0.0013	< 0.0000	< 0.0013

Comments

Additional analysis of Ba and Lanthanides was performed for information only.
Weight of ash after nitric acid leaching was 0.0661 g.
Data checked by FCM against the official results of analyses for RMAL3580 on 4/21/2011.

Fred C. Montgomery
Operator

4-21-2011
Date

Data Report Form DRF-44: Measurement of Impurities in Matrix Ring Blanks by the Burn-Leach Method

Procedure:	AGR-CHAR-DAM-44 Rev. 0
Operator:	Fred Montgomery
Ring blank lot ID:	RDKRS
Ring blank lot description:	Matrix blend with hexion Durite SC-1008 resin
Ring blank ID numbers:	Z003, Z041, Z025
DRF filename:	\\mc-agr\AGR\LeachBurnLeach\RDKRS_DRF44R0.xls

		First Leach	Second Leach	Total
	Leach solution ID:	BL11030202	BL11030402	
	Number of ring blanks in sample group:	3		
	Total weight of ring blanks in sample group	162.4		
	Total volume of leach solution (ml):	34.5	31.3	
	Radiochemical laboratory analysis number:	3580-002	3580-007	
Ba	Measured concentration of impurity in solution (µg/ml):	1.12E+02	8.94E+01	**Ba**
	Weight of impurity in sample group (µg):	3864.00	2798.22	
	Average concentration of impurity in ring blanks (ppmw):	23.7976	17.2337	41.0312
La	Measured concentration of impurity in solution (µg/ml):	2.72E+00	1.57E-02	**La**
	Weight of impurity in sample group (µg):	93.84	0.49	
	Average concentration of impurity in ring blanks (ppmw):	0.5779	0.0030	0.5810
Ce	Measured concentration of impurity in solution (µg/ml):	9.56E-01	4.24E-03	**Ce**
	Weight of impurity in sample group (µg):	32.98	0.13	
	Average concentration of impurity in ring blanks (ppmw):	0.2031	0.0008	0.2039
Nd	Measured concentration of impurity in solution (µg/ml):	4.84E-01	1.60E-03	**Nd**
	Weight of impurity in sample group (µg):	16.70	0.05	
	Average concentration of impurity in ring blanks (ppmw):	0.1028	0.0003	0.1031
Eu	Measured concentration of impurity in solution (µg/ml):	8.90E-02	1.24E-03	**Eu**
	Weight of impurity in sample group (µg):	3.07	0.04	
	Average concentration of impurity in ring blanks (ppmw):	0.0189	0.0002	0.0191
Gd	Measured concentration of impurity in solution (µg/ml):	1.27E-01	1.16E-01	**Gd**
	Weight of impurity in sample group (µg):	4.38	3.63	
	Average concentration of impurity in ring blanks (ppmw):	0.0270	0.0224	0.0493
Dy	Measured concentration of impurity in solution (µg/ml):	4.52E-02	< 2.00E-04	**Dy**
	Weight of impurity in sample group (µg):	1.56	< 0.01	
	Average concentration of impurity in ring blanks (ppmw):	0.0096	< 0.0000	< 0.0096
Er	Measured concentration of impurity in solution (µg/ml):	3.45E-02	< 2.00E-04	**Er**
	Weight of impurity in sample group (µg):	1.19	< 0.01	
	Average concentration of impurity in ring blanks (ppmw):	0.0073	< 0.0000	< 0.0074
Lu	Measured concentration of impurity in solution (µg/ml):	6.08E-03	< 2.00E-04	**Lu**
	Weight of impurity in sample group (µg):	0.21	< 0.01	
	Average concentration of impurity in ring blanks (ppmw):	0.0013	< 0.0000	< 0.0013

Comments

Additional analysis of Ba and Lanthanides was performed for information only.
Weight of ash after nitric acid leaching was 0.0632 g.
Data checked by FCM against the official results of analyses for RMAL3580 on 4/21/2011.

Fred C. Montgomery — Operator

4-21-2011 — Date

Data Report Form DRF-44: Measurement of Impurities in Matrix Ring Blanks by the Burn-Leach Method

Procedure:	AGR-CHAR-DAM-44 Rev. 0
Operator:	Fred Montgomery
Ring blank lot ID:	RDKRS
Ring blank lot description:	Matrix blend with hexion Durite SC-1008 resin
Ring blank ID numbers:	Z035, Z027, Z040
DRF filename:	\\mc-agr\AGR\LeachBurnLeach\RDKRS_DRF44R0.xls

		First Leach	Second Leach	Total
	Leach solution ID:	BL11030203	BL11030403	
	Number of ring blanks in sample group:	3		
	Total weight of ring blanks in sample group	162.5		
	Total volume of leach solution (ml):	39.0	35.3	
	Radiochemical laboratory analysis number:	3580-003	3580-008	
Ba	Measured concentration of impurity in solution (µg/ml):	7.74E+01	6.18E+01	Ba
	Weight of impurity in sample group (µg):	3018.60	2181.54	
	Average concentration of impurity in ring blanks (ppmw):	18.5782	13.4264	32.0046
La	Measured concentration of impurity in solution (µg/ml):	2.41E+00	1.23E-02	La
	Weight of impurity in sample group (µg):	93.99	0.43	
	Average concentration of impurity in ring blanks (ppmw):	0.5785	0.0027	0.5811
Ce	Measured concentration of impurity in solution (µg/ml):	8.44E-01	2.64E-03	Ce
	Weight of impurity in sample group (µg):	32.92	0.09	
	Average concentration of impurity in ring blanks (ppmw):	0.2026	0.0006	0.2032
Nd	Measured concentration of impurity in solution (µg/ml):	4.32E-01	8.40E-04	Nd
	Weight of impurity in sample group (µg):	16.85	0.03	
	Average concentration of impurity in ring blanks (ppmw):	0.1037	0.0002	0.1039
Eu	Measured concentration of impurity in solution (µg/ml):	8.19E-02	8.00E-04	Eu
	Weight of impurity in sample group (µg):	3.19	0.03	
	Average concentration of impurity in ring blanks (ppmw):	0.0197	0.0002	0.0198
Gd	Measured concentration of impurity in solution (µg/ml):	1.04E-01	8.03E-02	Gd
	Weight of impurity in sample group (µg):	4.06	2.83	
	Average concentration of impurity in ring blanks (ppmw):	0.0250	0.0174	0.0424
Dy	Measured concentration of impurity in solution (µg/ml):	4.12E-02	< 2.00E-04	Dy
	Weight of impurity in sample group (µg):	1.61	< 0.01	
	Average concentration of impurity in ring blanks (ppmw):	0.0099	< 0.0000	< 0.0099
Er	Measured concentration of impurity in solution (µg/ml):	3.15E-02	< 2.00E-04	Er
	Weight of impurity in sample group (µg):	1.23	< 0.01	
	Average concentration of impurity in ring blanks (ppmw):	0.0076	< 0.0000	< 0.0076
Lu	Measured concentration of impurity in solution (µg/ml):	5.56E-03	< 2.00E-04	Lu
	Weight of impurity in sample group (µg):	0.22	< 0.01	
	Average concentration of impurity in ring blanks (ppmw):	0.0013	< 0.0000	< 0.0014

Comments

Additional analysis of Ba and Lanthanides was performed for information only.
Weight of ash after nitric acid leaching was 0.0656 g.
Data checked by FCM against the official results of analyses for RMAL3580 on 4/21/2011.

