CONF-841105--12 CONF-841105--12

DE84 014752

SEVEN PIN BUNDLE FAST TOP TESTS L01 AND L02*

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Tests L01 and L02 were the first two seven pin bundle tests in the PFR/TREAT program of fuel failure tests carried out jointly by the US and the UK. The two tests were on bottom plenum annular pellet mixed oxide fuel clad in 316 stainless steel. L01 used fresh fuel, while L02 used PFR irradiated 4% burn-up fuel, to determine any differences in the failure mechanism and subsequent fuel behavior due to irradiation. They were performed in flowing sodium in the Mark IIIA version of a TREAT integral loop. Both were fast transient overpower (TOP) tests intended to simulate 5 $/s reactivity ramp hypothetical accidents in a large fast reactor.

The test objectives were to obtain information on fuel motion in the central hole before failure, the time and location of cladding failures, and material motion in the channel after failure, having particular regard to the effect of irradiation. L01 and L02 are the seven pin counterparts to the C01 and C02 single pin capsule tests described in Ref. 1; seven pins in flowing sodium being a more representative environment for post failure events. The C01 and L01 tests have been described in a previous paper[2].

The power transients consisted of power plateaux of approximately 4 secs duration - to establish nominal operating conditions - followed by power bursts to 27 (L01) and 29 (L02) times the plateau power respectively. The power transients were planned to provide the same energy input to the pins in

* Work performed under the auspices of the U. S. Department of Energy.

both tests (Figure 1).

Cladding failure is indicated by measured pressure spikes and flow excursions. In fresh fuel (L01) cladding failure did not occur until 60 ms after peak power, but in irradiated fuel (L02) failure occurred 20 ms before peak power.

Fuel motion during the test was recorded by the hodoscope. In L01 the time of first fuel movement agrees with the time of failure indicated by the flowmeters and pressure transducers, but in L02 the first fuel movements were detected by the hodoscope 130 ms before the signals on flowmeters and transducers. The initial dispersal as seen by the hodoscope was different in the two tests, but the final fuel configuration seen in the hodoscope scan was similar in fresh fuel (L01) the loss was mainly from the top half of the pin bundle but in irradiated fuel (L02) it was mainly from the bottom half of the pin bundle.

The posttest examination has shown no major differences between fresh and irradiated fuel in the extent of fuel disruption, cladding failure, and flow-tube failure (all approximately the upper 2/3) under these conditions. Upper and lower metal blockages were formed in both tests.

Analysis has been carried out in the UK with TRAFIC, PINEX-AR, SABRE, and SIMMER codes, and in the US with the COBRA and FSTATE codes. The analysis has shown that the failure of fresh fuel pins can be predicted on the hypothesis of "melt through", and the failure of irradiated pins on the basis of cladding strain under internal pressure. These results are consistent with the corresponding single pin tests (C01, C02), and provide further support to the view that these fuel failure models are appliable to the reactor situation. The onset of boiling was neither calculated nor observed until after these failure times.

The tests have shown that fuel motion from both fresh and irradiated fuel pins is dispersive under these conditions. Reactivity worth calculations based on hodoscope results show that reactivity decreased by about 10% following cladding failure - slower in the case of irradiated fuel (Figure 2).

In summary, tests L01 and L02 produced cladding failures well explained by current models, and substantial decreases in fuel reactivity worth due to post-failure fuel dispersion. This encourages the view that such accidents would be self terminating.

References

1. Wood, M. H. et al., The PFR/TREAT Capsule Experiments C01, C02 and C03. This Session.

2. Tylka, J. P. et al., PFR/TREAT C01 and L01 Experiments, Proceedings of the L.M.F.B.R. Safety Topical Meeting, July 23, 1982 - Lyon - Ecully France, Vol. 4, P 439.

