A Preliminary Analysis on Safety Effect of Downgraded Heavy Water of a Research Reactor

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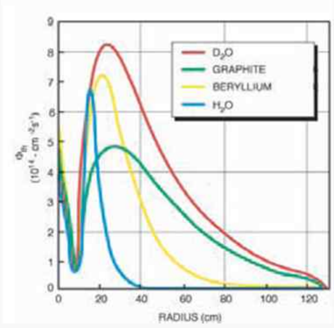
I. Introduction

- **Heavy water, which is an effective moderator with low absorption cross section, is used as a reflector in a Research Reactor (RR).**
- **reflector is installed around reactor core submerged in reactor pool: light water is coolant that is stored in reactor pool.**
- **Failures such as pipe ruptures in heavy water system inside reactor pool introduce an issue concerned with power control.**



An Example for FRM-II Core Condition (IAEA Tec. Report Series 455, p. 217)

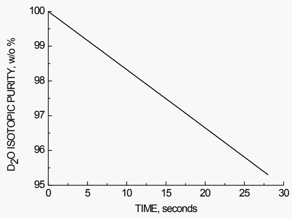
II. Short Description of Sequence of Operation

- **In auto control mode, power of RR is controlled by neutron detectors installed around reflector.**
- **When a leakage in HWS inside pool, light water ingresses inside reflector tank: quality of reflector downgraded.**
- **Huge difference in neutron absorption CX between D2O and H2O induce loss of neutron flux even though thermal power unchanged.**
- **Reactor regulating system will identify this loss of flux as loss of power. RRS will immediately respond in order to compensate power loss in auto mode.**
- **Reactor power will start to increase continuously as quality of heavy water.**
- **Of trip parameters, high neutron power cannot be used due to faulty reading. Instead high gamma power in Reactor Protection System will be used to recognize this power transient.**

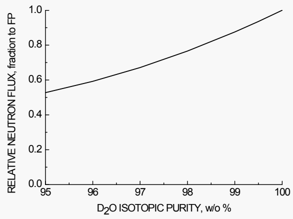
Time (sec)	Event	Remarks
0	A pipe rupture inside pool	Initial power
~	Power reached to setpoint	Protection System
	Trip actuated, rod released	Delay 1. Trip 2. Inactivate magnet
6	Negative reactivity inserted	Peak of CHFR, PCT

III. Numerical models and Assumptions

- **First, amount of light water as a function of time: rated flow rate is selected as rate of change in quality in a conservative manner.**
- **Second, neutron flux at detector location is calculated.**
- **n reactor power to be followed will be calculated by combining downgrading of heavy water and reduction of neutron flux.**

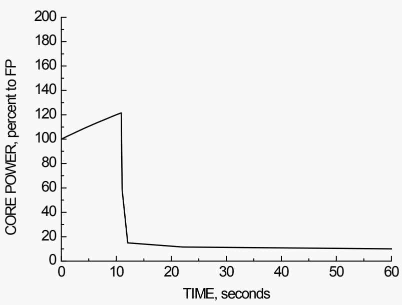


< Effect of Ingress of H2O on purity >

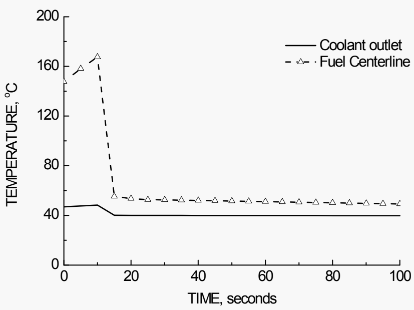


< Neutron flux to purity >

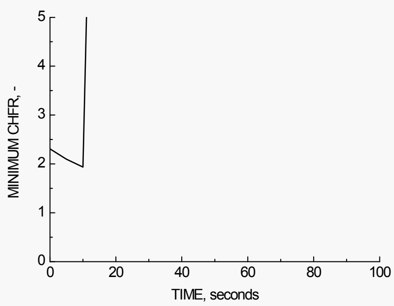
IV. Results and Conclusions



< Core power >



< Temperature transient >



< Minimum CHFR>

- **A PIE related to the power control introduced by downgraded heavy water was analyzed by simulating the reactor transient with the RELAP code.**
- **The fuel integrity was shown to be assured using the RPS.**

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