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Use of Hastelloy X-280 in Reactor Core Test Alternate
Conceptual Design

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DISTRIBUTION			ABSTRACT			
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	J. G. Asquith	LB02	A cursory investigation was performed to access the feasibility of using 20 mil thick Hastelloy X-280 cladding in place of the 32 mil thick Incoloy 800 in the conceptual core model for the Reactor Core Test. Fuel and cladding dimensions are presented as are the extrapolated changes in core excess and control worth.			
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I. INTRODUCTION

The effects on reactor excess reactivity and control worth caused by changing the cladding material from Incoloy 800 to Hastelloy X-280 were investigated in a cursory fashion. The ground rules for making the change were that the element-to-element pitch remains at 0.670 inches, as per the conceptual model design using Incoloy 800 cladding⁽¹⁾.

II. RESULTS

The effect on excess and control were estimated based on the method of Reference 2, with appropriate values being used for the worth of Hastelloy X-280. The worth of Hastelloy X-280 was estimated using the data of Reference 3 but at the anticipated specification limits for each of the constituents and impurities except nickel, which made up the balance of the alloy. The assumed composition of the Hastelloy X-280 is shown in Table I.

TABLE I
Assumed Hastelloy X-280 Composition and Component Worths
(15 mil thick cladding)

	<u>W/O</u>	<u>Worth(\$)</u>
Fe	20.0	.043
Cr	23.0	.239
Ni	45.299	.875
Mn	1.0	.173
Mo	10.0	1.186
B	.001	.046
Co	.2	.470
W	.5	.430
		<u>\$3.46 / core</u>

The fuel and cladding dimensions for the Hastelloy X-280 clad core are given in Table II. The external dimensions of the two zones of fuel elements are the same as those quoted in Reference 1. The estimated excess reactivity and control worth changes relative to the Reference Conceptual Model⁽¹⁾ are +\$3.88 in excess reactivity and -\$1.14 in control worth. Confirmation of these numbers would require detailed nuclear calculations.

TABLE II
Fuel Element Dimensions for Hastelloy X-280 Clad Elements

<u>Inner Zone</u>		<u>Outer Zone</u>
127	Number of Elements	168
0.670	Pitch*	0.670
-0.030	Spacing	-0.015
0.640	Cladding O.D.	0.655
-0.040	Cladding Thickness	0.040
0.600	Cladding I.D.	0.615
-0.016	Glass plus Gap Thickness	-0.016
0.584	Fuel O.D.	0.599
0.600	Cladding I.D.	0.615
0.040	Cladding Thickness	0.040
0.640	Cladding O.D.**	0.655
0.060	2* Fin Height	0.030
0.700	Fin Envelope Diameter	0.685

* All dimensions in inches, diametral

** Cladding O.D. = Neutral Element Envelope

It is fairly clear that the estimated change in control worth for the Hastelloy X-280 clad core is excessive relative to the estimated available control of approximately \$10.10⁽⁴⁾ for the reference Conceptual Model with the Flight Configuration reflector. The control worth could be enhanced by decreasing the hydrogen content of the fuel, although the magnitude of this trade has not yet been quantified. Solely on the basis of the additional excess reactivity available, it would be possible to reduce

the $(H/Zr)_{eff}$ from the current level of 1.81 to approximately 1.67.

III. ALTERNATE METHODS OF CHANGING TO HASTELLOY X-280

At least two other approaches to change in cladding material were considered. In the first, the cladding thickness was increased while maintaining the 0.670 inch pitch until the excess reactivity was approximately the same as for the reference Conceptual Model. Increasing the cladding thickness to 25 mils while correspondingly reducing the fuel diameter makes the Hastelloy X-280 clad core \$0.53 more reactive than the reference model. The effect on drum worth was estimated to be -\$0.67 relative to the reference model.

The other approach considered was to use 20 mil thick Hastelloy X-280 but to decrease the fuel element pitch to maintain the excess reactivity of the reference model. The preliminary estimates indicate that a pitch of 0.630 inch with appropriate changes in fuel diameter, vessel dimensions, etc., will give a net reactivity change of about -\$0.12 relative to the reference Conceptual Model and a change in control worth of +\$0.26. This approach would require change of the dimensions of many of the internal and external core components such as grid plates, internal reflectors, core vessel, reflector dimensions, control drum radius, etc.

IV. CONCLUSIONS AND RECOMMENDATIONS

The results indicated herein are preliminary in nature and need the benefit of confirmatory APC calculations of both excess reactivity and drum worth. It is believed that the trends indicated are accurate. A change to Hastelloy X-280 cladding could be made while maintaining the pitch constant at 0.670 inches. Such a change would cause the minimum number of changes to other core components and could be accomplished at a much later date and lower cost (then) than a modification involving a fuel element pitch change. If a change in cladding material is seriously contemplated, it should be made as soon as possible so the appropriate changes in pitch may also be incorporated into the design, rather than having to make the change within the constraint of the current 0.670 inch pitch.

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