Fred C. Montgomery
Operator

4-21-2011
Date

Data Report Form DRF-44: Measurement of Impurities in Matrix Ring Blanks by the Burn-Leach Method

Procedure:	AGR-CHAR-DAM-44 Rev. 0
Operator:	Fred Montgomery
Ring blank lot ID:	RDKRS
Ring blank lot description:	Matrix blend with hexion Durite SC-1008 resin
Ring blank ID numbers:	Z019, Z036, Z044
DRF filename:	\\mc-agr\AGR\LeachBurnLeach\RDKRS_DRF44R0.xls

		First Leach	Second Leach	Total
	Leach solution ID:	BL11030204	BL11030404	
	Number of ring blanks in sample group:	3		
	Total weight of ring blanks in sample group	162.5		
	Total volume of leach solution (ml):	40.7	40.9	
	Radiochemical laboratory analysis number:	3580-004	3580-009	
Ba	Measured concentration of impurity in solution (µg/ml):	6.74E+01	7.71E+01	**Ba**
	Weight of impurity in sample group (µg):	2743.18	3153.39	
	Average concentration of impurity in ring blanks (ppmw):	16.8794	19.4035	36.2830
La	Measured concentration of impurity in solution (µg/ml):	2.38E+00	1.26E-02	**La**
	Weight of impurity in sample group (µg):	96.87	0.52	
	Average concentration of impurity in ring blanks (ppmw):	0.5960	0.0032	0.5992
Ce	Measured concentration of impurity in solution (µg/ml):	8.32E-01	3.08E-03	**Ce**
	Weight of impurity in sample group (µg):	33.86	0.13	
	Average concentration of impurity in ring blanks (ppmw):	0.2084	0.0008	0.2091
Nd	Measured concentration of impurity in solution (µg/ml):	4.32E-01	1.04E-03	**Nd**
	Weight of impurity in sample group (µg):	17.58	0.04	
	Average concentration of impurity in ring blanks (ppmw):	0.1082	0.0003	0.1085
Eu	Measured concentration of impurity in solution (µg/ml):	7.57E-02	9.60E-04	**Eu**
	Weight of impurity in sample group (µg):	3.08	0.04	
	Average concentration of impurity in ring blanks (ppmw):	0.0190	0.0002	0.0192
Gd	Measured concentration of impurity in solution (µg/ml):	9.52E-02	9.87E-02	**Gd**
	Weight of impurity in sample group (µg):	3.87	4.04	
	Average concentration of impurity in ring blanks (ppmw):	0.0238	0.0248	0.0487
Dy	Measured concentration of impurity in solution (µg/ml):	3.97E-02	< 2.00E-04	**Dy**
	Weight of impurity in sample group (µg):	1.62	< 0.01	
	Average concentration of impurity in ring blanks (ppmw):	0.0099	< 0.0001	< 0.0100
Er	Measured concentration of impurity in solution (µg/ml):	3.04E-02	< 2.00E-04	**Er**
	Weight of impurity in sample group (µg):	1.24	< 0.01	
	Average concentration of impurity in ring blanks (ppmw):	0.0076	< 0.0001	< 0.0077
Lu	Measured concentration of impurity in solution (µg/ml):	5.36E-03	< 2.00E-04	**Lu**
	Weight of impurity in sample group (µg):	0.22	< 0.01	
	Average concentration of impurity in ring blanks (ppmw):	0.0013	< 0.0001	< 0.0014

Comments

Additional analysis of Ba and Lanthanides was performed for information only.
Weight of ash after nitric acid leaching was 0.0630 g.
Data checked by FCM against the official results of analyses for RMAL3580 on 4/21/2011.

Fred C. Montgomery
Operator

4-21-2011
Date

Data Report Form DRF-44: Measurement of Impurities in Matrix Ring Blanks by the Burn-Leach Method

Procedure:	AGR-CHAR-DAM-44 Rev. 0
Operator:	Fred Montgomery
Ring blank lot ID:	RDKRS
Ring blank lot description:	Matrix blend with hexion Durite SC-1008 resin
Ring blank ID numbers:	Blank
DRF filename:	\\mc-agr\AGR\LeachBurnLeach\RDKRS_DRF44R0.xls

		First Leach	Second Leach	Total
	Leach solution ID:	BL11030205	BL11030405	
	Number of ring blanks in sample group:	1		
	Total weight of ring blanks in sample group			
	Total volume of leach solution (ml):	34.7	32.7	
	Radiochemical laboratory analysis number:	3580-005	3580-010	
Ba	Measured concentration of impurity in solution (µg/ml):	< 2.00E-02	< 2.00E-02	Ba
	Weight of impurity in sample group (µg):	< 0.69	< 0.65	
	Average concentration of impurity in ring blanks (ppmw):			
La	Measured concentration of impurity in solution (µg/ml):	< 2.00E-04	2.40E-04	La
	Weight of impurity in sample group (µg):	< 0.01	0.01	
	Average concentration of impurity in ring blanks (ppmw):			
Ce	Measured concentration of impurity in solution (µg/ml):	< 2.00E-04	< 2.00E-04	Ce
	Weight of impurity in sample group (µg):	< 0.01	< 0.01	
	Average concentration of impurity in ring blanks (ppmw):			
Nd	Measured concentration of impurity in solution (µg/ml):	< 2.00E-04	< 2.00E-04	Nd
	Weight of impurity in sample group (µg):	< 0.01	< 0.01	
	Average concentration of impurity in ring blanks (ppmw):			
Eu	Measured concentration of impurity in solution (µg/ml):	< 2.00E-04	< 2.00E-04	Eu
	Weight of impurity in sample group (µg):	< 0.01	< 0.01	
	Average concentration of impurity in ring blanks (ppmw):			
Gd	Measured concentration of impurity in solution (µg/ml):	< 2.00E-04	< 2.00E-04	Gd
	Weight of impurity in sample group (µg):	< 0.01	< 0.01	
	Average concentration of impurity in ring blanks (ppmw):			
Dy	Measured concentration of impurity in solution (µg/ml):	< 2.00E-04	< 2.00E-04	Dy
	Weight of impurity in sample group (µg):	< 0.01	< 0.01	
	Average concentration of impurity in ring blanks (ppmw):			
Er	Measured concentration of impurity in solution (µg/ml):	< 2.00E-04	< 2.00E-04	Er
	Weight of impurity in sample group (µg):	< 0.01	< 0.01	
	Average concentration of impurity in ring blanks (ppmw):			
Lu	Measured concentration of impurity in solution (µg/ml):	< 2.00E-04	< 2.00E-04	Lu
	Weight of impurity in sample group (µg):	< 0.01	< 0.01	
	Average concentration of impurity in ring blanks (ppmw):			

Comments

Additional analysis of Ba and Lanthanides was performed for information only.
Data checked by FCM against the official results of analyses for RMAL3580 on 4/21/2011.

Fred C. Montgomery
Operator

4-21-2011
Date

6 Analysis of Ash Residue Remaining After Burn-Leach

As reported in Section 4, a white ash residue remained in the leaching vessel after the completion of burn-leach analysis. This ash residue was analyzed by ICP-MS after microwave digestion and the results are reported on the following pages. IRF-20B Supplemental summarizes the analysis for the list of specified impurities and adds the data from the microwave digestion analysis of the ash residue to that obtained from the standard burn-leach analysis using boiling nitric acid. Following the inspection report form are the individual data report forms for the measurements that were performed. The impurity content detected in the ash residue was essentially insignificant (typically around 10% of what was detected by the burn-leach analysis), with the exception of Ti (where the total impurity content increased by ~50%). However, the magnitude of the Ti impurity content is still very low compared to what is allowed by the specification.

As expected, the dominant metallic impurity in the ash residue was silicon (96-98 wt% of the impurities detected). Based on the amount of Si detected in the ash residue, the average Si impurity content in the ring blanks was around 100 ppmw. A measureable amount of Ba was also detected in the ash residue (1-4 ppmw), which was ≤10% of what was detected by the burn-leach analysis reported in Section 5.

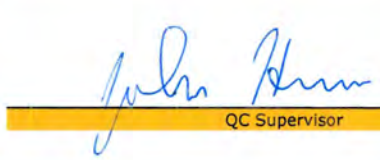
Inspection Report Form IRF-20B Supplemental: Summary of Impurities in Ring Blanks Including Analysis of Ash Residue

Procedure:	AGR-CHAR-PIP-20 Rev. 1
Operator:	Fred Montgomery
Ring blank lot ID:	RDKRS
Ring blank lot description:	Matrix blend with hexion Durite SC-1008 resin