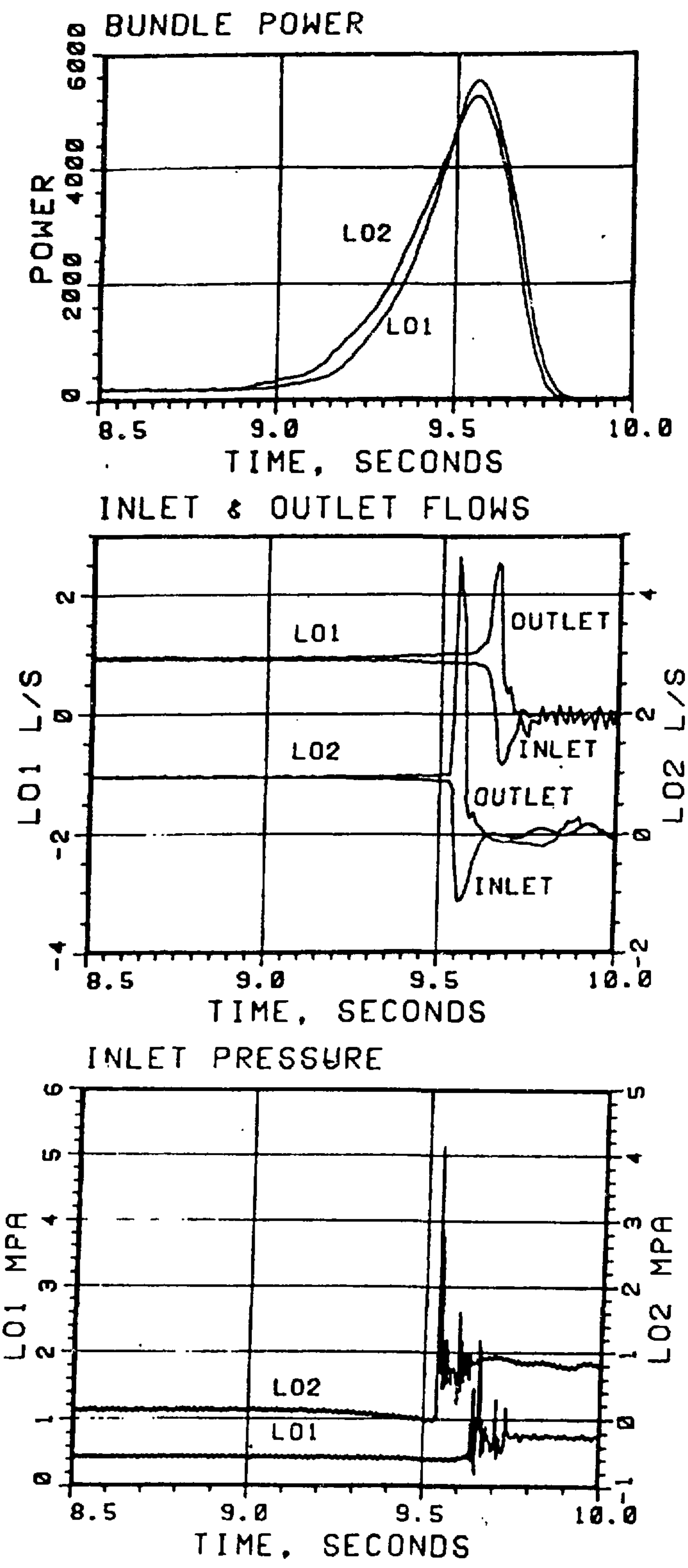

FIG. 1. SELECTED LO1 AND LO2 RESULTS

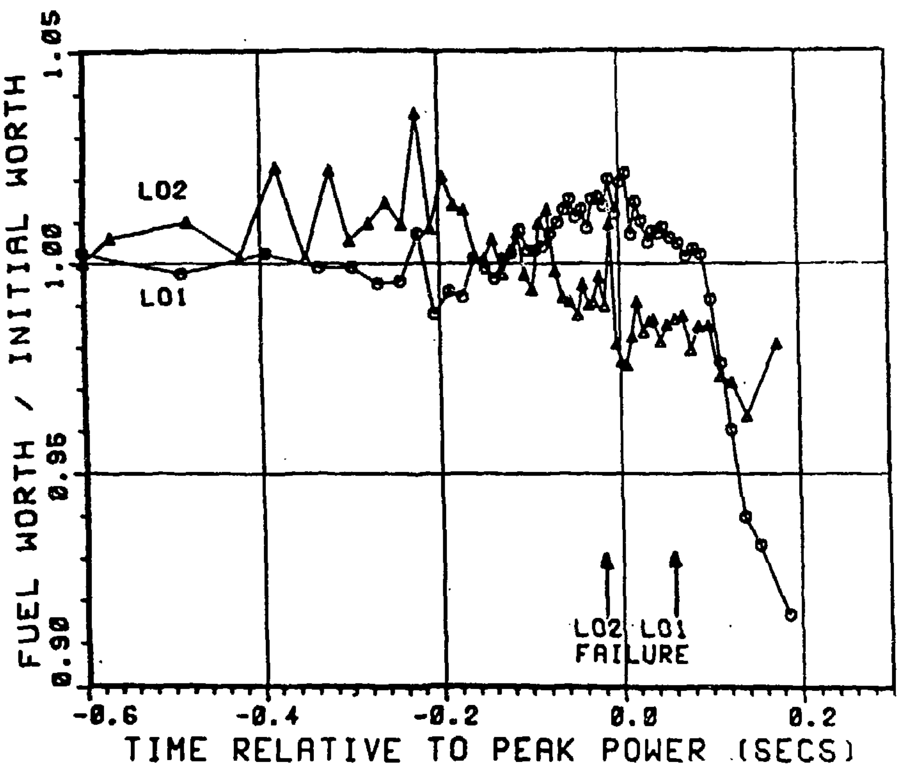

FIG. 2 REACTIVITY WORTH CHANGES AT PIN FAILURE