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DOCUMENT NO BNWL-CC-253

C-91

PROJECT	DATE	SERIES AND COPY NO.
	September 15, 1965	[redacted]

BATTELLE-NORTHWEST

RICHLAND, WASHINGTON

ISSUING FILE

TITLE AND AUTHOR

LETTER TO G. MILAK
ARGONNE NATIONAL LABORATORY

D. W. BRITE

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R. F. Dickerson	30001	3001	SEP 22 1965	

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PACIFIC NORTHWEST LABORATORY
P.O. Box 999 Richland, Washington 99352
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Cable Address BATNORLAB

September 15, 1965

[redacted]

Argonne National Laboratory
9700 South Cass Avenue
Argonne, Illinois 60440

Attention: G. C. Milak

Dear Gus:

The attached Table I contains data regarding the W-UO_2 cermet fuel grids fabricated to date at Battelle-Northwest in support of the ANL program. All of the grids were furnace cooled from approximately 1100 C after impaction at 1600 C, except where indicated otherwise, and then stress relieved by heating in hydrogen at 100 C/hour to 1750 C, holding there for three to 12 hours and furnace cooling to room temperature.

The W particles used in six of the grids were Allied Chemical 100μ granules. The UO_2-W used for four of the grids were 55 vol% W-coated particles purchased from NUMEC. The UO_2-Gd_2O_3-W particles used for three of the grids were purchased from 3M, where they were processed as Lot Number RP-211-1. The UO_2-Dy_2O_3-W particles were also purchased from 3M, and were processed as Lot Number RP-211-2. The Gd_2O_3 and Dy_2O_3 stabilized particles contained a nominal 6.93 wgt% Gd_2O_3 and 7.13 wgt% Dy_2O_3 in the substrate phase before coating. The tungsten coating was 55 vol%. Analytical data available for the stabilized particles are shown in Table II.

All of the grids except Number 13 and Number 16 have been sent to ANL. We will send these as soon as we finish dissolving the molybdenum mandrels. We are still having difficulty dissolving the molybdenum from the longer grids.

Sincerely,
ORIGINAL SIGNED BY
D. W. BRITE

D. W. Brite
Ceramic Materials Development

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This document c[redacted] data as defined in the Atomic [redacted] transmittal [redacted] of its contents in any [redacted] to [redacted]uthorized person is prohibited.

DWB/af

Attachments: Table I
Table II

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[redacted] AUTOMATIC DOWNGRADING

G. Milak September 15, 1965

Distribution:

C-2 J. J. Dickson, ANL
C-3 J. F. Schumar, ANL
C-4 J. M. Musser, AEC, FLOO
C-5 J. M. Morrissey, USAEC, Washington, D.C.
C-6 F. W. Albaugh, BNW
C-7 D. R. de Halas, BNW
C-8 R. F. Dickerson, BNW
C-9 K. Drumheller, BNW
C-10 D. W. Brite, BNW
C-11 K. R. Sump, BNW
C-12 Central Files/7552

TABLE I

ANL CERMET GRID FABRICATION DATA

GRID NO.	PARTICLE TYPE	CAN TYPE*	CAN O.D. INCHES	CAN LENGTH INCHES	FINAL HOLE DIAMETER INCHES	FINAL LENGTH - INCHES	DISTANCE ACROSS FLATS, INCHES	IMPACT PRESSURE KPSI
1	W	A	2-1/2	4	0.080	1.561	1.970	286
2	W	B	2-3/8	4				
3	W	B	2-3/8	4				286
4	W	B	2-3/8	5	0.068	2.775	1.880	282
5	W	C	2-3/8	4-1/2	0.063	2.230	1.892	315
6	UO_2-W	C	2-3/8	4-1/2	0.068	2.346	1.875	308
7	UO_2-W	C	2-3/8	4-1/2	0.070	2.135	1.881	305
8	UO_2-W	D	2-3/8	4-1/2	0.072	2.610	--	254
9	W	D	2-3/8	4-1/2	0.070	2.367	1.905	306
10	UO_2-Gd_2O_3-W	C	2-3/8	4-1/2	0.069	1.921	1.850	310
11	UO_2-Dy_2O_3-W	C	2-3/8	4-1/2	0.071	2.225	1.870	310
12	UO_2-Gd_2O_3-W	C**	3	4-1/2	0.062	1.780	1.605	262
13	$UO_2Dy_2O_3$-W	C**	2-3/8	7	0.070	4.50	1.700	272
14	UO_2-W	C**	3	7	0.062	2.835	1.635	232
15	UO_2-Dy_2O_3-W	B**	2-3/8	4-1/2	0.065	2.065	1.600	272
16	$UO_2Gd_2O_3$ -W	C**	2-3/8	7				217

* A - Round ID can. Thin Mo hexagonal shim used to form outer grid shape.