Ring blank ID numbers:	Z026, Z015, Z014	Z003, Z041, Z025	Z035, Z027, Z040	Z019, Z036, Z044	Mean	Standard Deviation
Uranium					**Uranium**	
Impurity content detected by acid leach (ppmw)	0.016	0.020	0.014	0.014	0.016	0.003
Impurity content detected in ash (ppmw)	0.0009	0.0014	0.0015	0.0008	0.0011	0.0003
Total impurity content in ring blanks (ppmw)	0.017	0.021	0.015	0.015	0.017	0.003
Iron					**Iron**	
Impurity content detected by acid leach (ppmw)	< 0.048	< 0.052	< 0.041	0.101	< 0.06	0.03
Impurity content detected in ash (ppmw)	0.001	0.001	0.012	0.023	0.009	0.010
Total impurity content in ring blanks (ppmw)	< 0.049	< 0.053	< 0.053	0.124	< 0.07	0.04
Chromium					**Chromium**	
Impurity content detected by acid leach (ppmw)	< 0.0031	< 0.0034	< 0.0026	< 0.0029	< 0.0030	0.0003
Impurity content detected in ash (ppmw)	< 0.0004	< 0.0005	< 0.0005	< 0.0005	< 0.0005	0.0000
Total impurity content in ring blanks (ppmw)	< 0.0035	< 0.0039	< 0.0031	< 0.0034	< 0.0035	0.0003
Manganese					**Manganese**	
Impurity content detected by acid leach (ppmw)	< 0.0008	< 0.0008	< 0.0009	< 0.0010	< 0.0009	0.0001
Impurity content detected in ash (ppmw)	< 0.0004	< 0.0005	< 0.0005	< 0.0005	< 0.0005	0.0000
Total impurity content in ring blanks (ppmw)	< 0.0013	< 0.0013	< 0.0014	< 0.0015	< 0.0013	0.0001
Cobalt					**Cobalt**	
Impurity content detected by acid leach (ppmw)	< 0.0007	< 0.0007	< 0.0007	< 0.0008	< 0.0007	0.0001
Impurity content detected in ash (ppmw)	0.0002	< 0.0002	< 0.0002	< 0.0002	< 0.0002	0.0000
Total impurity content in ring blanks (ppmw)	< 0.0009	< 0.0008	< 0.0009	< 0.0010	< 0.0009	0.0001
Nickel					**Nickel**	
Impurity content detected by acid leach (ppmw)	< 0.0046	< 0.0045	< 0.0042	< 0.0048	< 0.0045	0.0002
Impurity content detected in ash (ppmw)	< 0.0006	< 0.0006	< 0.0006	< 0.0006	< 0.0006	0.0000
Total impurity content in ring blanks (ppmw)	< 0.0051	< 0.0051	< 0.0048	< 0.0054	< 0.0051	0.0002
Calcium					**Calcium**	
Impurity content detected by acid leach (ppmw)	3.574	3.483	3.731	4.188	3.7	0.3
Impurity content detected in ash (ppmw)	0.133	0.138	0.133	0.146	0.138	0.006
Total impurity content in ring blanks (ppmw)	3.706	3.621	3.864	4.334	3.9	0.3
Aluminum					**Aluminum**	
Impurity content detected by acid leach (ppmw)	1.218	1.168	0.934	1.134	1.11	0.12
Impurity content detected in ash (ppmw)	0.212	0.242	0.206	0.204	0.216	0.018
Total impurity content in ring blanks (ppmw)	1.430	1.410	1.140	1.338	1.33	0.13
Titanium					**Titanium**	
Impurity content detected by acid leach (ppmw)	0.567	0.551	0.576	0.614	0.58	0.03
Impurity content detected in ash (ppmw)	0.311	0.356	0.190	0.287	0.29	0.07
Total impurity content in ring blanks (ppmw)	0.878	0.907	0.766	0.901	0.86	0.07
Vanadium					**Vanadium**	
Impurity content detected by acid leach (ppmw)	1.149	1.164	1.152	1.215	1.17	0.03
Impurity content in residual ash (ppmw)	0.0239	0.0254	0.0239	0.0223	0.0239	0.0013
Total impurity content in ring blanks (ppmw)	1.172	1.190	1.176	1.238	1.19	0.03
Titanium plus Vanadium					**Titanium plus Vanadium**	
Impurity content detected by acid leach (ppmw)	1.715	1.716	1.728	1.829	1.75	0.05
Impurity content detected in ash (ppmw)	0.335	0.381	0.214	0.309	0.31	0.07
Total impurity content in ring blanks (ppmw)	2.051	2.097	1.943	2.138	2.06	0.08

Comments

Total impurity content in this table is the sum of the impurities detected by the standard burn-leach procedure plus the impurities detected by microwave digestion of the ash residue remaining after the standard burn-leach in nitric acid. Most of the residual ash was consumed by the microwave digestion. In addition to the impurities reported in the table, appreciable amounts of Si and Ba were also detected in the ash.



QC Supervisor

9-1-11

Date

Data Report Form DRF-44 Supplemental: Measurement of Impurities in Matrix Ring Blank Ash

Procedure:	AGR-CHAR-DAM-44 Rev. 0
Operator:	Fred Montgomery
Ring blank lot ID:	RDKRS
Ring blank lot description:	Matrix blend with Hexion Durite SC-1008 resin
Ring blank ID numbers:	Z026, Z015, Z014
DRF filename:	\\mc-agr\AGR\LeachBurnLeach\RDKRS_DRF44R0.xlsx

		From Ash Analysis	From Acid Leach	Revised Total
	Ash ID:	11041801		
	Number of ring blanks in sample group:	3		
	Total weight of ring blanks in sample group (g):	162.8		
	Total weight of residual ash (g):	0.016		
	Radiochemical laboratory analysis number:	3745-001		
U	Measured concentration of impurity in ash (µg/g):	9.68E+00		U
	Weight of impurity detected (µg):	0.15	2.62	
	Average concentration of impurity in ring blanks (ppmw):	0.0009	0.0161	0.0170
Fe	Measured concentration of impurity in ash (µg/g):	1.23E+01		Fe
	Weight of impurity detected (µg):	0.19	< 7.78	
	Average concentration of impurity in ring blanks (ppmw):	0.0012	< 0.0478	< 0.0490
Cr	Measured concentration of impurity in ash (µg/g):	< 4.52E+00		Cr
	Weight of impurity detected (µg):	< 0.07	< 0.50	
	Average concentration of impurity in ring blanks (ppmw):	< 0.0004	< 0.0031	< 0.0035
Mn	Measured concentration of impurity in ash (µg/g):	< 4.52E+00		Mn
	Weight of impurity detected (µg):	< 0.07	< 0.14	
	Average concentration of impurity in ring blanks (ppmw):	< 0.0004	< 0.0008	< 0.0013
Co	Measured concentration of impurity in ash (µg/g):	1.94E+00		Co
	Weight of impurity detected (µg):	0.03	< 0.12	
	Average concentration of impurity in ring blanks (ppmw):	0.0002	< 0.0007	< 0.0009
Ni	Measured concentration of impurity in ash (µg/g):	< 5.81E+00		Ni
	Weight of impurity detected (µg):	< 0.09	< 0.74	
	Average concentration of impurity in ring blanks (ppmw):	< 0.0006	< 0.0046	< 0.0051
Ca	Measured concentration of impurity in ash (µg/g):	1.39E+03		Ca
	Weight of impurity detected (µg):	21.60	581.71	
	Average concentration of impurity in ring blanks (ppmw):	0.1327	3.5736	3.7063
Al	Measured concentration of impurity in ash (µg/g):	2.23E+03		Al
	Weight of impurity detected (µg):	34.50	198.20	
	Average concentration of impurity in ring blanks (ppmw):	0.2119	1.2176	1.4295
Ti	Measured concentration of impurity in ash (µg/g):	3.27E+03		Ti
	Weight of impurity detected (µg):	50.70	92.28	
	Average concentration of impurity in ring blanks (ppmw):	0.3115	0.5669	0.8783
V	Measured concentration of impurity in ash (µg/g):	2.51E+02		V
	Weight of impurity detected (µg):	3.89	186.96	
	Average concentration of impurity in ring blanks (ppmw):	0.0239	1.1485	1.1724

Comments

Additional ring blank impurities greater than about 1 ppmw detected in ash: 93 ppmw Si, 1 ppmw Ba.
Data checked by FCM against the official results of analyses for RMAL3745 on 8/19/2011.

