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E. I. du Pont de Nemours & Company
Explosives Department
Atomic Energy Division
Wilmington 98, Delaware

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UNCLASSIFIED MEETING AT BMI ON
ELECTROPLATING URANIUM FOR EXTRUSION CLADDING
November 8, 1956

On November 8, 1956, a meeting was held at BMI, Columbus, Ohio, for the following purposes:

1. To determine the best method of electroplating uranium cores for extrusion cladding;
2. To determine if there were any shortcomings in the SRL method of plating which could be the cause of the poor bonding experienced with internally extrusion-clad tubes;
3. To make what corrections and revisions were necessary in the SRL plating procedure to assure the optimum quality of nickel electroplate on the basis of present information.

SUMMARY:

There was a thorough review of the process employed by BMI, by SRL, by AECL, and by the Canada Bureau of Mines to electroplate approximately a 0.5 mil thick layer of nickel on uranium flat plate cores as a bonding layer for cladding with aluminum. SRL reviewed also the process currently employed by SEP to electroplate slugs.

SRL agreed that there was more smut and discoloration on their electroplate than on BMI plates. SRL deposited also a thinner plate (0.1 to 0.4 mils) than Battelle (0.5 to 0.8 mils). SRL surface activation was also more severe than necessary, and led to a rougher substrate onto which the nickel was plated; it was agreed that a smoother surface was better than a rougher surface to plate.

It was agreed that alkaline cleaning steps would be introduced at SRL to eliminate smut and discoloration; that surface activation would be modified still further to produce a smoother surface; and that the thickness of the plate would be increased over the average, and held more uniformly at nominal 0.5 mils (until some change in thickness is required).

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With respect to translating this procedure to tubes, it was the general agreement that tubes cannot be satisfactorily plated in the horizontal position, but must be plated vertically; this is essential for properly plating the inside surfaces. When plated vertically, the recommendations agreed upon, as outlined below, should produce satisfactory plating.

DISCUSSION:

Those present were:

<u>BMI</u>	<u>Graham, Crowley and Associates</u>	<u>AEC, SROO</u>	<u>du Pont</u>
R. J. Carlson	A. K. Graham,	T. B. Niland	C. C. McBride
C. J. Slunder	Consultant		R. C. May
R. J. Fiorentino			W. J. O'Leary
J. G. Beach			
	<u>AECL</u>	<u>Canada BuMines</u>	
	Ian Morrison	H. J. Weld	

It was understood by the participants that deviations in plating practices could have caused the different results obtained on clad plates as evaluated by bond strength tests and corrosion resistance; it was also understood that the greatest deviation in results that du Pont has encountered has been the bond strength of internally extrusion-clad tubular cores versus flat plate cores.

After discussing the reasons for the differences in techniques currently in use at the several sites, and the apparent consequences of these differences judged by appearance, behavior, bond strength, and the like, it was agreed by all that it was desirable to standardize. In the absence of uranium cores whose surface finish and surface quality are as assuredly reproducible as those of a commercial steel, it is important to eliminate as many variables as possible, to concentrate on uniform surface preparation, uniform surface cleaning, uniform adherence and thickness of nickel, and uniform quality of nickel plate. This will facilitate comparison of test data, and will permit later a more systematic and intelligent deviation from an established norm to satisfy the requirements of a particular site.

The standard electroplating procedure will be as follows, until sufficient cross-information has been developed to warrant changes:

1. Pre-clean

Vapor degrease in trichlorethylene.

Rinse, room temperature process water.

Pickle, HNO_3 11 $\pm$ 1N, 2-3 minutes at 60°-65°C (140°-150°F) to remove scale.

Rinse, room temperature process water.

2. Re-rack

Place in second stainless steel rack, with pointed stainless screw contacts, 2 on top, 3 on bottom. The entire rack is coated with "Parlon", which in turn is coated with 4 to 7 layers of "Microtex". Attach thieves separately to this rack.

3. Clean and Activate

Alkaline soak-clean. Use "Anodex", 75 gm/liter (10 oz/gal) 3 minutes at 80°C (180°F). Purpose: to prevent smut formation.

Rinse, process water at room temperature.

Anodic etch - H_3PO_4 , 5.5 M; HCl 0.2 M; 40-50 amps/ft² for 6-10 minutes at 40°-45°C (105°-125°F).

Pickle to remove oxide, HNO_3 11 $\pm$ 1 N at room temperature for 3 to 5 minutes, with agitation to provide against depletion of the HNO_3 .

Rinse - process overflow water; bring the core out through a spray of water. Avoid drag-out of HNO_3 into plating bath.

4. Electroplate, using high sulfate bath. It is not material if $\text{Na}_2\text{SO}_4 \cdot 7 \text{H}_2\text{O}$ or $\text{MgSO}_4 \cdot 7 \text{H}_2\text{O}$ is used. It is important to plate at a pH of 5.5 $\pm$ 0.1, at a current density of 15-16 amps/ft², and at 35°C $\pm$ 2°C (95°F $\pm$ 4°F). It is desirable to strike for a short time, depending on current density, at up to 30 amps/ft² if possible without burning the plate. Time of plating should be such as is required to deposit nickel 0.5 mil $\pm$ 0.1 mil thick. (Previous differences in plate thickness: BMI 0.5 mil minimum, 0.7-0.8 mil maximum at edges; SRL 0.4 mil maximum grading down to 0.1 mil, especially on tubes).

Rinse - cold process water.

5. Wash

Alkaline dip to prevent staining - use "Anodex", 75 gm/liter (10 oz/gal).

Rinse, cold process H₂O.

Rinse, hot deionized H₂O spray.

Forced hot air dry.

With respect to plating the inside of tubes, it was agreed by SRL, BMI, and Dr. Graham, all of whom had had the experience, that plating should be done vertically rather than horizontally. The above outlined cleaning and plating process should be used also on tubes.

WJO'L/hw

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