Comment on "Time-Independent Neutronic Analysis of the Chernobyl Accident"

The paper by Landeyro and Buccafurni on the Chernobyl accident[1] was very interesting, but it would have been better if Ref. 24 in it had read: M. RAJAMÄKI and F. WASASTJERNA, *Nucl. Sci. Eng.*, **101**, 41 (1989). This work is publicly available, unlike a private communication, and in addition, mentioning only my name obscures the contribution of Dr. Rajamäki: Investigating the reactivity effects of cooling caused by fuel fragmentation in the Chernobyl accident was his idea; I carried out the calculations. Of course, since our paper appeared only a few months before Landeyro and Buccafurni submitted theirs, it is understandable that it may have been too late for inclusion among their references.

Landeyro and Buccafurni wrote[2]: "The increase in the water/fuel ratio can lead to an initial growth in reactivity...." If this refers to our work, it appears to be a misunderstanding. What we found was that a decrease in the total density of the homogenized fuel-and-water mixture initially led to increased reactivity, which we attributed to decreased resonance absorption. This should be clear from the paper by Rajamäki and me, but I may, of course, have expressed myself unclearly in the private communication referred to by Landeyro and Buccafurni.

More importantly, I was gratified to note that Landeyro and Buccafurni used a realistic ^{135}Xe concentration in their calculations. This is a point that would have deserved more emphasis, since it may not be widely known that the void coefficient of an RBMK reactor depends strongly on the ^{135}Xe concentration in the fuel. Xenon-135 absorbs neutrons mainly below 0.1 eV, and the hardening of the thermal spectrum with increasing void shifts neutrons out of this range, resulting in decreasing absorption in the ^{135}Xe. This makes the void coefficient significantly more positive at high ^{135}Xe concentrations.

A rough quantitative estimate of the above effect, based on CASMO-HEX calculations, is provided in Table I. According to this, going from no xenon to 2.267 times the steady-state concentration (a rough estimate of what the concentration may have been at the time of the accident) increases the change in k_∞ from complete voiding by ~70%. (Here, k_∞ was used rather than k_{eff} because k_∞ gives more insight into local physics.) Admittedly, Table I should not be taken too seriously because CASMO-HEX is unreliable for RBMK calculations above ~50% void (the method of calculating the resonance absorption uses an approximation that is invalid in this range), but it does indicate the importance of using a realistic value for the ^{135}Xe concentration.

TABLE I

Effect of the ^{135}Xe Concentration on the Void Coefficient in an RBMK Reactor

^{135}Xe Concentration Relative to Steady State	Δk_∞ on Increase of Void	
	0 to 50%	0 to 100%
0.000	0.00948	0.01016
2.267	0.01114	0.01752
4.534	0.01250	0.02350

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REFERENCES

1. P. A. LANDEYRO and A. BUCCAFURNI, *Nucl. Sci. Eng.*, **108**, 126 (1991).

2. P. A. LANDEYRO and A. BUCCAFURNI, *Nucl. Sci. Eng.*, **108**, 142 (1991).

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I thank F. Wasastjerna very much for his comments on our paper, and I apologize for not mentioning M. Rajamäki's name.

The work[1] we referred to is a Nuclear Energy Agency Committee on Reactor Physics report that, as is well known, can only be referenced as a private communication. The quoted sentence is the last in a paragraph that lists some phenomena which occur during fuel bursting and their contrasting effects on reactivity.

The work of Rajamäki and Wasastjerna and the Ref. 23

paper,[2] as well, were mentioned in reference to analysis of the assumed second peak and its cause. Both references, together with Ref. 25 (Ref. 3), were used as previous logic steps to introduce our calculations.

That statement is a survey of our "mind model" of this hypothetical second part of the Chernobyl accident, which we conceived before the calculations. At that time, we thought that this part of the accident had developed in two phases. During the first phase, the interaction of molten particles and water produces sudden vaporization and an increase in void fraction, thereby increasing reactivity, while during a second phase, the steam slows the UO_2 particles, resulting in a lack of fissile material responsible for the reactivity decrease.

During the transition between the two phases, a positive and a negative reactivity insertion mechanism coexist: Vaporization is still present, increasing the reactivity, while the resonance integral of ^{238}U grows, decreasing the reactivity.

The sentence "The increase in the water/fuel ratio can lead to an initial growth in reactivity..." means that we considered that the vaporization effects might overcome the effects from the increase in resonance integral at the very beginning of the transition.

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1. F. WASASTJERNA, TRC, Finland, Private Communication (1987).

2. F. REISCH, *Nucl. News*, **30**, 67 (Dec. 1987).

3. M. SOBAJIMA and T. FUJISHIRO, *Nucl. Eng. Des.*, **106**, 179 (1988).