Frederick C. Montgomery
Operator

9-1-2011
Date

Data Report Form DRF-44 Supplemental: Measurement of Impurities in Matrix Ring Blank Ash

Procedure:	AGR-CHAR-DAM-44 Rev. 0
Operator:	Fred Montgomery
Ring blank lot ID:	RDKRS
Ring blank lot description:	Matrix blend with Hexion Durite SC-1008 resin
Ring blank ID numbers:	Z003, Z041, Z025
DRF filename:	\\mc-agr\AGR\LeachBurnLeach\RDKRS_DRF44R0.xlsx

		From Ash Analysis	From Acid Leach	Revised Total
	Ash ID:	11041802		
	Number of ring blanks in sample group:	3		
	Total weight of ring blanks in sample group (g):	162.4		
	Total weight of residual ash (g):	0.018		
	Radiochemical laboratory analysis number:	3745-002		
U	Measured concentration of impurity in ash (µg/g):	1.24E+01		U
	Weight of impurity detected (µg):	0.22	3.21	
	Average concentration of impurity in ring blanks (ppmw):	0.0014	0.0198	0.0211
Fe	Measured concentration of impurity in ash (µg/g):	1.24E+01		Fe
	Weight of impurity detected (µg):	0.22	< 8.47	
	Average concentration of impurity in ring blanks (ppmw):	0.0014	< 0.0521	< 0.0535
Cr	Measured concentration of impurity in ash (µg/g):	< 4.49E+00		Cr
	Weight of impurity detected (µg):	< 0.08	< 0.55	
	Average concentration of impurity in ring blanks (ppmw):	< 0.0005	< 0.0034	< 0.0039
Mn	Measured concentration of impurity in ash (µg/g):	< 4.49E+00		Mn
	Weight of impurity detected (µg):	< 0.08	< 0.13	
	Average concentration of impurity in ring blanks (ppmw):	< 0.0005	< 0.0008	< 0.0013
Co	Measured concentration of impurity in ash (µg/g):	< 1.69E+00		Co
	Weight of impurity detected (µg):	< 0.03	< 0.11	
	Average concentration of impurity in ring blanks (ppmw):	< 0.0002	< 0.0007	< 0.0008
Ni	Measured concentration of impurity in ash (µg/g):	< 5.62E+00		Ni
	Weight of impurity detected (µg):	< 0.10	< 0.72	
	Average concentration of impurity in ring blanks (ppmw):	< 0.0006	< 0.0045	< 0.0051
Ca	Measured concentration of impurity in ash (µg/g):	1.26E+03		Ca
	Weight of impurity detected (µg):	22.40	565.51	
	Average concentration of impurity in ring blanks (ppmw):	0.1380	3.4829	3.6208
Al	Measured concentration of impurity in ash (µg/g):	2.21E+03		Al
	Weight of impurity detected (µg):	39.30	189.64	
	Average concentration of impurity in ring blanks (ppmw):	0.2420	1.1680	1.4100
Ti	Measured concentration of impurity in ash (µg/g):	3.25E+03		Ti
	Weight of impurity detected (µg):	57.80	89.54	
	Average concentration of impurity in ring blanks (ppmw):	0.3560	0.5515	0.9075
V	Measured concentration of impurity in ash (µg/g):	2.32E+02		V
	Weight of impurity detected (µg):	4.13	189.04	
	Average concentration of impurity in ring blanks (ppmw):	0.0254	1.1643	1.1897

Comments

Additional ring blank impurities greater than about 1 ppmw detected in ash: 106 ppmw Si, 3 ppmw Ba.
Data checked by FCM against the official results of analyses for RMAL3745 on 8/19/2011.

Frederick C. Montgomery — Operator

9-1-2011 — Date

Data Report Form DRF-44 Supplemental: Measurement of Impurities in Matrix Ring Blank Ash

Procedure:	AGR-CHAR-DAM-44 Rev. 0
Operator:	Fred Montgomery
Ring blank lot ID:	RDKRS
Ring blank lot description:	Matrix blend with Hexion Durite SC-1008 resin
Ring blank ID numbers:	Z035, Z027, Z040
DRF filename:	\\mc-agr\AGR\LeachBurnLeach\RDKRS_DRF44R0.xlsx

		From Ash Analysis	From Acid Leach	Revised Total
	Ash ID:	11041803		
	Number of ring blanks in sample group:	3		
	Total weight of ring blanks in sample group (g):	162.5		
	Total weight of residual ash (g):	0.018		
	Radiochemical laboratory analysis number:	3745-003		
U	Measured concentration of impurity in ash (µg/g):	1.33E+01		U
	Weight of impurity detected (µg):	0.24	2.23	
	Average concentration of impurity in ring blanks (ppmw):	0.0015	0.0137	0.0152
Fe	Measured concentration of impurity in ash (µg/g):	1.10E+02		Fe
	Weight of impurity detected (µg):	2.00	< 6.60	
	Average concentration of impurity in ring blanks (ppmw):	0.0123	< 0.0406	< 0.0529
Cr	Measured concentration of impurity in ash (µg/g):	< 4.42E+00		Cr
	Weight of impurity detected (µg):	< 0.08	< 0.42	
	Average concentration of impurity in ring blanks (ppmw):	< 0.0005	< 0.0026	< 0.0031
Mn	Measured concentration of impurity in ash (µg/g):	< 4.42E+00		Mn
	Weight of impurity detected (µg):	< 0.08	< 0.14	
	Average concentration of impurity in ring blanks (ppmw):	< 0.0005	< 0.0009	< 0.0014
Co	Measured concentration of impurity in ash (µg/g):	< 1.66E+00		Co
	Weight of impurity detected (µg):	< 0.03	< 0.12	
	Average concentration of impurity in ring blanks (ppmw):	< 0.0002	< 0.0007	< 0.0009
Ni	Measured concentration of impurity in ash (µg/g):	< 5.52E+00		Ni
	Weight of impurity detected (µg):	< 0.10	< 0.69	
	Average concentration of impurity in ring blanks (ppmw):	< 0.0006	< 0.0042	< 0.0048
Ca	Measured concentration of impurity in ash (µg/g):	1.19E+03		Ca
	Weight of impurity detected (µg):	21.60	606.28	
	Average concentration of impurity in ring blanks (ppmw):	0.1329	3.7314	3.8644
Al	Measured concentration of impurity in ash (µg/g):	1.85E+03		Al
	Weight of impurity detected (µg):	33.50	151.73	
	Average concentration of impurity in ring blanks (ppmw):	0.2062	0.9338	1.1400
Ti	Measured concentration of impurity in ash (µg/g):	1.71E+03		Ti
	Weight of impurity detected (µg):	30.90	93.58	
	Average concentration of impurity in ring blanks (ppmw):	0.1902	0.5759	0.7661
V	Measured concentration of impurity in ash (µg/g):	2.15E+02		V
	Weight of impurity detected (µg):	3.89	187.26	
	Average concentration of impurity in ring blanks (ppmw):	0.0239	1.1525	1.1764

Comments

Additional ring blank impurities greater than about 1 ppmw detected in ash: 106 ppmw Si, 4 ppmw Ba.
Data checked by FCM against the official results of analyses for RMAL3745 on 8/19/2011.

Frederick C. Montgomery
Operator

9-1-2011
Date

Data Report Form DRF-44 Supplemental: Measurement of Impurities in Matrix Ring Blank Ash

Procedure:	AGR-CHAR-DAM-44 Rev. 0
Operator:	Fred Montgomery
Ring blank lot ID:	RDKRS
Ring blank lot description:	Matrix blend with Hexion Durite SC-1008 resin
Ring blank ID numbers:	Z019, Z036, Z044
DRF filename:	\\mc-agr\AGR\LeachBurnLeach\RDKRS_DRF44R0.xlsx

		From Ash Analysis	From Acid Leach	Revised Total
	Ash ID:	11041804		
	Number of ring blanks in sample group:	3		
	Total weight of ring blanks in sample group (g):	162.5		
	Total weight of residual ash (g):	0.017		
	Radiochemical laboratory analysis number:	3745-004		
U	Measured concentration of impurity in ash (µg/g):	7.60E+00		U
	Weight of impurity detected (µg):	0.13	2.23	
	Average concentration of impurity in ring blanks (ppmw):	0.0008	0.0137	0.0145
Fe	Measured concentration of impurity in ash (µg/g):	2.18E+02		Fe
	Weight of impurity detected (µg):	3.73	16.47	
	Average concentration of impurity in ring blanks (ppmw):	0.0230	0.1014	0.1243
Cr	Measured concentration of impurity in ash (µg/g):	< 4.68E+00		Cr
	Weight of impurity detected (µg):	< 0.08	< 0.48	
	Average concentration of impurity in ring blanks (ppmw):	< 0.0005	< 0.0029	< 0.0034
Mn	Measured concentration of impurity in ash (µg/g):	< 4.68E+00		Mn
	Weight of impurity detected (µg):	< 0.08	< 0.16	
	Average concentration of impurity in ring blanks (ppmw):	< 0.0005	< 0.0010	< 0.0015
Co	Measured concentration of impurity in ash (µg/g):	< 1.75E+00		Co
	Weight of impurity detected (µg):	< 0.03	< 0.13	
	Average concentration of impurity in ring blanks (ppmw):	< 0.0002	< 0.0008	< 0.0010
Ni	Measured concentration of impurity in ash (µg/g):	< 5.85E+00		Ni
	Weight of impurity detected (µg):	< 0.10	< 0.77	
	Average concentration of impurity in ring blanks (ppmw):	< 0.0006	< 0.0048	< 0.0054
Ca	Measured concentration of impurity in ash (µg/g):	1.39E+03		Ca
	Weight of impurity detected (µg):	23.80	680.56	
	Average concentration of impurity in ring blanks (ppmw):	0.1464	4.1876	4.3341
Al	Measured concentration of impurity in ash (µg/g):	1.94E+03		Al
	Weight of impurity detected (µg):	33.10	184.34	
	Average concentration of impurity in ring blanks (ppmw):	0.2037	1.1343	1.3380
Ti	Measured concentration of impurity in ash (µg/g):	2.73E+03		Ti
	Weight of impurity detected (µg):	46.60	99.76	
	Average concentration of impurity in ring blanks (ppmw):	0.2867	0.6139	0.9006
V	Measured concentration of impurity in ash (µg/g):	2.12E+02		V
	Weight of impurity detected (µg):	3.62	197.50	
	Average concentration of impurity in ring blanks (ppmw):	0.0223	1.2153	1.2376

