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HANFORD ATOMIC PRODUCTS OPERATION - RICHLAND, WASHINGTON

TIME-TEMPERATURE BEHAVIOR OF FUEL ELEMENTS DISCHARGED TO AIR - CVI FUEL ELEMENTS

F. R. Zaloudek

JUN 6 1961
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HW-67747 Sup 1

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TIME-TEMPERATURE BEHAVIOR OF FUEL ELEMENTS
DISCHARGED TO AIR - CVI FUEL ELEMENTS

The report HW-67747 Rev 1 was concerned with the time-temperature transient for K-III fuel elements which fail to enter the basin following their discharge from the reactor, and, more specifically, it was concerned with the time required for the aluminum cladding to reach its melting temperature following this incident. It was stated in that report that the results presented were typical for K-III and O-II fuel elements. The purpose of this supplement is to report the results of an extension of this investigation to CVI overbore fuel elements.

Using the techniques discussed in HW-67747 Rev 1, time-temperature relations for the discharge to air of an 18-piece CVI charge were calculated considering tube powers ranging from 1200 KW to 2000 KW in 100 KW increments. Only the fuel elements in the region of maximum thermal neutron flux were considered, and, for this purpose, a peak to average specific heat generation ratio of 1.42 was assumed. Various discharge times were considered ranging from discharge during equilibrium to that occurring approximately 200 hours following the reactor shutdown. Uranium exposure of 4 months was assumed.

The results of these calculations are demonstrated graphically in Figure 1. They show that the CVI fuel elements which were exposed in the region of maximum heat generation during normal operation at tube powers of 1200 KW, 1400 KW, 1600 KW, and 1800 KW and discharged to air during operation will undergo a loss of the jacket due to melting in less than 308, 200, 210, 181, and 169 seconds respectively. If discharged 62 hours, 94 hours, 129 hours, 160 hours, and 195 hours following shutdown from operating levels characterized by the respective tube powers mentioned above, the fuel elements will probably not suffer any jacket melting, however, temperatures approaching the melting point of aluminum will be experienced during the resulting temperature transient.

The effects of the use of fog spray upon the temperatures attained by the fuel elements were also investigated. It was determined that the application of 0.5 inches per minute of fog was sufficient to almost immediately arrest the temperature rise of the fuel element, and if applied when the temperature of the fuel element approaches that of melting aluminum, it will effect a reduction in temperature to a value below 212 F in approximately 5 to 10 minutes.

Although the main purpose of this investigation was to determine aluminum jacket melting times, fragmentary indications of uranium melting times were obtained during the calculations. These have been included as Table I.

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The results presented in this supplement may be applied to other charge lengths of CVI fuel elements by the technique described in HW-67747 Rev 1.

Acknowledgement is given to G. R. Sparks, Process Engineering Operation, Process Technology Subsection, IPD for assistance in the calculation of the results reported herein.

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TABLE I
TIME INTERVAL REQUIRED FOR A FUEL ELEMENT
DISCHARGED TO AIR TO ATTAIN URANIUM MELTING TEMPERATURE

<u>Tube</u> <u>Power</u> <u>KW</u>	<u>Time of Discharge</u> <u>After Shutdown</u> <u>Hr.</u>	<u>Time Interval</u> <u>To Melt Uranium</u> <u>Sec.</u>
1200	0	1053
	1	(No Melting)
1300	0	880
	1	(No Melting)
1400	0	760
	1	2826
	2	(No Melting)
1500	0	669
	1	2076
	2	(No Melting)
1600	0	598
	1	1763
	2	2790
	4	(No Melting)
1700	0	541
	1	1554
	2	2194
	4	(No Melting)
1800	0	494
	1	1399
	2	1894
	4	(No Melting)
1900	0	454
	1	1276
	2	1687
	4	2636
2000	9	(No Melting)
	0	420
	1	1176
	2	1530
	4	2220
	8	(No Melting)

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