B - Round ID can, converted to hexagonal ID with machined Mo slabs.

C - Hexagonal ID can machined from bar stock.

D - Round ID can. Hexagonal shape to be formed by machining after impaction.

** Impacted in 4 inch diameter die, using steel sleeve heated to approximately 900 C to fill clearance between billet and die.

TABLE I (Continued)

GRID NO.	TEMP. °C	GRID WEIGHT GRAMS	TAPER IF ANY, IN INCHES	HOURGLASS EFFECT, IF ANY, INCHES	CRACKS?	REMARKS
1	1600	792	0.030	None	No	Shows that thin (0.010") Mo can be impacted longitudinally without buckling.
2	1600				No	Lavite die liner allowed rapid ejection of impacted billet.
3	1600				No	First use of 0.060" diameter Mo mandrels. Shows that critical L/D ratio has not been exceeded.
4	1600	1540	0.005	0.010	No	Graphite die liner used caused greater cooling of impacted billet before ejection compared to lavite die liner.
5	1600	1234	0.011	0.017	Yes Circumferential Only	Pullout of W particles on sides due to prying Mo sides off before completely dissolved.
6	1600	1016	0.017	0.051	Yes Radial	Not furnace cooled due to billet sticking in die. Graphite die liner used.
7	1600	901	0.025	0.015	Yes Radial	Billet stuck in die, graphite die liner used.
8	1600	1385	None	0.020	Yes Radial	Lavite-copper foil die liner allowed easy ejection. Mandrel assembly twisted 3/8" during impaction.
9	1600	1352	--	--	No	Machined hexagonal surfaces grooved due to hourglassing of mandrel assembly.
10	1600	772	0.030	0.010	No	Rapid ejection. One of better grids.
11	1600	912	0.020	0.023	No	Rapid ejection. One of better grids.
12	1600	417	0.075	0.010	No	Leak in can bottom caused air drawn through can to entrain fuel particles. Consequentl billet was not completely filled when impacted, resulting in a badly distorted gr
13	1600	1403	0.070	0.020	No	Difficulties in dissolving the extra-long mandrels have resulted in acid attack of the grid.
14	1500	776		0.010	No	Grid is distorted due to same cause as Grid 12. 1500 C temp. was used because of trouble with heating equipment.
15	1600	580	0.005	<0.005	No	Very good hole straightness.
16	1600					Steel die liner was grooved on outer surface to cause greater length reduction of billet, thus maintaining correct grid dimensions.

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TABLE II

Substrate Data

$UO_2-Dy_2O_3$ - W

Uranium	81.53 w/o
Dysprosia	7.16 w/o
Density *	10.4 g/cc
O/U	2.04
Chlorine	< 5 ppm
Fluorine	< 5 ppm
Major to minor axis < 2:1	100 %
Lattice parameter	5.448 A

Spectrographic impurities (expressed in ppm)

Ag	< 1	Cr	< 10	Mo	50
Al	150	Cu	< 3	Ni	< 30
B	0.5	Fe	< 10	Si	70
Ca	< 30	Mg	10	Sn	< 3
Cd	< 1	Mn	< 3	Zn	< 70

Coated Data

Uranium	23.8 w/o
Density*	14.4 g/cc
Chlorine	35 ppm
Fluorine	5 ppm

Spectrographic impurities (expressed in ppm)

Ag	< 1	Cr	< 10	Mo	< 30
Al	< 30	Cu	30	Ni	< 10
B	< 1	Fe	< 10	Si	100
Ca	< 10	Mg	20	Sn	< 10
Cd	< 1	Mn	< 3	Zn	< 100

* Densities are determined by Mercury Porosimeter

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TABLE II (Continued)

Substrate Data

<u>UO_2-Gd_2O_3 - W</u>

Uranium	81.99 w/o
Gadolinia	7.01 %
Density *	9.8 g/cc
O/U	2.05
Chlorine	5 ppm
Fluorine	5 ppm
Major to minor axis < 2:1	100 %
Lattice parameter	5.453 A

Spectrographic Impurities (expressed in ppm)

Ag	< 1	Cr	< 10	Mo	40
Al	90	Cu	< 3	Ni	< 30
B	0.6	Fe	30	Si	50
Ca	< 30	Mg	5	Sn	< 3
Cd	< 1	Mn	< 3	Zn	< 70

Coated Data

Uranium	21.8 w/o
Density *	14.6 g/cc
Chlorine	80 ppm
Fluorine	5 ppm

Spectrographic impurities (expressed in ppm)

Ag	< 1	Cr	< 10	Mo	< 30
Al	30	Cu	20	Ni	< 10
B	< 1	Fe	< 10	Si	30
Ca	< 10	Mg	< 10	Sn	< 10
Cd	< 1	Mn	< 3	Zn	< 100

* Densities are determined by Mercury Porosimeter.