Comments

Additional ring blank impurities greater than about 1 ppmw detected in ash: 102 ppmw Si, 2 ppmw Ba.
Data checked by FCM against the official results of analyses for RMAL3745 on 8/19/2011.

Frederick C. Montgomery
Operator

9-1-2011
Date

7 Analysis of Impurity Content in Machined Matrix Rings

Of the 30 ring blanks sent to INL (Table 3), 6 were returned to ORNL after machining for analysis of impurity content. The 26 mm diameter, 63 mm long solid cylindrical ring blanks were machined down to approximately 24.4 mm diameter, 50.8 mm long cylinders. An approximately 12.5 mm diameter hole was drilled down the axis to receive the fuel compacts. Thermocouple and melt wire cylindrical wells were also drilled into the shoulder of the rings.

Machined matrix rings were burned in air and the ash was leached twice by boiling nitric acid. Ash residue remaining after the standard burn-leach analysis was analyzed by ICP-MS after microwave digestion. The analysis was performed on the 6 machined matrix rings, in three sample groups with 2 rings in each sample group. The following pages are copies of the inspection report form IRF-20B, which summarizes the results of the burn-leach analysis, and IRF-20B Supplemental, which adds data from microwave digestion of the residual ash to the results of the burn-leach analysis. Following the inspection report forms are the individual data report forms for the measurements that were performed.

Table 6 compares the results of the machined matrix ring impurity analysis to the impurity analysis of the ring blanks reported in Section 4 and Section 6. The values reported in Table 6 include data from both burn-leach of the machined matrix rings and subsequent microwave digestion of the ash residue. There was no significant change in the uranium content. Other impurities showed a small but measurable increase, which could be related to contamination from the machining or extra handling. All of these values are still well below the specified limits, so the additional contamination should not present an issue.

Table 6. Impurity content (ppmw) before and after machining

Specified Impurity	Upper Limit at 95% confidence	RDKRS Ring Blanks		Machined Matrix Rings	
		mean	std. dev.	mean	std. dev.
Uranium	≤ 0.5	0.017	0.003	0.013	0.005
Iron	≤ 20	<0.07	0.04	<0.44	0.18
Chromium	≤ 10	<0.0035	0.0003	<0.035	0.011
Manganese	≤ 10	<0.0013	0.0001	<0.0059	0.0009
Cobalt	≤ 10	<0.0009	0.0001	<0.0057	0.0016
Nickel	≤ 10	<0.0051	0.0002	<0.025	0.002
Calcium	≤ 45	3.9	0.3	5.6	0.9
Aluminum	≤ 20	1.33	0.13	2.4	0.3
Titanium	NA	0.86	0.07	1.2	0.2
Vanadium	NA	1.19	0.03	1.82	0.11
Titanium plus Vanadium	≤ 85	2.06	0.08	3.0	0.3

Inspection Report Form IRF-20B: Summary of Impurities in Matrix Rings

Procedure:	AGR-CHAR-PIP-20 Rev. 1
Operator:	Fred Montgomery
Ring blank lot ID:	RDKRS-Machined
Ring blank lot description:	Rings machined from blanks made using matrix blend with Hexion Durite SC-1008 resin

Ring blank ID numbers:	Z005, Z010	Z022, Z023	Z037, Z039		Mean	Standard Deviation
Uranium					**Uranium**	
Average impurity content in ring blanks (ppmw)	< 0.009	0.009	0.018		< 0.012	0.005
Iron					**Iron**	
Average impurity content in ring blanks (ppmw)	< 0.287	0.602	0.355		< 0.41	0.17
Chromium					**Chromium**	
Average impurity content in ring blanks (ppmw)	< 0.026	0.045	0.030		< 0.033	0.010
Manganese					**Manganese**	
Average impurity content in ring blanks (ppmw)	< 0.0044	0.0061	0.0048		< 0.0051	0.0009
Cobalt					**Cobalt**	
Average impurity content in ring blanks (ppmw)	< 0.0041	0.0068	0.0042		< 0.0050	0.0016
Nickel					**Nickel**	
Average impurity content in ring blanks (ppmw)	< 0.0199	0.0239	0.0195		< 0.021	0.002
Calcium					**Calcium**	
Average impurity content in ring blanks (ppmw)	5.576	4.528	6.277		5.5	0.9
Aluminum					**Aluminum**	
Average impurity content in ring blanks (ppmw)	1.843	2.527	1.927		2.1	0.4
Titanium					**Titanium**	
Average impurity content in ring blanks (ppmw)	0.710	0.817	0.740		0.76	0.05
Vanadium					**Vanadium**	
Average impurity content in ring blanks (ppmw)	1.739	1.928	1.725		1.80	0.11
Titanium plus Vanadium					**Titanium plus Vanadium**	
Average impurity content in ring blanks (ppmw)	2.449	2.745	2.465		2.55	0.17

Comments
Six ring blanks were machined by INL into matrix rings and returned to ORNL for analysis. After burning and leaching with nitric acid, a white ash remained in the leach vessel. These impurity analysis results do not include content of the ash. This ash was mostly silica.

QC Supervisor

9-7-11

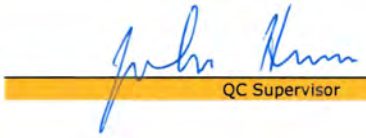
Date

Inspection Report Form IRF-20B Supplemental: Summary of Impurities in Matrix Rings Including Analysis of Ash Residue

Procedure:	AGR-CHAR-PIP-20 Rev. 1
Operator:	Fred Montgomery
Ring blank lot ID:	RDKRS-Machined
Ring blank lot description:	Rings machined from blanks made using matrix blend with Hexion Durite SC-1008 resin

