HUMAN RADIATION EXPERIMENTS

RECORDS PROVENANCE FORM

REPOSITORY NAME	INEL
COLLECTION NAME	Technical Reports & Meetings
BOX NUMBER	2884 Folder: W. E. Kessler, G. F. Brockett, and G. E. Bingham "Zirconium-Hydride Fuel Behavior in the SNAPTRAN Transient Tests"
ADDITIONAL LOCATION INFORMATION	FRC BOX# 71 A488
FILE TITLE	Zirconium-Hydride Fuel Behavior in the Snaptran Transient Tests
TOTAL PAGES	
BATE NUMBER RANGE	
DOCUMENT NUMBER RANGE	

HEI Form Document No.:
Document No.:
Document Title:
Cross references:
Items of Interest:

726931

ZIRCONIUM-HYDRIDE FUEL BEHAVIOR

IN THE

SNAPTRAN TRANSIENT TESTS

By

W. E. Kessler

G. F. Brockett

G. E. Bingham

Phillips Petroleum Company
Atomic Energy Division
Idaho Falls, Idaho

REPOSITORY INEL

COLLECTION Idaho Nuclear Corp., Aerojet Nuclear Company, and EG&G Tech. ~~Information Section Reports & Tech.~~ Pubs
INEL Box# 2084

BOX No. FRC #100764; Acc.# 71 A 488

FOLDER ZIRCONIUM-HYDRIDE FUEL BEHAVIOR IN THE SNAPTRAN TRANSIENT TESTS

1186436

For Presentation at the Summer Meeting of the
American Nuclear Society
June 20-23, 1966
Denver, Colorado

ZIRCONIUM-HYDRIDE FUEL BEHAVIOR IN THE SNAPTRAN TRANSIENT TESTS

By

W. E. Kessler *
G. F. Brockett *
G. E. Bingham *

Phillips Petroleum Company
Atomic Energy Division
P. O. Box 2067
Idaho Falls, Idaho

Number of Pages: 3

* Member, American Nuclear Society

1186437

ZIRCONIUM-HYDRIDE FUEL BEHAVIOR IN SNAPTRAN TRANSIENT TESTS

SUMMARY

Zirconium-Hydride-Uranium (ZrH_x-U) fueled reactors of the type represented by the SNAP 10A/2 and SNAP-8 aerospace reactors contain within the fuel matrix chemically bound hydrogen which serves not only as an effective moderator allowing the use of non-hydrogenous coolants, but also serves as an intrinsic safety mechanism to limit the energy release from inadvertant nuclear excursions.

The SNAPTRAN-3 test, performed in April 1964, consisted of rapid introduction of reactivity by immersion of the reactor in water without the beryllium reflector. The principle purpose of the test was to provide information concerning the transient power and fuel behavior and the release of fission products from the fuel. The SNAPTRAN-1 non-destructive kinetics testing program, performed in late 1964 and 1965 on a modified SNAP 10A/2 reactor, was aimed at providing data and information on the dynamic power response and fuel behavior as a function of the amount of reactivity added and the initial fuel temperature. The SNAPTRAN-2 test, conducted on January 11, 1966, was a continuation of the SNAPTRAN-1 program into the destructive region and provided additional information concerning the negative reactivity feedback coefficients, the nature of fuel disassembly and fission product release.

The results of the three test series (1)(2)(3)(4) provided information concerning the thermally induced prompt negative temperature coefficient and fuel behavior of importance in assessing the safety of this type reactor. The negative reactivity coefficient was determined

1186438

to be 12 ± 1 cents/MW-sec and to be essentially constant during a power excursion for fuel temperatures ranging from ambient temperature to 1900°F. At about 1900°F the hydrogen is disassociated from the fuel lattice at a sufficient rate to initiate fuel disintegration resulting in complete core disassembly. With these data, it is possible to accurately predict the transient behavior and therefore the safety of the system.

The behavior of the zirconium-hydride fuel material as determined during the SNAPTRAN testing program indicates that for SNAP 10A/2 type reactors, inadvertant reactivity excursions below 1.7 dollars are non-destructively self-limited by the inherent temperature dependent negative reactivity feedback mechanisms; and that for excursions resulting from essentially any amount of reactivity above 1.7 dollars, the inherent disassembly characteristics of this type fuel limit the energy release to well below 100 MW-seconds.

In the water immersion test, the temperature of the fuel particles immediately following initiation of disassembly was rapidly reduced by the quenching effect of water environment. Rapid cooling of the fuel limited the release of noble gases and their daughters to the environment from the fuel to less than 5% of that available in the fuel. The iodine release from the fuel was limited to less than 13% of that available, however, due to the scrubbing effect of the water, less than 0.1% escaped from the water to the atmosphere. On the other hand, in the air environment test, fuel disintegration was accompanied by hydrogen-oxygen combustion and rapid burning of a large portion of the fuel, resulting in particle temperatures in excess of 3000°F. These high temperatures enhanced the release of fission products. Approximately

1186439

100% of the noble gases and their daughters and 50% of the available iodine were released to the atmosphere.

The mechanical behavior of the hydride fuel material was found from the SNAPTRAN-2 destructive test to be predictable with a simple two-dimensional model employing temperature driven gas expansion and mass acceleration considerations. The negative reactivity feedback of the SNAP 10A/2 type reactors was determined for a variety of reactivity and temperature conditions from the SNAPTRAN testing program. This reactivity feedback is large and essentially constant over a wide range of reactor periods and allows a high degree of accuracy in the prediction of the transient behavior of the zirconium-hydride fueled reactors. Armed with an understanding of both the nuclear and mechanical behavior over a wide range of temperatures and energy deposition rates, the analysis of the kinetic behavior of zirconium-hydride fueled reactors can be performed with a high degree of confidence and accuracy.

---

(1) W. E. Kessler, O. L. Cordes, G. A. Dinneen, R. D. Fletcher, and G. F. Brockett, "SNAPTRAN 2/10A-3 Destructive Test Results", IDO-17019 (January 1965).

(2) K. A. Dietz, E. W. Mellow, "Quarterly Technical Report, July - December, 1964", IDO-17077 (March 1966).

(3) H. D. Curet, ed., "Quarterly Technical Report, January-March, 1965", IDO-17126 (March 1966).

(4) K. A. Dietz, ed., "Quarterly Technical Report, April-June, 1965", IDO-17145 (April 1966).

1186440