Headline: Viewpoint - The failure of Maple

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The article on the Maple reactors is an accurate reflection of events (Maple cancelled by David Mosey, NEI August 2008, p5). One statement in particular, however, leaves an incorrect impression. It was claimed that, according to a joint statement by Canadian natural resource minister Gary Lunn and health minister Tony Clement, "the Maple project underwent a number of tests between January and April, which all failed."

As the manager of nuclear commissioning on the project as well as being one of the early physicists on the project, I have to say that the tests did not fail. The tests achieved their objectives. The purpose of the tests was to evaluate the contributions to the positive power coefficient of reactivity (PCR) from various sources. The onus for understanding the effect was put on AECL by the regulator. Furthermore, the regulator was not as open-minded as another comment in the article might imply regarding the safety issues, because a safety case could be made for operation even with the positive PCR.

In pursuit of understanding the PCR, three potential contributing phenomena had been identified: bowing of the highly enriched targets; bowing of the low enriched driver fuel; and impaired flow of water between the reflector tank wall and the adjacent flow tubes. Measurement tests were carried out prior to these three tests to establish that the situation had not changed in the preceding period of shutdown - ie they established the baseline for the measurements. The first test, aimed at evaluating the contribution from the Mo-99 production targets, showed a 30% reduction in the magnitude of the PCR. This test replaced the targets with low-enriched driver fuel bundles. So, the 30% reduction cannot be taken as the definitive contribution from the targets because another potential contributor was being used in the test. The definitive value of the contribution from targets would not be available until all three tests were completed.

The second test in the series was evaluating the potential contribution to the positive PCR from heating of the recirculating water between the reflector tank wall and the adjacent flow tubes. The water had been clearly shown to be recirculating in an out-of-reactor full scale hydraulic test rig. It was not possible, however, to measure the temperature of the water in these 6mm wide gaps around the periphery of the core while the reactor was operating, ie we did not have any indication of what the water temperature actually was. If the water in the gaps was heating up by 15 degC, this would have provided another 30-50% of the positive PCR effect. The test with remediated water flow measured no change in the PCR, ie the recirculating water was in fact providing adequate cooling. This test was carried out as the second in the series because it could be implemented more easily than the modifications to the fuel bundles to inhibit bowing of the fuel elements (test 3).

It is at this point that the project was terminated. The preparations for the modified fuel bundles were well advanced, having been carried out in parallel with the modifications to remediate the gap water flow. I point out that an outward deflection of a fraction of a millimetre of the Maple fuel elements in the fuel bundles, due to asymmetric heating, would account for 100% of the remaining positive contribution of the PCR.

That this bowing could take place was an engineering issue that was easily solvable. The Korean research reactor Hanaro is based on Maple technology. Hanaro has a negative PCR of the value that we calculated for Maple. The Hanaro fuel is also produced by AECL. There are, however, subtle differences in the two fuel designs that arose due to early fuel vibration concerns in the Hanaro design. The fuel vibration issue had been solved by one means for Maple while for Hanaro the fuel was modified and

made stiffer. The stiffer fuel bundle design plus a slightly different distribution of the fuel meat, led to a reduction in the amount of fuel element bowing combined with a reduced impact of any fuel bowing that might take place.

I repeat: the tests did not fail. The tests were measuring contributions from various sources and the test series was interrupted and terminated prematurely. The Maple reactor design is probably the safest reactor design in existence since it actually has three shutdown systems, two fast and one slower. In the strange world of reactor licensing, credit in safety analysis is taken only for the second trip on the slowest shutdown system, thus ignoring the two fast systems completely. The Maple reactor operated like a dream and was/is fully capable of meeting all objectives. All you have to do is finish the last test or put Hanaro-design fuel in it.

Some may regard this assumption as speculation. They are entitled to their opinion. However, my group had calculated the potential contributions from the bowing of LEU elements for Maple and Hanaro and the reduced impact of bowing of elements of the Hanaro fuel design is not speculation. How much bowing actually takes place is an extremely difficult calculation and the result depends strongly on assumptions of the end restraints. Furthermore, it would have been possible to improve the early calculation that under-reported the amount of LEU bowing that takes place. This work also was in progress. In the end, the only definitive measure, when you are at the edge of what is possible to calculate, is to do the test.