Ring blank ID numbers:	Z005, Z010	Z022, Z023	Z037, Z039		Mean	Standard Deviation
Uranium					**Uranium**	
Impurity content detected by acid leach (ppmw)	< 0.009	0.009	0.018		< 0.012	0.005
Impurity content detected in ash (ppmw)	0.0009	0.0008	0.0014		0.0010	0.0003
Total impurity content in ring blanks (ppmw)	0.010	0.010	0.019		0.013	0.005
Iron					**Iron**	
Impurity content detected by acid leach (ppmw)	< 0.287	0.602	0.355		< 0.41	0.17
Impurity content detected in ash (ppmw)	< 0.018	0.041	< 0.018		< 0.026	0.013
Total impurity content in ring blanks (ppmw)	< 0.305	0.643	< 0.373		< 0.44	0.18
Chromium					**Chromium**	
Impurity content detected by acid leach (ppmw)	< 0.026	0.045	0.030		< 0.033	0.010
Impurity content detected in ash (ppmw)	0.0010	0.0029	0.0017		0.0019	0.0010
Total impurity content in ring blanks (ppmw)	< 0.027	0.048	0.032		< 0.035	0.011
Manganese					**Manganese**	
Impurity content detected by acid leach (ppmw)	< 0.0044	0.0061	0.0048		< 0.0051	0.0009
Impurity content detected in ash (ppmw)	< 0.0008	< 0.0008	< 0.0008		< 0.0008	0.0000
Total impurity content in ring blanks (ppmw)	< 0.0052	< 0.0070	< 0.0056		< 0.0059	0.0009
Cobalt					**Cobalt**	
Impurity content detected by acid leach (ppmw)	< 0.0041	0.0068	0.0042		< 0.0050	0.0016
Impurity content detected in ash (ppmw)	< 0.0007	< 0.0007	< 0.0007		< 0.0007	0.0000
Total impurity content in ring blanks (ppmw)	< 0.0048	< 0.0075	< 0.0049		< 0.0057	0.0016
Nickel					**Nickel**	
Impurity content detected by acid leach (ppmw)	< 0.0199	0.0239	0.0195		< 0.021	0.002
Impurity content detected in ash (ppmw)	< 0.0036	< 0.0035	< 0.0035		< 0.0035	0.0000
Total impurity content in ring blanks (ppmw)	< 0.0235	< 0.0274	< 0.0230		< 0.025	0.002
Calcium					**Calcium**	
Impurity content detected by acid leach (ppmw)	5.576	4.528	6.277		5.5	0.9
Impurity content detected in ash (ppmw)	0.146	0.112	0.097		0.12	0.03
Total impurity content in ring blanks (ppmw)	5.722	4.640	6.374		5.6	0.9
Aluminum					**Aluminum**	
Impurity content detected by acid leach (ppmw)	1.843	2.527	1.927		2.1	0.4
Impurity content detected in ash (ppmw)	0.372	0.301	0.328		0.33	0.04
Total impurity content in ring blanks (ppmw)	2.216	2.829	2.254		2.4	0.3
Titanium					**Titanium**	
Impurity content detected by acid leach (ppmw)	0.710	0.817	0.740		0.76	0.05
Impurity content detected in ash (ppmw)	0.655	0.492	0.210		0.5	0.2
Total impurity content in ring blanks (ppmw)	1.365	1.309	0.950		1.2	0.2
Vanadium					**Vanadium**	
Impurity content detected by acid leach (ppmw)	1.739	1.928	1.725		1.80	0.11
Impurity content in residual ash (ppmw)	0.031	0.026	0.020		0.026	0.005
Total impurity content in ring blanks (ppmw)	1.770	1.954	1.745		1.82	0.11
Titanium plus Vanadium					**Titanium plus Vanadium**	
Impurity content detected by acid leach (ppmw)	2.449	2.745	2.465		2.55	0.17
Impurity content detected in ash (ppmw)	0.685	0.518	0.230		0.5	0.2
Total impurity content in ring blanks (ppmw)	3.135	3.263	2.695		3.0	0.3

Comments
Total impurity content in this table is the sum of the impurities detected by the standard burn-leach procedure plus the impurities detected by microwave digestion of the ash residue remaining after the standard burn-leach in nitric acid. Most of the residual ash was consumed by the microwave digestion. In addition to the impurities reported in the table, appreciable amounts of Si and Ba were also detected in the ash.



QC Supervisor

9-7-11

Date

Data Report Form DRF-44: Measurement of Impurities in Matrix Ring Blanks by the Burn-Leach Method

Procedure:	AGR-CHAR-DAM-44 Rev. 0
Operator:	Fred Montgomery
Ring blank lot ID:	RDKRS-Machined
Ring blank lot description:	Rings machined from blanks made using matrix blend with Hexion Durite SC-1008 resin
Ring ID numbers:	Z005, Z010
DRF filename:	\\mc-agr\AGR\LeachBurnLeach\RDKRS-Machined_DRF44R0.xls

		First Leach	Second Leach	Total
	Leach solution ID:	BL11071501	BL11071801	
	Number of ring blanks in sample group:	2		
	Total weight of ring blanks in sample group (g):	56.2		
	Total volume of leach solution (ml):	39.9	38.0	
	Radiochemical laboratory analysis number:	3864-001	3864-005	
U	Measured concentration of impurity in solution (µg/ml):	1.23E-02	< 2.00E-04	U
	Weight of impurity in sample group (µg):	0.49	< 0.01	
	Average concentration of impurity in ring blanks (ppmw):	0.0087	< 0.0001	< 0.0089
Fe	Measured concentration of impurity in solution (µg/ml):	3.64E-01	< 4.12E-02	Fe
	Weight of impurity in sample group (µg):	14.52	< 1.57	
	Average concentration of impurity in ring blanks (ppmw):	0.2586	< 0.0279	< 0.2865
Cr	Measured concentration of impurity in solution (µg/ml):	3.40E-02	< 2.00E-03	Cr
	Weight of impurity in sample group (µg):	1.36	< 0.08	
	Average concentration of impurity in ring blanks (ppmw):	0.0242	< 0.0014	< 0.0255
Mn	Measured concentration of impurity in solution (µg/ml):	4.33E-03	< 1.91E-03	Mn
	Weight of impurity in sample group (µg):	0.17	< 0.07	
	Average concentration of impurity in ring blanks (ppmw):	0.0031	< 0.0013	< 0.0044
Co	Measured concentration of impurity in solution (µg/ml):	4.19E-03	< 1.62E-03	Co
	Weight of impurity in sample group (µg):	0.17	< 0.06	
	Average concentration of impurity in ring blanks (ppmw):	0.0030	< 0.0011	< 0.0041
Ni	Measured concentration of impurity in solution (µg/ml):	2.04E-02	< 8.00E-03	Ni
	Weight of impurity in sample group (µg):	0.81	< 0.30	
	Average concentration of impurity in ring blanks (ppmw):	0.0145	< 0.0054	< 0.0199
Ca	Measured concentration of impurity in solution (µg/ml):	7.35E+00	5.22E-01	Ca
	Weight of impurity in sample group (µg):	293.27	19.84	
	Average concentration of impurity in ring blanks (ppmw):	5.2223	0.3532	5.5756
Al	Measured concentration of impurity in solution (µg/ml):	2.44E+00	1.62E-01	Al
	Weight of impurity in sample group (µg):	97.36	6.16	
	Average concentration of impurity in ring blanks (ppmw):	1.7337	0.1096	1.8433
Ti	Measured concentration of impurity in solution (µg/ml):	8.99E-01	1.06E-01	Ti
	Weight of impurity in sample group (µg):	35.87	4.03	
	Average concentration of impurity in ring blanks (ppmw):	0.6388	0.0717	0.7105
V	Measured concentration of impurity in solution (µg/ml):	2.43E+00	1.80E-02	V
	Weight of impurity in sample group (µg):	96.96	0.68	
	Average concentration of impurity in ring blanks (ppmw):	1.7266	0.0122	1.7387

Comments

Weight of ash after nitric acid leaching was 0.0134 g.
Data checked by FCM against the official results of analyses for RMAL3864 on 8/22/2011.

Frederick C. Montgomery — Operator

9-1-2011 — Date

Data Report Form DRF-44: Measurement of Impurities in Matrix Ring Blanks by the Burn-Leach Method

Procedure:	AGR-CHAR-DAM-44 Rev. 0
Operator:	Fred Montgomery
Ring blank lot ID:	RDKRS-Machined
Ring blank lot description:	Rings machined from blanks made using matrix blend with Hexion Durite SC-1008 resin
Ring ID numbers:	Z022, Z023
DRF filename:	\\mc-agr\AGR\LeachBurnLeach\RDKRS-Machined_DRF44R0.xls

