THE DEVELOPMENT OF A TRIP MAP FOR THE MCMASTER NUCLEAR REACTOR

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All nuclear reactors in Canada are required to have effective trip parameters which will initiate reactor shutdown during events that challenge fuel cooling. To satisfy this requirement, analysis is performed for accident and upset events occurring from various initial power levels and range of event severity. For each initiating event and all initial power levels, at least one trip parameter should be effective to safely shutdown the reactor. For power reactors the results of this analysis are summarized in a graphical diagram referred to as a trip map which shows the range of power levels and initiating event severity for which individual trip parameters are effective.
Unique to research reactors, the McMaster Nuclear Reactor (MNR) is developing such a trip map. Development of this map requires modeling a fuel element using the point kinetics program PARET and modeling the response of the reactor shutdown system.

Description of Reactor

Commissioned in 1959, the MNR is a pool-type reactor. Pool-type reactors immerse the core within a pool of light-water. The pool's water serves as a part of the primary core cooling circuit and as the neutron moderator for the fission reaction.

The core uses an arrangement of plate-type fuel elements made of light enriched uranium. The core is capable of up to 5MW thermal with a neutron flux of $1x10^{14}$ n/cm^{2}s. The core heat is removed under forced convection to a water-to-water heat exchanger and the secondary coolant circuit ultimately disposes of the heat in a water-to-air heat exchanger. During the lack of forced convection, the reactor core is designed to accommodate natural convection of the pool water.

MNR is primarily used for the production of medical radioisotopes and neutron radiography, but also plays a role on the McMaster campus as a research reactor. The reactor's "medium" strength neutron fields, of up to $4x10^{13}$ n/cm^{2}s, are used by the engineering, health physics, biology, chemistry and medicine departments for research and instruction.

Procedure to Develop Trip Map

Trip maps are a visual representation of the initial reactor power level at the beginning of a reactivity insertion event, the rate of reactivity insertion, and a description of the shutdown system which prevents overpower or physical damage in such a combination of power and insertion.

In order to develop the trip map, a simulation program called PARET will be used. PARET is a coupled thermalhydraulics and point kinetics model. In order to simulate the reactor core under a reactivity event, one fuel element will be modeled. Monitoring the neutron power of the fuel element in PARET at various initial powers and insertion rates, while having knowledge of the MNR's trip characteristics, the map will be generated after many PARET runs.

This results obtained from this procedure will be developed into report form and submitted to the Canadian Nuclear Safety Commission for review and eventual approval as part of the MNR safety report. The CNSC will use the trip map to confirm that the MNR is equipped to deal with reactivity changes at any initial power level.