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The Solution High Energy Burst Assembly (SHEBA) at Los Alamos is a low enriched (4.95 wt. %) aqueous uranyl fluoride solution critical assembly. There are two SHEBA configurations, both consisting of right circular cylinders with a central control rod. The first configuration, hereafter called the old SHEBA, had a fuel solution diameter of 54.6 cm and a measured critical solution height of 36.5 cm. An improved modification, hereafter called the new SHEBA, has a fuel solution diameter of 48.9 cm but since it is not yet operational, the critical solution height has not yet been measured. In this presentation we describe the application of the discrete ordinates (S_N) code TWODANT[1] using Hansen Roach cross sections[2,3] and the MCNP Monte Carlo code[4] using continuous energy cross sections for calculating the critical solution heights for both the old and new SHEBA assemblies. We compare the code's predictions and show that a single calculation with a standard computer code may yield misleading results, especially when using a Monte Carlo code.

Initially, calculations were made on the old SHEBA with the reported critical solution height of 36.5 cm. TWODANT with Hansen Roach cross sections gave a k_{eff} of 0.998 and MCNP yielded a k_{eff} of 1.0059 ± 0.0022. These results appeared to be in excellent agreement with the experimental k_{eff} = 1.00. Calculations were then made on the new SHEBA with a predicted critical solution height of 44.0 cm. TWODANT yielded a k_{eff} of 0.9996 and MCNP gave a k_{eff} of 1.0031 ± 0.0029. Again the agreement between the two codes (and cross section data) appeared to be excellent.

We then made additional independent calculations with MCNP in which the starting random numbers were changed and, in some cases, the number of active cycles and number of histories per cycle were also changed. The results of these calculations are shown in the table. These results indicate that for both the old and new SHEBA, the initial MCNP k_{eff} 's appear to be on the low side of the overall uncertainty range in k_{eff} . They also show that there can be a ***subconscious*** bias in the person performing the calculations. In the initial runs we were expecting a k_{eff} of unity, so we tended to mentally accept the results (within one sigma of unity) as confirming that MCNP did, in fact, agree with what we ***wanted*** the answer to be. In actuality, the MCNP results indicate a predicted k_{eff} closer to 1.01 than to 1.00 for both SHEBAs. While these differences in k_{eff} may not seem significant, they translate into noticable differences in critical height of the solution. For the old SHEBA, MCNP predicts a critical height of about 35.5 cm instead of 36.5 cm; for the new SHEBA, MCNP predicts a critical height of about 42 cm instead of 44 cm. The differences between the TWODANT and the MCNP predictions are, in fact, differences due to differing cross sections, that is, differences between Hansen Roach 16 group data and ENDF/B-V continuous energy data.

The results of this work point out several items of interest. First, one must be very careful in interpreting a Monte Carlo result reported as $k_{eff} \pm 0.008$. It seems to be human nature to focus on the value of k_{eff} . We may recognize that there is an uncertainty band associated with that value of k_{eff} , but we usually still think in terms of the value of k_{eff} . It is suggested by the author that one develops the habit of thinking (and reporting) Monte Carlo k_{eff} as simply "k_{eff} lies between k1 and k2" where k1 is, perhaps, $k_{calc} - 2\sigma$ and k2 is $k_{calc} + 2\sigma$. In actuality, this is all that we can say about the k_{eff} from a Monte Carlo calculation. Second, it is interesting to see that with the old SHEBA, the Hansen Roach cross sections predict the actual critical height quite well while the ENDF/B-V cross sections tend to underpredict the actual critical height. For the new SHEBA the predicted critical solution height for the Hansen Roach cross sections is similarly greater than that predicted from the ENDF/B V cross sections used by MCNP. It will be interesting to see what the actual experimental critical height is in the new SHEBA. Finally, we note that while the k_{eff} values for a given solution height differ by less than 1 % between Hansen Roach and ENDF/B V cross sections, the difference in solution height is pronounced – about 1 2 cm.

MCNP Results for Old SHEBA (36.5 cm height) & New SHEBA (44.0 cm height)

Run	Old SHEBA		New SHEBA	
	No. Active Histories	$k_{eff} \pm \sigma$	No. Active Histories	$k_{eff} \pm \sigma$
Initial	150,000	1.0020 ± 0.0022	100,000	1.0034 ± 0.0029
1	100,000	1.0027 ± 0.0026	100,000	1.0088 ± 0.0024
2	100,000	1.0062 ± 0.0026	100,000	1.0127 ± 0.0028
3	50,000	1.0072 ± 0.0031	100,000	1.0069 ± 0.0012
4	50,000	1.0095 ± 0.0038	100,000	1.0093 ± 0.0013
5			200,000	1.0069 ± 0.0018
6			200,000	1.0100 ± 0.0018

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