		First Leach	Second Leach	Total
	Leach solution ID:	BL11071502	BL11071802	
	Number of ring blanks in sample group:	2		
	Total weight of ring blanks in sample group	57.0		
	Total volume of leach solution (ml):	28.8	24.5	
	Radiochemical laboratory analysis number:	3864-002	3864-006	
U	Measured concentration of impurity in solution (µg/ml):	1.79E-02	2.80E-04	U
	Weight of impurity in sample group (µg):	0.52	0.01	
	Average concentration of impurity in ring blanks (ppmw):	0.0090	0.0001	0.0092
Fe	Measured concentration of impurity in solution (µg/ml):	1.15E+00	4.76E-02	Fe
	Weight of impurity in sample group (µg):	33.12	1.17	
	Average concentration of impurity in ring blanks (ppmw):	0.5814	0.0205	0.6019
Cr	Measured concentration of impurity in solution (µg/ml):	7.96E-02	1.03E-02	Cr
	Weight of impurity in sample group (µg):	2.29	0.25	
	Average concentration of impurity in ring blanks (ppmw):	0.0402	0.0044	0.0447
Mn	Measured concentration of impurity in solution (µg/ml):	1.05E-02	< 1.91E-03	Mn
	Weight of impurity in sample group (µg):	0.30	< 0.05	
	Average concentration of impurity in ring blanks (ppmw):	0.0053	< 0.0008	0.0061
Co	Measured concentration of impurity in solution (µg/ml):	1.21E-02	< 1.62E-03	Co
	Weight of impurity in sample group (µg):	0.35	< 0.04	
	Average concentration of impurity in ring blanks (ppmw):	0.0061	< 0.0007	0.0068
Ni	Measured concentration of impurity in solution (µg/ml):	4.05E-02	< 8.00E-03	Ni
	Weight of impurity in sample group (µg):	1.17	< 0.20	
	Average concentration of impurity in ring blanks (ppmw):	0.0205	< 0.0034	0.0239
Ca	Measured concentration of impurity in solution (µg/ml):	8.48E+00	5.60E-01	Ca
	Weight of impurity in sample group (µg):	244.22	13.72	
	Average concentration of impurity in ring blanks (ppmw):	4.2872	0.2408	4.5281
Al	Measured concentration of impurity in solution (µg/ml):	4.77E+00	2.69E-01	Al
	Weight of impurity in sample group (µg):	137.38	6.59	
	Average concentration of impurity in ring blanks (ppmw):	2.4116	0.1157	2.5273
Ti	Measured concentration of impurity in solution (µg/ml):	1.35E+00	3.12E-01	Ti
	Weight of impurity in sample group (µg):	38.88	7.64	
	Average concentration of impurity in ring blanks (ppmw):	0.6825	0.1342	0.8167
V	Measured concentration of impurity in solution (µg/ml):	3.48E+00	3.93E-01	V
	Weight of impurity in sample group (µg):	100.22	9.63	
	Average concentration of impurity in ring blanks (ppmw):	1.7594	0.1690	1.9284

Comments

Weight of ash after nitric acid leaching was 0.0131 g.
Data checked by FCM against the official results of analyses for RMAL3864 on 8/22/2011.

Frederick C. Montgomery
Operator

9-1-2011
Date

Data Report Form DRF-44: Measurement of Impurities in Matrix Ring Blanks by the Burn-Leach Method

Procedure:	AGR-CHAR-DAM-44 Rev. 0
Operator:	Fred Montgomery
Ring blank lot ID:	RDKRS-Machined
Ring blank lot description:	Rings machined from blanks made using matrix blend with Hexion Durite SC-1008 resin
Ring ID numbers:	Z037, Z039
DRF filename:	\\mc-agr\AGR\LeachBurnLeach\RDKRS-Machined_DRF44R0.xls

		First Leach	Second Leach	Total
	Leach solution ID:	BL11071503	BL11071803	
	Number of ring blanks in sample group:	2		
	Total weight of ring blanks in sample group	57.0		
	Total volume of leach solution (ml):	30.0	25.0	
	Radiochemical laboratory analysis number:	3864-003	3864-007	
U	Measured concentration of impurity in solution (µg/ml):	2.53E-02	9.72E-03	U
	Weight of impurity in sample group (µg):	0.76	0.24	
	Average concentration of impurity in ring blanks (ppmw):	0.0133	0.0043	0.0176
Fe	Measured concentration of impurity in solution (µg/ml):	6.40E-01	< 4.12E-02	Fe
	Weight of impurity in sample group (µg):	19.20	< 1.03	
	Average concentration of impurity in ring blanks (ppmw):	0.3369	< 0.0181	0.3550
Cr	Measured concentration of impurity in solution (µg/ml):	5.33E-02	5.01E-03	Cr
	Weight of impurity in sample group (µg):	1.60	0.13	
	Average concentration of impurity in ring blanks (ppmw):	0.0281	0.0022	0.0303
Mn	Measured concentration of impurity in solution (µg/ml):	7.51E-03	< 1.91E-03	Mn
	Weight of impurity in sample group (µg):	0.23	< 0.05	
	Average concentration of impurity in ring blanks (ppmw):	0.0040	< 0.0008	0.0048
Co	Measured concentration of impurity in solution (µg/ml):	6.55E-03	< 1.62E-03	Co
	Weight of impurity in sample group (µg):	0.20	< 0.04	
	Average concentration of impurity in ring blanks (ppmw):	0.0034	< 0.0007	0.0042
Ni	Measured concentration of impurity in solution (µg/ml):	3.03E-02	< 8.00E-03	Ni
	Weight of impurity in sample group (µg):	0.91	< 0.20	
	Average concentration of impurity in ring blanks (ppmw):	0.0160	< 0.0035	0.0195
Ca	Measured concentration of impurity in solution (µg/ml):	1.12E+01	8.69E-01	Ca
	Weight of impurity in sample group (µg):	336.00	21.73	
	Average concentration of impurity in ring blanks (ppmw):	5.8960	0.3812	6.2772
Al	Measured concentration of impurity in solution (µg/ml):	3.47E+00	2.28E-01	Al
	Weight of impurity in sample group (µg):	104.10	5.70	
	Average concentration of impurity in ring blanks (ppmw):	1.8267	0.1000	1.9267
Ti	Measured concentration of impurity in solution (µg/ml):	1.39E+00	1.93E-02	Ti
	Weight of impurity in sample group (µg):	41.70	0.48	
	Average concentration of impurity in ring blanks (ppmw):	0.7317	0.0085	0.7402
V	Measured concentration of impurity in solution (µg/ml):	3.27E+00	7.87E-03	V
	Weight of impurity in sample group (µg):	98.10	0.20	
	Average concentration of impurity in ring blanks (ppmw):	1.7214	0.0035	1.7249

Comments

Weight of ash after nitric acid leaching was 0.0161 g.
Data checked by FCM against the official results of analyses for RMAL3864 on 8/22/2011.

Frederick C. Montgomery
Operator

9-1-2011
Date

Data Report Form DRF-44 Supplemental: Measurement of Impurities in Matrix Ring Blank Ash

Procedure:	AGR-CHAR-DAM-44 Rev. 0
Operator:	Fred Montgomery
Ring blank lot ID:	RDKRS-Machined
Ring blank lot description:	Rings machined from blanks made using matrix blend with Hexion Durite SC-1008 resin
Ring blank ID numbers:	Z005, Z010
DRF filename:	\\mc-agr\AGR\LeachBurnLeach\RDKRS-Machined_DRF44R0.xls

		From Ash Analysis	From Acid Leach	Revised Total
	Ash ID:	ASH 11071901		
	Number of ring blanks in sample group:	2		
	Total weight of ring blanks in sample group (g):	56.2		
	Total weight of residual ash (g):	0.013		
	Radiochemical laboratory analysis number:	3865-001		
U	Measured concentration of impurity in ash (µg/g):	3.81E+00		U
	Weight of impurity detected (µg):	0.05	< 0.50	
	Average concentration of impurity in ring blanks (ppmw):	0.0009	< 0.0089	0.0098
Fe	Measured concentration of impurity in ash (µg/g):	< 7.69E+01		Fe
	Weight of impurity detected (µg):	< 1.03	<16.09	
	Average concentration of impurity in ring blanks (ppmw):	< 0.0183	< 0.2865	< 0.3049
Cr	Measured concentration of impurity in ash (µg/g):	4.25E+00		Cr
	Weight of impurity detected (µg):	0.06	< 1.43	
	Average concentration of impurity in ring blanks (ppmw):	0.0010	< 0.0255	< 0.0265
Mn	Measured concentration of impurity in ash (µg/g):	< 3.56E+00		Mn
	Weight of impurity detected (µg):	< 0.05	< 0.25	
	Average concentration of impurity in ring blanks (ppmw):	< 0.0008	< 0.0044	< 0.0052
Co	Measured concentration of impurity in ash (µg/g):	< 3.03E+00		Co
	Weight of impurity detected (µg):	< 0.04	< 0.23	
	Average concentration of impurity in ring blanks (ppmw):	< 0.0007	< 0.0041	< 0.0048
Ni	Measured concentration of impurity in ash (µg/g):	< 1.49E+01		Ni
	Weight of impurity detected (µg):	< 0.20	< 1.12	
	Average concentration of impurity in ring blanks (ppmw):	< 0.0036	< 0.0199	< 0.0235
Ca	Measured concentration of impurity in ash (µg/g):	6.12E+02		Ca
	Weight of impurity detected (µg):	8.20	313.10	
	Average concentration of impurity in ring blanks (ppmw):	0.1460	5.5756	5.7216
Al	Measured concentration of impurity in ash (µg/g):	1.56E+03		Al
	Weight of impurity detected (µg):	20.90	103.51	
	Average concentration of impurity in ring blanks (ppmw):	0.3722	1.8433	2.2155
Ti	Measured concentration of impurity in ash (µg/g):	2.74E+03		Ti
	Weight of impurity detected (µg):	36.76	39.90	
	Average concentration of impurity in ring blanks (ppmw):	0.6545	0.7105	1.3650
V	Measured concentration of impurity in ash (µg/g):	1.29E+02		V
	Weight of impurity detected (µg):	1.73	97.64	
	Average concentration of impurity in ring blanks (ppmw):	0.0308	1.7387	1.7695

Comments

Additional ring blank impurities greater than about 1 ppmw detected in ash: 78 ppmw Si, 4.5 ppmw Ba.
Data checked by FCM against the official results of analyses for RMAL3865 on 8/22/2011.

Fred C. Montgomery
Operator

9-1-2011
Date

Data Report Form DRF-44 Supplemental: Measurement of Impurities in Matrix Ring Blank Ash

Procedure:	AGR-CHAR-DAM-44 Rev. 0
Operator:	Fred Montgomery
Ring blank lot ID:	RDKRS-Machined
Ring blank lot description:	Rings machined from blanks made using matrix blend with Hexion Durite SC-1008 resin
Ring blank ID numbers:	Z022, Z023
DRF filename:	\\mc-agr\AGR\LeachBurnLeach\RDKRS-Machined_DRF44R0.xls

		From Ash Analysis	From Acid Leach	Revised Total
	Ash ID:	ASH 11071902		
	Number of ring blanks in sample group:	2		
	Total weight of ring blanks in sample group (g):	57.0		
	Total weight of residual ash (g):	0.013		
	Radiochemical laboratory analysis number:	3865-002		
U	Measured concentration of impurity in ash (µg/g):	3.28E+00		U
	Weight of impurity detected (µg):	0.04	0.52	
	Average concentration of impurity in ring blanks (ppmw):	0.0008	0.0092	0.0099
Fe	Measured concentration of impurity in ash (µg/g):	1.77E+02		Fe
	Weight of impurity detected (µg):	2.32	34.29	
	Average concentration of impurity in ring blanks (ppmw):	0.0407	0.6019	0.6426
Cr	Measured concentration of impurity in ash (µg/g):	1.26E+01		Cr
	Weight of impurity detected (µg):	0.17	2.54	
	Average concentration of impurity in ring blanks (ppmw):	0.0029	0.0447	0.0476
Mn	Measured concentration of impurity in ash (µg/g):	< 3.64E+00		Mn
	Weight of impurity detected (µg):	< 0.05	< 0.35	
	Average concentration of impurity in ring blanks (ppmw):	< 0.0008	< 0.0061	< 0.0070
Co	Measured concentration of impurity in ash (µg/g):	< 3.10E+00		Co
	Weight of impurity detected (µg):	< 0.04	< 0.39	
	Average concentration of impurity in ring blanks (ppmw):	< 0.0007	< 0.0068	< 0.0075
Ni	Measured concentration of impurity in ash (µg/g):	< 1.53E+01		Ni
	Weight of impurity detected (µg):	< 0.20	< 1.36	
	Average concentration of impurity in ring blanks (ppmw):	< 0.0035	< 0.0239	< 0.0274
Ca	Measured concentration of impurity in ash (µg/g):	4.85E+02		Ca
	Weight of impurity detected (µg):	6.35	257.94	
	Average concentration of impurity in ring blanks (ppmw):	0.1115	4.5281	4.6396
Al	Measured concentration of impurity in ash (µg/g):	1.31E+03		Al
	Weight of impurity detected (µg):	17.16	143.97	
	Average concentration of impurity in ring blanks (ppmw):	0.3013	2.5273	2.8285
Ti	Measured concentration of impurity in ash (µg/g):	2.14E+03		Ti
	Weight of impurity detected (µg):	28.03	46.52	
	Average concentration of impurity in ring blanks (ppmw):	0.4921	0.8167	1.3088
V	Measured concentration of impurity in ash (µg/g):	1.13E+02		V
	Weight of impurity detected (µg):	1.48	109.85	
	Average concentration of impurity in ring blanks (ppmw):	0.0260	1.9284	1.9544

Comments

Additional ring blank impurities greater than about 1 ppmw detected in ash: 80 ppmw Si, 1.8 ppmw Ba.
Data checked by FCM against the official results of analyses for RMAL3865 on 8/22/2011.

Frederick C. Montgomery
Operator

9-1-2011
Date

Data Report Form DRF-44 Supplemental: Measurement of Impurities in Matrix Ring Blank Ash

Procedure:	AGR-CHAR-DAM-44 Rev. 0
Operator:	Fred Montgomery
Ring blank lot ID:	RDKRS-Machined
Ring blank lot description:	Rings machined from blanks made using matrix blend with Hexion Durite SC-1008 resin
Ring blank ID numbers:	Z037, Z039
DRF filename:	\\mc-agr\AGR\LeachBurnLeach\RDKRS-Machined_DRF44R0.xls

		From Ash Analysis	From Acid Leach	Revised Total
	Ash ID:	ASH 11071903		
	Number of ring blanks in sample group:	2		
	Total weight of ring blanks in sample group (g):	57.0		
	Total weight of residual ash (g):	0.016		
	Radiochemical laboratory analysis number:	3865-003		
U	Measured concentration of impurity in ash (µg/g):	4.97E+00		U
	Weight of impurity detected (µg):	0.08	1.00	
	Average concentration of impurity in ring blanks (ppmw):	0.0014	0.0176	0.0190
Fe	Measured concentration of impurity in ash (µg/g):	< 6.40E+01		Fe
	Weight of impurity detected (µg):	< 1.03	<20.23	
	Average concentration of impurity in ring blanks (ppmw):	< 0.0181	< 0.3550	< 0.3731
Cr	Measured concentration of impurity in ash (µg/g):	6.08E+00		Cr
	Weight of impurity detected (µg):	0.10	1.72	
	Average concentration of impurity in ring blanks (ppmw):	0.0017	0.0303	0.0320
Mn	Measured concentration of impurity in ash (µg/g):	< 2.96E+00		Mn
	Weight of impurity detected (µg):	< 0.05	< 0.27	
	Average concentration of impurity in ring blanks (ppmw):	< 0.0008	< 0.0048	< 0.0056
Co	Measured concentration of impurity in ash (µg/g):	< 2.52E+00		Co
	Weight of impurity detected (µg):	< 0.04	< 0.24	
	Average concentration of impurity in ring blanks (ppmw):	< 0.0007	< 0.0042	< 0.0049
Ni	Measured concentration of impurity in ash (µg/g):	< 1.24E+01		Ni
	Weight of impurity detected (µg):	< 0.20	< 1.11	
	Average concentration of impurity in ring blanks (ppmw):	< 0.0035	< 0.0195	< 0.0230
Ca	Measured concentration of impurity in ash (µg/g):	3.42E+02		Ca
	Weight of impurity detected (µg):	5.51	357.73	
	Average concentration of impurity in ring blanks (ppmw):	0.0966	6.2772	6.3738
Al	Measured concentration of impurity in ash (µg/g):	1.16E+03		Al
	Weight of impurity detected (µg):	18.68	109.80	
	Average concentration of impurity in ring blanks (ppmw):	0.3277	1.9267	2.2544
Ti	Measured concentration of impurity in ash (µg/g):	7.42E+02		Ti
	Weight of impurity detected (µg):	11.95	42.18	
	Average concentration of impurity in ring blanks (ppmw):	0.2096	0.7402	0.9498
V	Measured concentration of impurity in ash (µg/g):	7.19E+01		V
	Weight of impurity detected (µg):	1.16	98.30	
	Average concentration of impurity in ring blanks (ppmw):	0.0203	1.7249	1.7452

Comments

Additional ring blank impurities greater than about 1 ppmw detected in ash: 89 ppmw Si, 1.6 ppmw Ba.
Data checked by FCM against the official results of analyses for RMAL3865 on 8/22/2011.

Frederick C. Montgomery
Operator

9-1-2011
Date

Appendix A. Revision Log

Table 7. Changes made in Revision 1

Pages	Description of change
4	Updated Table of Contents.
15	Modified last paragraph to reflect completion of ash residue impurity analysis.
33-38	Added Section 6 to report ash residue impurity analysis results.
39-47	Added Section 7 to report machined matrix ring impurity analysis results.
48	Added Appendix A to track changes.